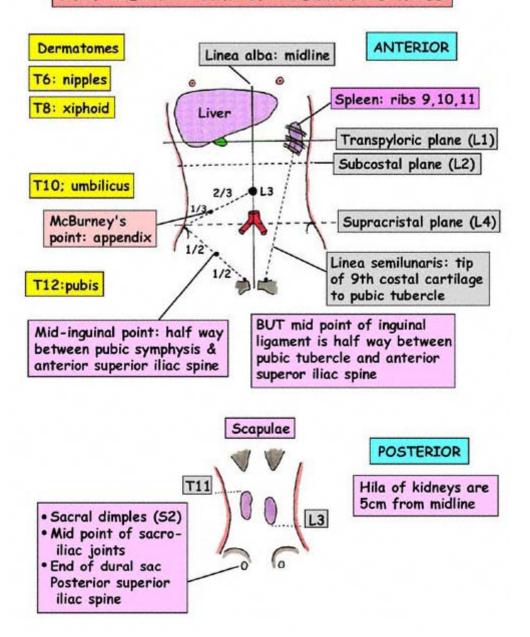
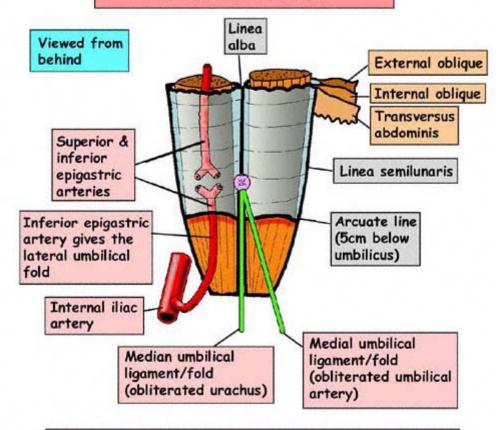


#### SURFACE ANATOMY OF ABDOMINAL WALL

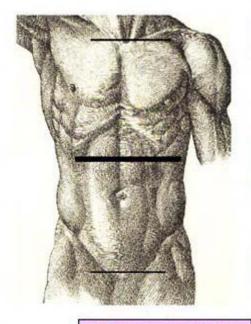


# POSTERIOR RECTUS SHEATH & UMBILICAL FOLDS



Note: There are three folds but only two ligaments. The inferior epigastric artery raises a fold of peritoneum but clearly is not a ligament

## TRANSPYLORIC PLANE



Suprasternal notch (T2/3)

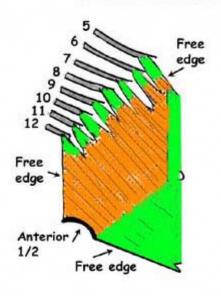
Transpyloric plane (L1) (1/2 way between)

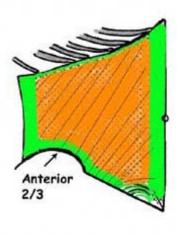
Pubic symphysis

#### On transpyloric plane

- L1 vertebra
- Pylorus
- Hila of kidneys
- Duodenojejunal flexure
- Fundus of gall bladder
- Neck of pancreas
- Origin of portal vein
- Transverse mesocolon
- 2nd part of duodenum
- Origin of superior mesenteric artery
- · Hilum of spleen
- · 9th costal cartilage
- End of spinal cord (just below)

# ABDOMINAL WALL MUSCLES EXTERNAL & INTERNAL OBLIQUE





EXTERNAL OBLIQUE From: anterior angles of last 8 ribs

To: xiphisternum, linea alba, pubic symphysis & crest, inguinal ligament,

anterior 1/2 iliac crest.

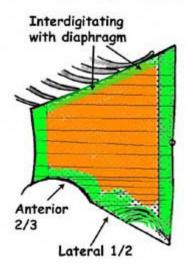
Downward/medial

N: T7-12

INTERNAL OBLIQUE
From: anterior 2/3 iliac
crest, lateral 2/3 inguinal
ligament, lumbar fascia
To: costal margin, rectus
sheath & linea alba.
Conjoint tendon to pubic
crest and pectineal line.
Upward/medial
N: T7-12, ilioinguinal

to conjoint tendon

## ABDOMINAL WALL MUSCLES TRANSVERSUS, RECTUS ABDOMINIS, PYRAMIDALIS



#### TRANSVERSUS ABDOMINIS

From: costal margin, lumbar fascia anterior 2/3 iliac crest, lateral 1/2 inguinal ligament To: rectus sheath & linea alba. Conjoint tendon to pubic crest & pectineal line Transverse
N: T7-12, ilioinguinal to conjoint tendon

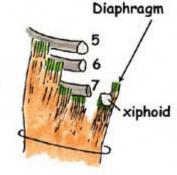
#### RECTUS ABDOMINIS

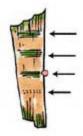
From: pubic crest, tubercle & symphysis To: costal cartilages 5,6,7, costal margin of 7, sternum & diaphragm

N: T7-12

N: 1/-12

(note: 3 morphological layers)



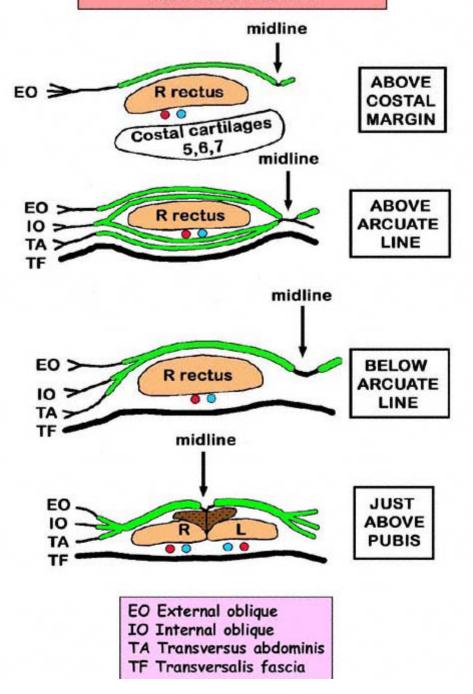


3 Tendinous intersections (rarely 4) Fusion to anterior sheath

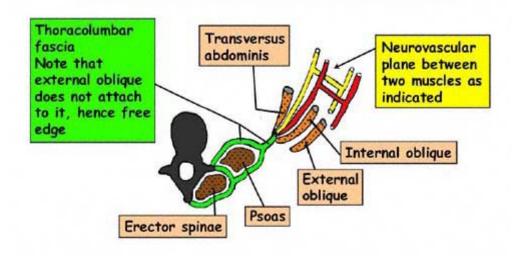
PYRAMIDALIS
From: front of
body of pubis
To: linea alba
N: T12 (subcostal)

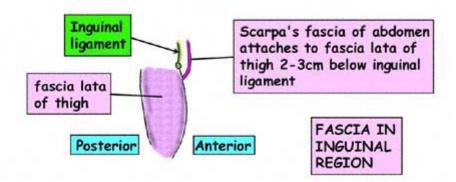


# ABDOMINAL WALL MUSCLES RECTUS SHEATH

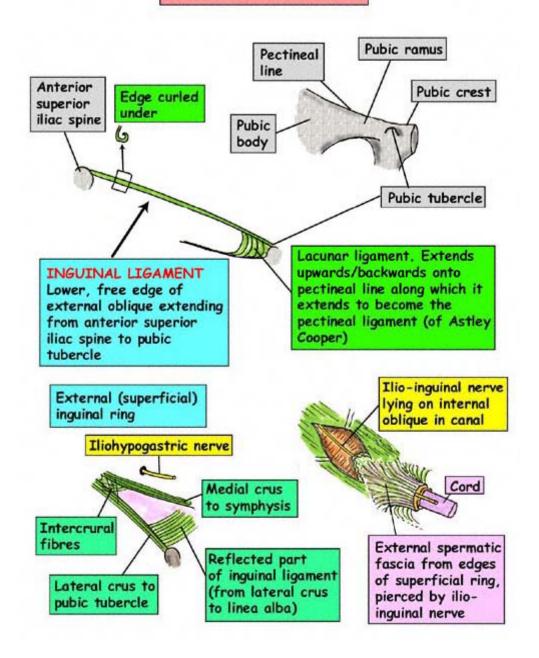


## ABDOMINAL WALL - THORACOLUMBAR FASCIA, NEUROVASCULAR PLANE & FASCIA OVER INGUINAL REGION

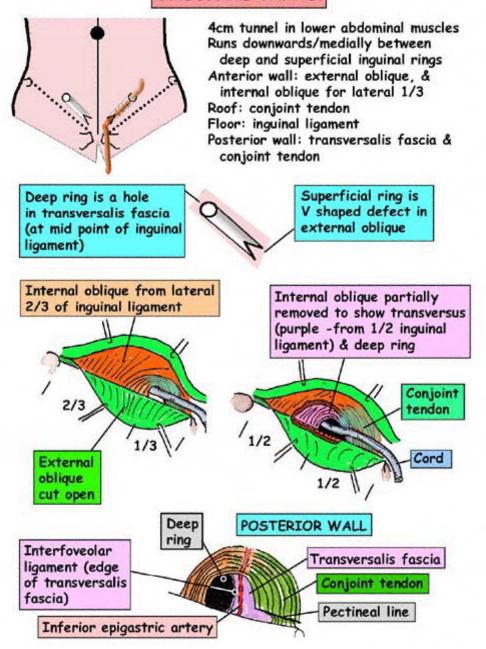




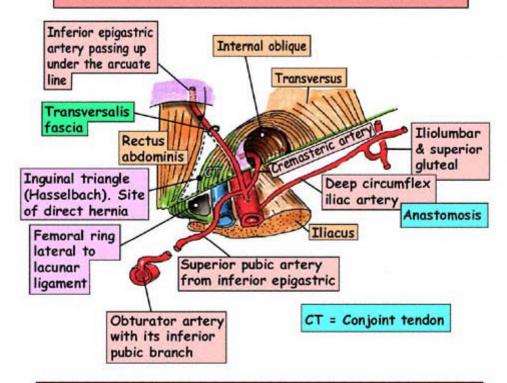
## INGUINAL LIGAMENT



### INGUINAL CANAL



# ABDOMINAL WALL RIGHT DEEP INGUINAL RING FROM INSIDE



Note: If the obturator artery is missing then the superior pubic branch of the inferior epigastric takes over. This artery is then called an abnormal (aberrent) obturator artery. Whether or not an abnormal obturator artery is present, the superior pubic branch of the inferior epigastric may run anteromedial to the sac of a femoral hernia in the femoral ring. If so, it can easily be damaged during a hernia repair. In this illustration it runs posterolateral and is thus not a hazzard

## SPERMATIC CORD

#### VIA THE DEEP INGUINAL RING

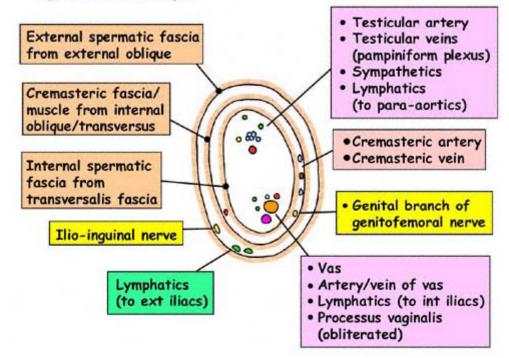
- · Vas
- · Artery to vas (inferior vesical)
- Testicular artery (aorta)
- Cremasteric artery (inferior epigastric) Cremaster muscle
- Cremasteric vein (inferior epigastric)
- · Testicular vein (IVC/left renal)
- Obliterated processus vaginalis
- Lymphatics
- Sympathetics
- · Genital branch of genitofemoral nerve (L2) Supplies motor to cremaster, sensory to fascia, tunica, scrotal skin, round ligament & labia majus

#### IN CANAL

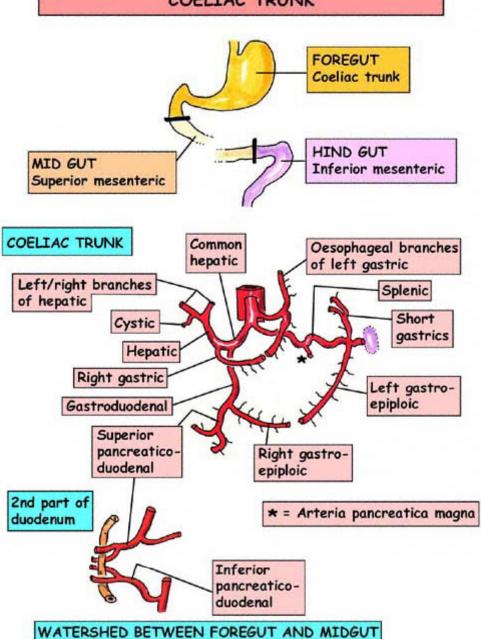
- · All these
- Internal spermatic fascia
- · Cremasteric fascia
- · Ilio-inquinal nerve

#### OUTSIDE SUPERFICIAL RING

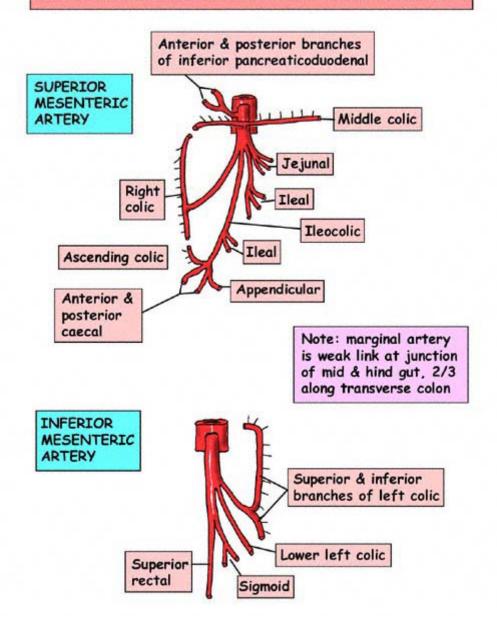
- · All these
- External spermatic fascia



## PRINCIPLES OF BOWEL ARTERIAL SUPPLY COELIAC TRUNK



## SUPERIOR & INFERIOR MESENTERIC ARTERIES



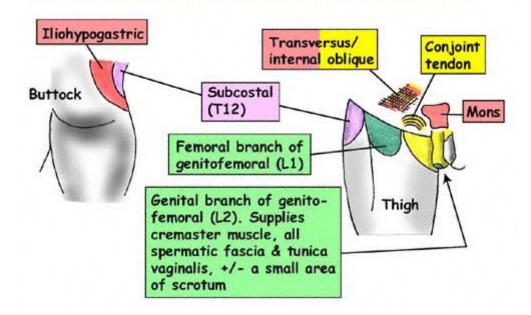
## ILIOHYPOGASTRIC, ILIO-INGUINAL & GENITOFEMORAL NERVES

#### ILIOHYPOGASTRIC NERVE

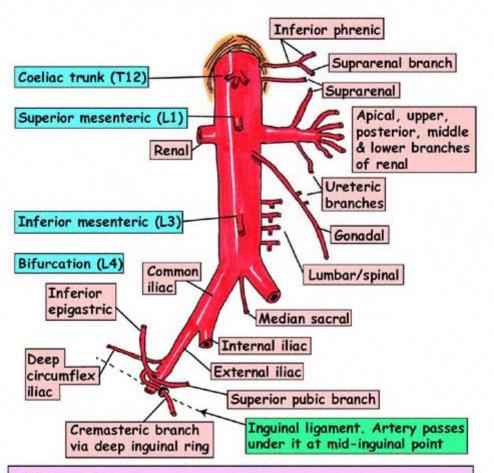
- · Main branch of L1
- · Sensory and motor
- · Pierces internal oblique above anterior superior iliac spine
- · Pierces external oblique above superficial inguinal ring
- Supplies: Upper buttock (lateral cutaneous branch)
  - Transversus & internal oblique (lowest fibres)
  - ·Skin of mons pubis

#### ILIO-INGUINAL NERVE

- · Muscular collateral branch of L1
- Motor and sensory
- · Pierces internal oblique above anterior superior iliac spine
- Supplies: Transversus & internal oblique (lowest fibres)
  - · Conjoint tendon
- Then enters inguinal canal from above/lateral and leaves via superficial inquinal ring
- Supplies: Upper medial thigh, anterior 1/3 scrotum, labia majora and root of penis



## ABDOMINAL AORTA AND RIGHT EXTERNAL ILIAC ARTERY

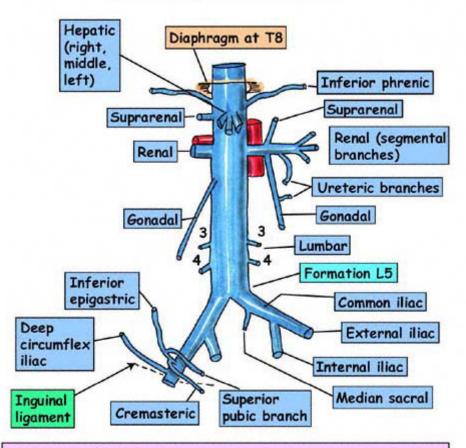


#### Relations of aorta

Left lateral: sympathetic chain. Right lateral: IVC, Cysterna chyli Both lateral: Azygos veins, para-aortic nodes, coeliac ganglia Anterior: Pancreas, splenic vein, left renal vein, 3rd part duodenum, mesentery, nodes, autonomic plexus, lesser sac, stomach, omentum, small bowel

Posterior: T12-L4, left lumbar veins

## INFERIOR VENA CAVA



Relations of IVC

Anterior: Bile duct, liver, opening of lesser sac,1st/3rd parts

of duodenum, head of pancreas, small bowel, right common iliac artery, root of mesentery, right

gonadal artery, portal vein

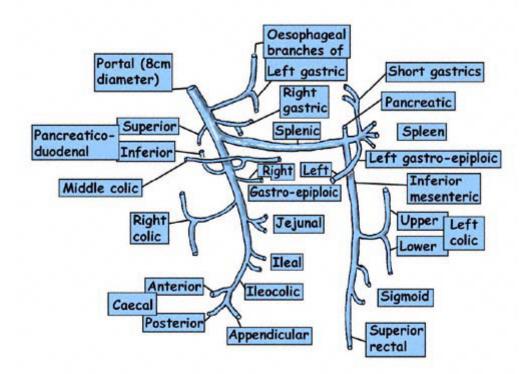
Posterior: Right renal artery, lumbar arteries, right crus of diaphragm, right suprarenal & its artery, bodies of L3,4,5, right psoas, right sympathetic chain, right

coeliac ganglion

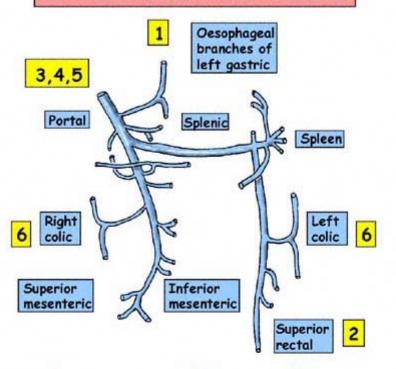
Note: NO tributaries from gut

## HEPATIC PORTAL SYSTEM

- · Drains venous blood from:
  - Whole bowel from lower 1/3 oesophagus to upper anal canal Spleen, pancreas, gall bladder
- To: Liver sinusoids
- Formed by: Superior mesenteric & splenic behind neck of pancreas. Inferior mesenteric joins splenic at variable distances along it



## PORTOSYSTEMIC ANASTOMOSES



#### 1 Lower oesophagus

Portal: Oesophageal branches of left gastric veins Systemic: Azygos veins

#### 2 Upper anal canal

Portal: Superior rectal vein Systemic: Middle/inferior rectal veins

#### 3 Umbilical

Portal: Veins of ligamentum teres

Systemic: Superior/inferior epigastic veins

#### 4 Bare area of liver

Portal: Hepatic/portal veins Systemic: Inferior phrenic veins

#### 5 Patent ductus venosus (rare)

Postal: Left branch of portal vein

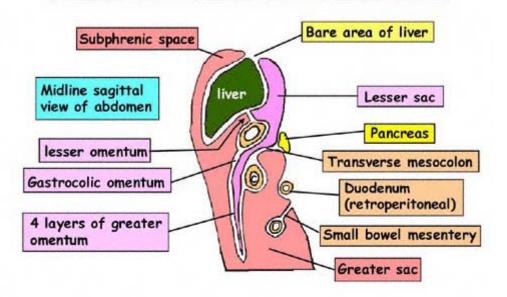
Systemic: Inferior vena cava

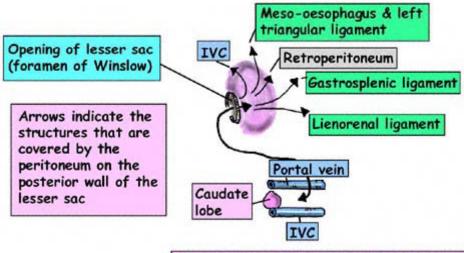
#### 6 Retroperitoneal

Portal: Colonic veins

Systemic: Body wall veins

#### PERITONEAL CAVITIES AND LESSER SAC

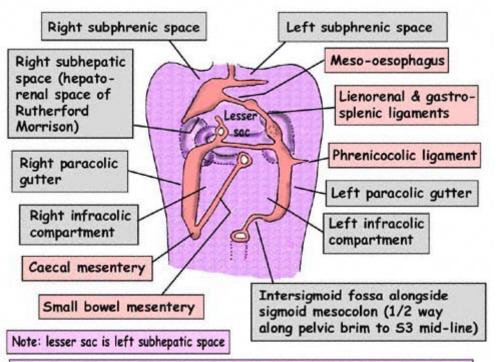




Foramen (above) viewed from in front and foramen (below) viewed the right side

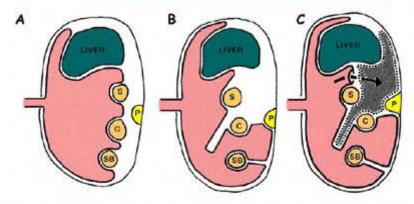
## ATTACHMENTS OF MESENTERIES WITH BOWEL EXCISED

The purpose of this diagram is to illustrate the width of the 'bare area' of peritoneum that would be left on the posterior abdominal wall if the bowel was excised. If the pink area is narrow then the bowel was on a mesentery. If it is wide then the bowel was retroperitoneal. Note that the majority of the duodenum has been left undisturbed



Note: Small bowel mesentery runs from the left L2 transverse process to the right sacro-iliac joint (S2). It is 6 inches (15cm) long and crosses left psoas, aorta, IVC, right psoas, right ureter, right common iliac bifurcation & into right iliac fossa

## DEVELOPMENT OF LESSER SAC

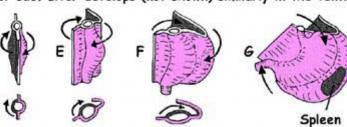


Pretend a large balloon is inserted into the abdomen via the umbilicus (A) & inflated to cover contents. It extends around liver but is prevented from completely surrounding it by attachments of inferior vena cava - hence bare area. It covers stomach (S), colon (C) & small bowel (SB). Between stomach & colon there is a prolapse of peritoneum - greater omentum.

Small bowel moves forwards (B), & its covering peritoneum is dragged with it to give a mesentery. Stomach rotates so that its right side is now facing posteriorly (E, F, G). Peritoneum that was on its right side (grey) expands behind stomach to give lesser sac. It pushes up behind liver, covered posterior wall of stomach, upper wall of transverse colon & 1/2 pancreas. It also pushes between layers of greater omentum to give 4 layers.

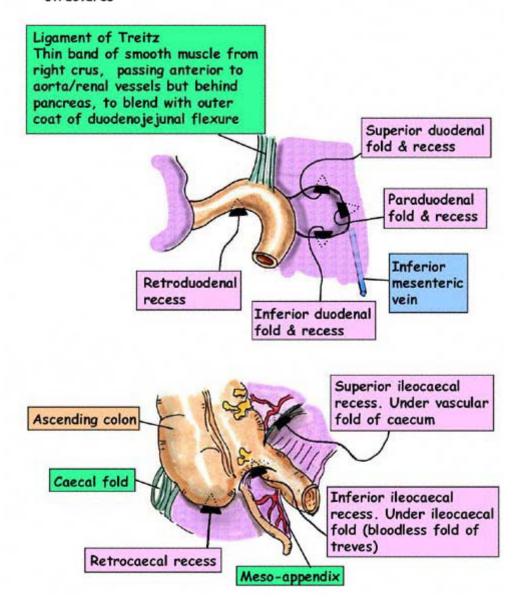
Access to lesser sac becomes a small hole (C) as the stomach rotates in coronal plane (G). The hole is posterior to lesser omentum & is aditus (opening) of lesser sac/foramen of Winslow/epiploic foramen. Lesser omentum is remnant of ventral mesentery (D, E, F, G) joining stomach to liver (C).

Note: Spleen forms in dorsal mesentery of stomach (G) & thus is in far left wall of lesser sac. Liver develops (not shown) similarly in the ventral mesentery.

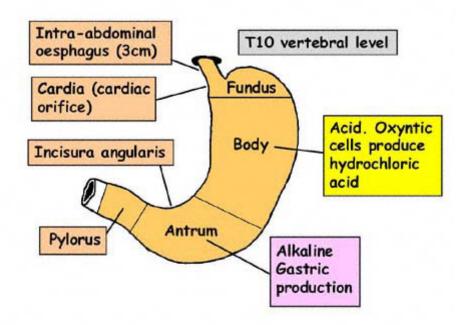


## PERITONEAL RECESSES

There are a number of small recesses, as shown below, that are potential areas for internal herniation of bowel or other structures



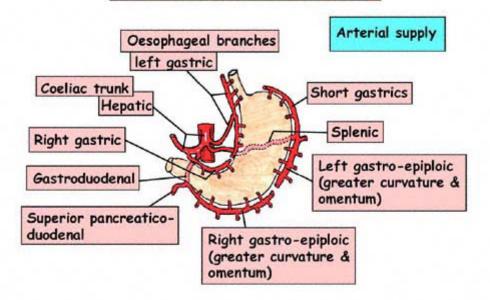
# STOMACH - TOPOGRAPHY & OESOPHAGOGASTRIC JUNCTION

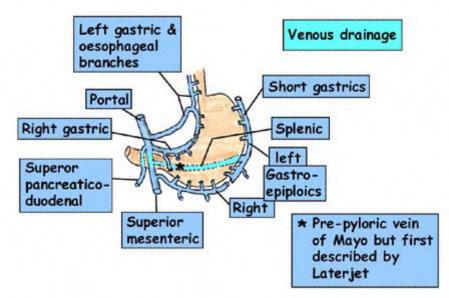


## Oesophagogastric junction

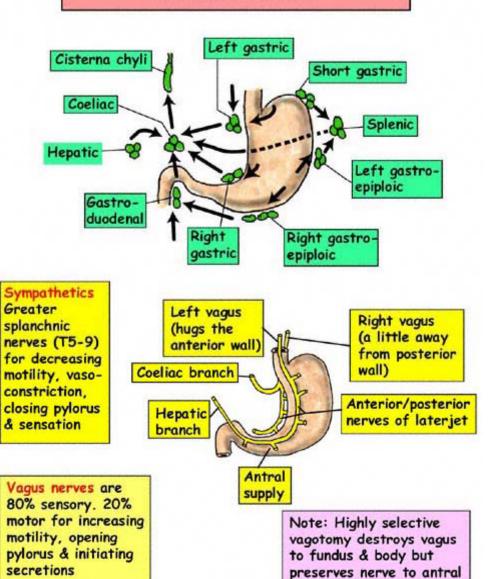
- Effective sphincter/valve because:
- · Circular fibres in diaphragm, right crus and oesophagus
- Phrenico-oesophageal ligament (fold of connective tissue)
- · Angle of junction
- Mucosal folds
- Intra-abdominal pressure acting to compress the intraabdominal oesophagus

## STOMACH - BLOOD SUPPLY & VENOUS DRAINAGE





## STOMACH - LYMPHATIC DRAINAGE & NERVE SUPPLY

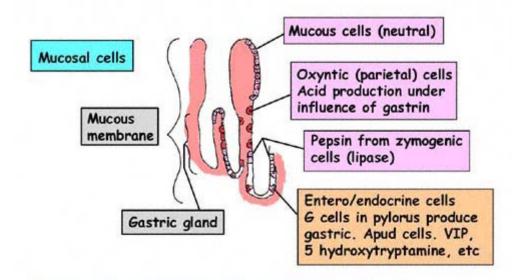


pump

#### STOMACH - MUSCLE COATS & CELLS

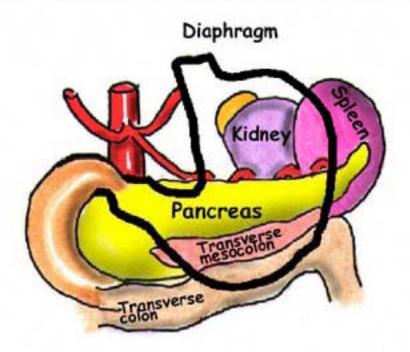


- Outer longitudinal
- · Inner circular
- Incomplete oblique innermost
- Mucosal rugae caused by muscle fibres



Note: The following are produced from the cells of the stomach; Pepsin, hydrochloric acid, gastrin, intrinsic factor, somatostatin, serotonin and endomorphin

## STOMACH - RELATIONS



## ANTERIOR

Abdominal wall Left costal margin Diaphragm Left lobe of liver

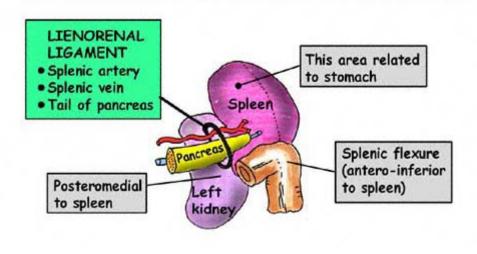
#### SUPERIOR

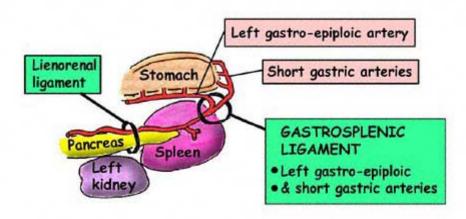
Left dome of diaphragm

### POSTERIOR

Lesser sac
Pancreas
Transverse mesocolon
Transverse colon
Left kidney/suprarenal gland
Spleen/splenic artery

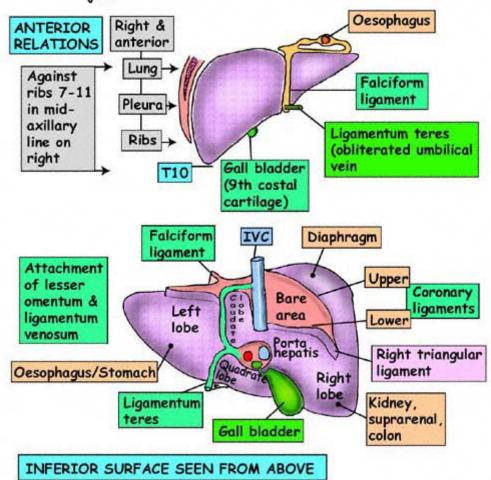
## LIENORENAL & GASTROSPLENIC LIGAMENTS





#### LIVER - GENERAL DESCRIPTION

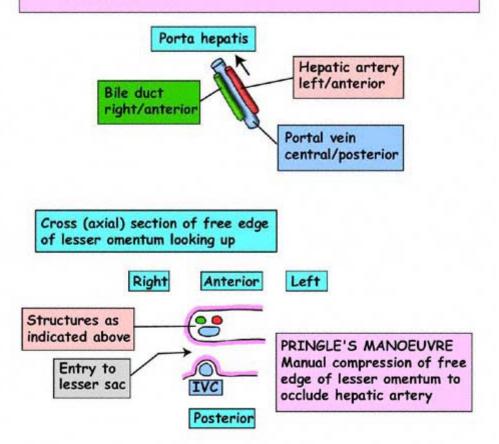
- Wedge shaped largest organ in body Weight 1500g
- 1500 blood flow per minute (30% of cardiac output)
- Lies: Right-6-10 ribs/costal cartilages; Left-6-7 costal cartilages
- Surfaces: anterior, superior, posteror, right all smooth/conves
   Postero-inferior (visceral) concave & features ++
- Supports: IVC & hepatic veins (+ ligamentum teres & peritoneum)
- Nerve supply: Right vagus via coeliac ganglia, left directly to porta hepatis. Sympathetics on vessles
- Reaches: T5 vertebra, nipples (5th intercostal space), xiphisternal joint



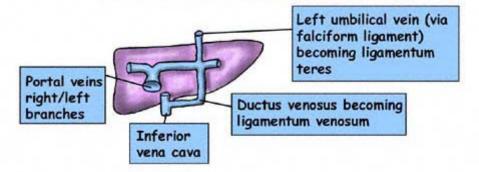
#### LIVER - PORTA HEPATIS

The porta hepatis is the area on the under surface of the liver at which the structures in the free edge of the lesser omentum enter/leave the liver. Peritoneum is reflected around it. It contains the following structures:

- Portal vein
- Left/right branches of hepatic artery
- · Left/right hepatic ducts
- Lymphatics and lymph nodes Autonomic nerves



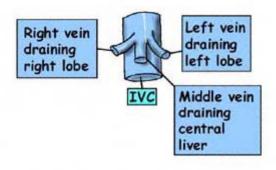
## LIVER - FETAL CIRCULATION & HEPATIC VEINS

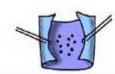


Blood returns from the placenta via left umbilical vein which joins the left branch of the portal vein. Most of the blood crosses over into the ductus venosus and hence to the inferior vena cava. Some blood enters the portal circulation and again reaches the inferior vena cava via thehepatic veins

#### HEPATIC VEINS

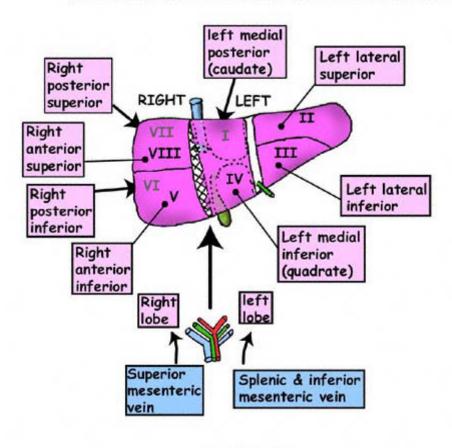
These veins drain the "cleansed" blood back into the systemic circulation from the liver. They do not follow the portobiliary segmentation. The veins suspend the liver from the inferior vena cava and are helped by the peritoneal reflections

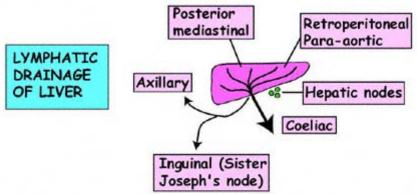




Accessory veins drain the liver directly into the (opened) IVC

## LIVER - PORTOBILIARY SEGMENTATION

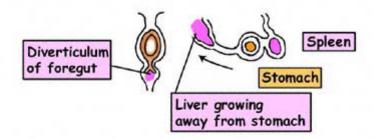


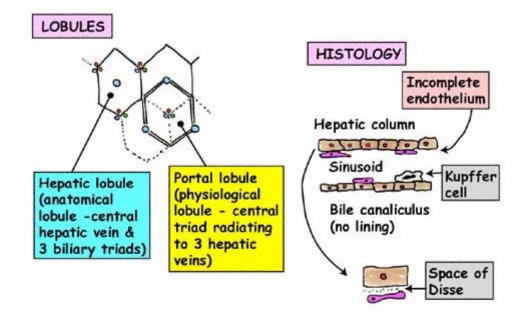


## LIVER - DEVELOPMENT, LOBULES & HISTOLOGY

#### **DEVELOPS**

- In ventral mesogastrium
- As foregut ventral diverticulum which grows into septum transversum & induces generation of hepatocytes
- Grows into vitelline veins so that cells are directly exposed to blood





# BILIARY TREE CYSTIC & ARTERIAL VARIATIONS

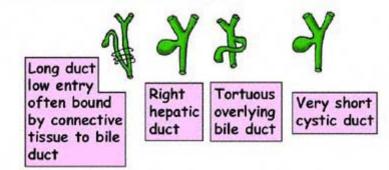
#### ARTERIAL VARIATIONS

- In the vast majority of people the cystic artery arises from the right branch of the hepatic artery
- In 27% it arises from the hepatic or common hepatic
- In 5% it arises from the left branch of the hepatic
- In 3% it arises from the gastroduodenal
- In 1% it arises from either the superior pancreaticoduodenal, left gastric, coeliac or superior mesenteric

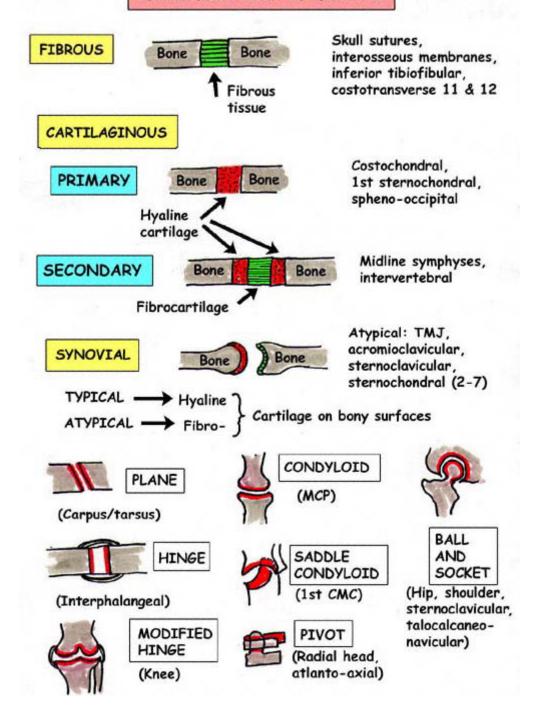
27% from hepatic or lower



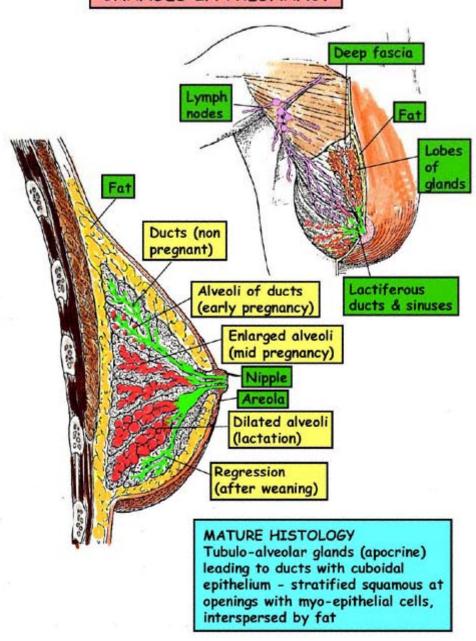
### CYSTIC DUCT VARIATIONS



#### CLASSIFICATION OF JOINTS



# BREAST STRUCTURE AND CHANGES IN PREGNANCY



#### BRACHIAL PLEXUS - UPPER C5,6

AETIOLOGY:

Birth traction (Erb Duchenne palsy) or adult trauma (Erb's palsy) eg motorbike accident

MUSCLE LOSS:

Deltoid, short shoulder muscles, brachialis, biceps, supinator, brachioradialis

MOVEMENT LOSS:

Abduction, external rotation of shoulder, supination, elbow flexion

ву:

DOMINATED Latissimus dorsi (C6,7,8), pronator teres (C6,7), pectorals (C6,7,8)

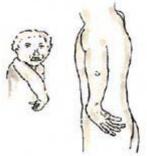
RESULT:

Atrophy, limpness of upper arm, internal rotation of shoulder, pronation of forearm, palm backwards -'hinting for tip'

SENSORY LOSS:

Upper and lower lateral cutaneous nerve of arm from axillary and radial but only if C6 is involved, lateral cutaneous nerve of forearm (musculocutaneous)

SUMMARY: C5 controls shoulder flexion, abduction, lateral rotation and elbow flexion C6 controls supination including supinator



ERB'S PALSY

### BRACHIAL PLEXUS - LOWER T1 KLUMPKE'S PALSY

AETIOLOGY: Pull on arm at breech delivery or apical carcinoma of lung

MUSCLE LOSS:

Small muscles of hand - lumbricals and interossei

MOVEMENT LOSS:

Flexion at metacarpophalangeal joints & diminished extension at interphalangeal joints

BY:

DOMINATED Long extensors acting on metacarpophalangeal joints Long flexors acting on interphalangeal joints

RESULT:

Clawed hand ('main en griffe') with or without Horner's syndrome (ptosis/small pupil) if there is damage to sympathetic chain

SENSORY LOSS:

T1 distribution - lower (+or- upper) inner arm & hand

Loss of bulk of 1st dorsal interosseous, inability to hold paper between outstretched fingers

NOTE: If C8 & T1 are involved, as with a cervical rib, there is weakness of small muscles & paraesthesia olong ulnar border of arm & hand



#### RADIAL IN AXILLA

AETIOLOGY: Crutch pressure, fracture of humerus

MUSCLE LOSS:

Triceps, extensors of wrist and fingers

MOVEMENT LOSS:

Extensor weakness at elbow, wrist, metacarpophalangeal joints. Interphalangeal joints are alright because of intact interossei & lumbricals

RESULT: Wrist drop and inability to grip

LOSS:

SENSORY Over 1st dorsal interosseous, +/- lower lateral cutaneous nerve of arm

TEST: Sensation as above. Power of brachioradialis, wrist extension & extension of elbow against resistance



WRIST DROP

#### RADIAL IN SPIRAL GROOVE

AETIOLOGY: Fracture mid shaft humerus, Saturday night palsy, injections

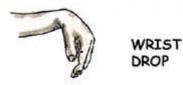
MUSCLE Extensors of wrist and fingers, but triceps & anconeus are spared

MOVEMENT Extensor weakness wrist, metacarpophalangeal joints. Interphalangeal joints are alright because of intact interossei & lumbricals

RESULT: Wrist drop and inability to grip. Extension of elbow is alright

SENSORY Over 1st dorsal interosseous, lower lateral cutaneous nerve of arm is usually alright

TEST: Power of wrist extension



#### RADIAL (POSTERIOR INTEROSSEOUS) IN FOREARM

AETIOLOGY:

Trauma, surgical mishap, fracture/dislocation of radial head

LOSS:

MUSCLE Extensors of wrist and fingers, but extensor carpi radialis longus is spared

MOVEMENT LOSS:

Extensor weakness of metacarpophalangeal joints. Interphalangeal joints are alright because of intact interossei & lumbricals. NO wrist drop & grip is alright as extensor carpi radialis longus is intact

RESULT:

No wrist drop & grip alright. Extension of elbow is alright

SENSORY LOSS:

No sensory loss if superficial radial alright

TEST:

Power of extension of metacarpophalangeal joints



#### ULNAR AT ELBOW

AETIOLOGY:

Fracture/dislocation of elbow, damage behind medial epicondyle

MUSCLE LOSS:

All intrinsic muscle of hand except radial 2 lumbricals, 4th & 5th slips of flexor digitorum profundus, flexor carpi ulnaris

RESULT:

Clawing & loss of grip between fingers (see T1 lesion in brachial plexus) BUT less clawing of index & middle fingers because of intact lumbricals and less clawing than in a wrist injury of ring & little fingers because of loss of flexor digitorum profundus to these fingers. Also there is radial deviation

SENSORY LOSS: Ulnar side of hand and ulnar 1 1/2 fingers

TEST:

Place paper between straight fingers. Try abducting fingers. Test sensation of 5th finger pulp. Froment's sign (see separate illustration). Wasting of 1st dorsal interosseous. Test distal interphalangeal joint of little finger for ulnar 1/2 of profundus



#### ULNAR AT WRIST

AETIOLOGY: Lacerations

LOSS:

MUSCLE All intrinsic muscle of hand except radial 2 lumbricals, (NOT flexor digitorum profundus, NOT flexor carpi ulnaris)

RESULT:

Clawed hand (no interossei therefore no flexion of metacarpophalangeal joints but instead they are extended by long extensors. There is flexion of interphalangeal joints by long flexors. No radial deviation. Note: LESS clawing of index & middle fingers because of intact median nerve to radial lumbricals but MORE clawing of ring & little fingers because of intact 1/2 flexor digitorum profundus than for an ulnar lesion at elbow

SENSORY LOSS:

Ulnar 1 1/2 fingers. Dorsal & palmar cutaneous branches may be spared

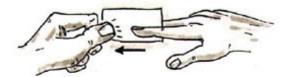
TEST:

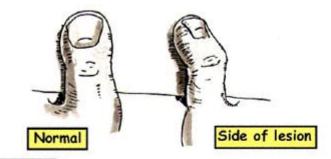
Place paper between straight fingers. Try abducting fingers. Test sensation of 5th finger pulp. Froment's sign (see separate illustration). Wasting of 1st dorsal interosseous.



ULNAR

TESTING FOR WEAKNESS OF INTEROSSEI - T1





#### FROMENT'S SIGN

Paper is pinched in the first web space between proximal phalanx of thumb and metacarpophalangeal joint of the index finger with the wrist in a neutral position. The metacarpophalangeal joints are extended and the thumb nail faces the patient to avoid trick movements. The side with the loss of adductor pollicis compensates by using flexor pollicis longus which flexes the distal interphalangeal joint of the thumb

#### MEDIAN NERVE - SUPRACONDYLAR

AETIOLOGY:

Supracondylar fracture/dislocation, tight bicipital aponeurosis, ligament of Struthers

LOSS:

MUSCLE Pronator teres, flexors of wrist/fingers except half flexor digitorum profundus & flexor carpi ulnaris. Thenar muscles except adductor pollicis & 2 radial lumbricals

MOVEMENT LOSS:

Loss of pronation, weak wrist flexion & abduction. No abduction or opposition of thumb and, as flexor pollicis is also lost, the thumb is useless. Long flexor tendons (flexors digitorum superficialis & profundus) to index & middle fingers lost

RESULT:

Ulnar deviation of wrist, thenar wasting, Papal benediction on flexing fingers (see below)

SENSORY LOSS:

Radial side of palm, fingers and nail beds of 3 1/2 fingers

TEST:

Sensory - loss of pulp of index finger. Motor - Pronation, Abductor pollicis brevis (+ or - opposition), both interphalangeal joints of index finger and flexor pollicis longus by touching tip of thumb pulp to pulp of index (see below on left)





#### Papal bendiction

- Thenar wasting
- Ulnar deviation
- Minimal flexion of digits 1-3

## MEDIAN NERVE - AT WRIST

AETIOLOGY: Laceration, carpal tunnel compression

LOSS:

MUSCLE Thenar (except adductor pollicis) 2 radial lumbricals

MOVEMENT LOSS:

Abduction and opposition of thumb. Flexion alright due to intact flexor pollicis longus

RESULT: Wasting of thenar muscles to give an 'ape' hand. Long flexors intact so no Papal benediction

SENSORY LOSS:

Radial 3 1/2 fingers +or- radial palm depending on palmar cutaneous branch

TEST:

Sensory - loss of pulp of index finger. Motor - Abductor pollicis brevis (+ or - opposition). Interphalangeal joints and pronation all intact

### CARPAL TUNNEL SYNDROME

AETIOLOGY: Anything causing diminution of size of carpal tunnel inflammation, arthritis, hypothryoidism, idiopathic, tenosynovitis, old fractures. All can lead to compression of median nerve

Under flexor retinaculum in concavity of carpal bones

RESULT: Paraesthesia/anaesthesia & loss of motor function of thumb, index & middle fingers. BUT preservation of sensation of palm (palmar cutaneous branch of median comes off a few centimetres above carpal tunnel)

TEST: Tapping over carpal tunnel may lead to tingling in median distribution in hand. Sensation should be maintained in the radial side of the palm

# VOLKMANN'S ISCHAEMIC CONTRACTURE

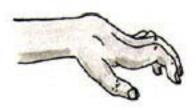
AETIOLOGY: Damage to brachial artery in supracondylar fracture. Ischaemia leading to contracture of long flexors and extensors in the forearm

RESULT:

'Claw hand'

Wrist flexed - bulkier flexors therefore more contracture.

Extension of metacarpophalangeal joints because of insertion of extensor tendons into these joints. Flexed interphalangeal joints because of insertion of long flexor tendons into these joints



# LONG THORACIC NERVE OF BELL-C5,6,7

AETIOLOGY: Damage during surgery in the axilla

RESULT: Loss of serratus anterior leading to 'winging' of scapula. Decreased flexion and abduction of arm

SENSORY Nil LOSS:

TEST: Patient presses against wall and scapula on side of lesion will 'wing' (stick out backwards)



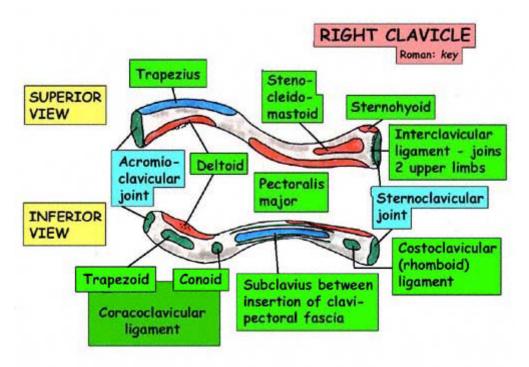
RIGHT WINGED SCAPULA WHILST PATIENT IS PUSHING AGAINST WALL

# SEGMENTAL NERVE SUPPLY TO MUSCLES

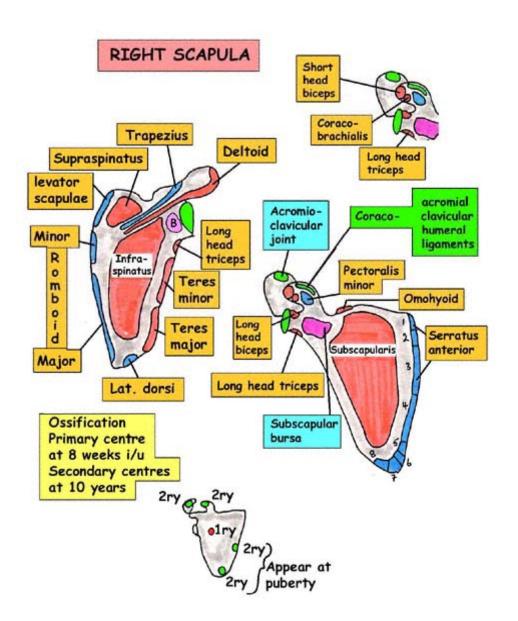
SEGMENT	MUSCLE	NERVE	
C5,6	Biceps brachii	Musculocutaneous	
C5,6	Brachialis	Musculocutaneous & radial	
C5,6	Brachioradialis	Radial	
C5,6	Coracobrachialis	Musculocutaneous	
C5,6	Deltoid	Axillary	
C5,6	Infraspinatus	Suprascapular	
C5,6	Subscapularis	Upper & lower subscapular	
C5,6	Supraspinatus	Suprascapular	
C5,6	Teres major	Lower subscapular	
C5,6	Teres minor	Axillary	
C6,7	Abductor pollicis longus	Posterior interosseous	
C6,7	Extensor carpi radialis brevis	Posterior interosseous	
C6,7	Extensor carpi radialis longus	Radial	
C6,7	Extensor pollicis brevis	Posterior interosseous	
C6,7	Flexor carpi radialis	Median	
C6,7	Palmaris longus	Median	
C6,7	Pronator teres	Median	
C6,7	Supinator	Posterior interosseous	
C6,7	Extensor carpi ulnaris	Posterior interosseous	
C6,7	Extensor digitorum	Posterior interosseous	
C6,7	Extensor indicis	Posterior interosseous	
C6,7	Extensor pollicis longus	Posterior interosseous	
C6,7	Triceps	Radial	
C7,8	Anconeus	Radial	
C7,8	Extensor digiti minimi	Posterior interosseous	
C7,8	Flexor digitorum profundus	Ulnar/ant interosseous	
C7,8	Flexor digitorum superficialis	Median	
C8,T1	Abductor digiti minimi	Ulnar - deep branch	
C8,T1	Abductor pollicis brevis	Median- muscular branch	
C8,T1	Adductor pollicis	Ulnar - deep branch	
C8,T1	Flexor carpi ulnaris	Ulnar	
C8,T1	Flexor digiti minimi	Ulnar - deep branch	
C8,T1	Flexor pollicis brevis	Median- muscular branch	
C8,T1	Flexor pollicis longus	Anterior interosseous	
C8,T1	Interossei	Ulnar - deep branch	
C8,T1	Lumbricals	Ulnar - deep branch/median	
C8,T1	Opponens digiti minimi	Ulnar - deep branch	
C8,T1	Opponens pollicis	Median- muscular branch	
C8,T1	Palmaris brevis	Ulnar - superficial branch	
C8,T1	Pronator quadratus	Anterior interosseous	

## SEGMENTAL NERVE SUPPLY TO MOVEMENTS AND REFLEXES IN UPPER LIMB

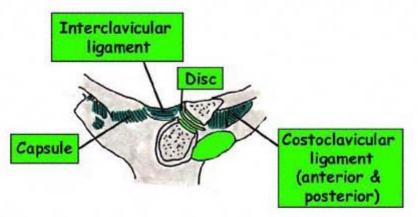
SHOULDER:	Flexion/abduction/lateral rotation	<i>C</i> 5
	Extension/adduction/medial rotation	C6,7,8
ELBOW:	Flexion (biceps reflex)	C5,6
	Extension (triceps reflex)	C6,7,8
FOREARM:	Pronation	C7,8
	Supination	C6
WRIST:	Flexion/extension	C7,8
FINGERS/ THUMB: (LONG TENDONS)	Flexion/extension	C7,8
HAND: (SMALL MUSCLES)	All movements	T1



- · Ossifies in membrane
- 1st to appear at 5 weeks intra-uterine
- Only one secondary centre at sternal end appears in teens
- One of last to fuse at 26-30 years
- No medullary cavity
- Most fractures are indirect trauma. Occur at junction of lateral 1/3 and medial 2/3
- Subclavius protects vessels
- Ligaments are:
  - Costoclavicular
  - Coracoclavicular
  - Acromioclaviular
  - Sternoclavicular



#### STERNOCLAVICULAR JOINT

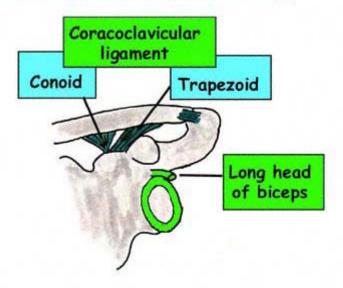


Synovial
Atypical (fibrocartilage on joint surfaces)
Fibrocartilaginous disc dividing it into 2 cavities
Manubrial surface is concave
Ball & socket (all the features of)
Disc attached to capsule, acts as shock absorber
Capsule thick above and posteriorly
Fulcrum at costoclavicular ligament
Clavicle rotates 40°
Nerves: supraclavicular (C3,4)

#### Ligaments

Thickening of capsule (above and posteriorly)
These are the anterior & posterior sternoclavicular ligaments
Interclavicular
Costoclavicular (strong). External (anterior) fibres &
Internal (posterior) fibres

## ACROMIOCLAVICULAR JOINT



Synovial Atypical

Thick superior capsule (acromioclavicular ligament)

Incomplete fibrocartilaginous disc in upper joint

Strong coracoclavicular ligament

Nerve: Lateral supraclavicular (C4)

Movements: gliding (passive) and 20° of rotation of

scapula

# MUSCLES ATTACHED TO COSTAL CARTILAGES

- Internal oblique abdominis
- Transversus abdominis
- Rectus abdominis
- Transversus thoracis (sternocostalis)
- Pectoralis major (1-7)
- Diaphragm

# SHOULDER JOINT (GLENOHUMERAL)

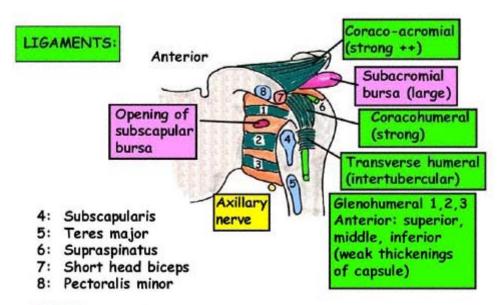
Shallow glenoid fossa - deepened by glenoid labrum Synovial, Ball and socket Humeral head is 1/3 hemisphere

Capsule: Strong & taut superiorly (anti-sag), inferiorly lax and inserted lower to allow wide abduction,

flexion and extension

Synovium: Envelops biceps tendon, communicates with

bursae anteriorly and posteriorly



Blood: circumflex humerals

Nerves: Subscapular, suprascapular, axillary (Hilton's law)

Bursae: Subscapular, subacromial, infraspinatus, supraspinatus

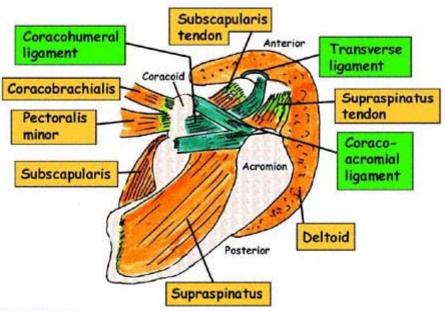
Stability: Bones (poor), Capsule (relatively poor), Muscles +++

ligaments +++

Support: Rotator cuff (subscapularis, supraspinatus,

infraspinatus, teres minor), long head biceps, triceps in abduction, muscles from chest to arm

# LOOKING DOWN ON RIGHT SHOULDER



#### Relations

Superior: Supraspinatus, bursa, long head of biceps,

coraco-acromial ligament

Inferior: Long head of triceps, axillary nerve, posterior

circumflex humeral artery, teres major

Posterior: Infraspinatus, teres minor, deltoid

Anterior: Subscapularis, bursa, deltoid

#### Movements

Flexion: Pectoralis major, biceps, coracobrachialis, deltoid

Extension: Deltoid, latissimus dorsi, teres major

Adduction: Pectoralis major, latissimus dorsi, teres major Abduction: Supraspinatus (0-30°), deltoid & supraspinatus

(30°-90°), scapular rotation, supraspinatus, deltoid

(90° - 160°)

Internal rotation: Subscapularis, teres major, latissimus dorsi

External rotation: Teres minor, infraspinatus, deltoid

#### HUMERUS (MUSCLE ATTACHMENTS) Greater tuberosity Greater tuberosity Head Supraspinatus Infraspinatus Subscapularis **Bicipital** groove Anatomical neck Teres minor (transverse ligament) Surgical neck Lateral head Latissimus dorsi of triceps Pectoralis major Teres major Deltoid Deltoid (tuberosity) Coracobrachialis Spiral groove Spiral groove Brachialis Brachioradialis Medial head (supracondylar Intermuscular of triceps ridge) septum Pronator Extensor carpi teres radialis longus Flexor Supinator 0 0 Common carpi Common flexor ulnaris extensor Anconeus origin origin Groove for Trochlea Olecranon Capitulum ulnar nerve fossa

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#### OSSIFICATION OF HUMERUS

Primary centre in mid shaft at 8 weeks interuterine Secondary centre in head, greater and lesser tuberosities at 1 year

Lower end and elbow is more complex and is remembered best with the following mnemonic:





#### Note

Bone growth in the upper limb is at the upper humerus and at lower radius and ulna

2 years Capitulum 4 years Radial head

6 years Internal (medial) epicondyle

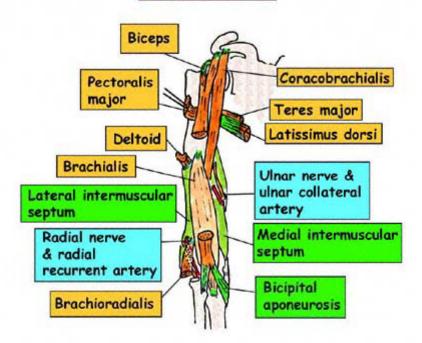
8 years Trochlea 10 years Olecranon

12 years External (lateral) epicondyle

# EVENTS OCCURING AT MID HUMERUS

- Insertion of deltoid and coracobrachalis
- Start of origin of brachialis
- Ulnar nerve and superior ulnar collateral artery leave the anterior compartment
- · Radial nerve emerges from spiral groove
- Median nerve crosses brachial artery
- Basilic vein perforates deep fascia
- Nutrient artery enters humerus

#### ANTERIOR ARM



#### Medial intermuscular septum

Pierced by:

Ulnar nerve Ulnar collateral artery

Gives origin to :

Brachialis (anteriorly)
Triceps (posteriorly)

#### Lateral intermuscular septum

Pierced by:

Radial nerve

Radial recurrent artery

Gives origin to:

Brachioradialis (anteriorly)

Extensor carpi radialis longus

(anteriorly)

Triceps (posteriorly)

Brachialis (anteriorly)

#### ANTERIOR ARM MUSCLES

#### BICEPS

Origin: Long head - Supraglenoid tubercle

Short head - coracoid

Insertion: Radial tuberosity & bicipital aponeurosis

Action: Flexes shoulder & elbow. Supinates

Nerve supply: Musculocutaneous

#### BRACHIALIS

Origin: Anterior/lower 1/2 humerus & medial and

lateral intermuscular septum

Insertion: Coronoid process & tubercle of ulna

Action: Flexes elbow

Nerve supply: Musculocutaneous and twig from radial

#### CORACOBRACHIALIS

Origin: Coracoid

Insertion: Anteromedial humerus

mid shaft

Action: Adducts and flexes shoulder Nerve supply: Musculocutaneous

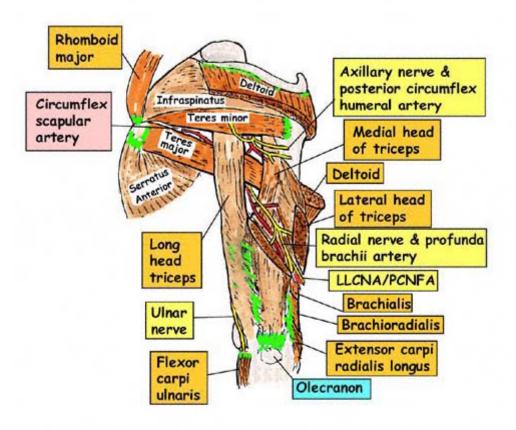
Note: Coracobrachialis is the equivalent to the three adductors in the leg. It is thus vestigially tripartite and

a third head may remain as a supratrochlear spur (ligament of Struthers)



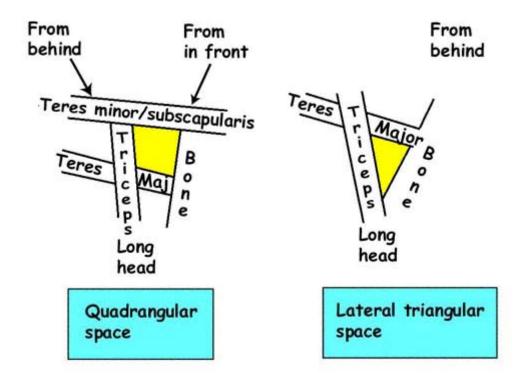
Brachial artery & median nerve

#### POSTERIOR ARM MUSCLES AND SPACES

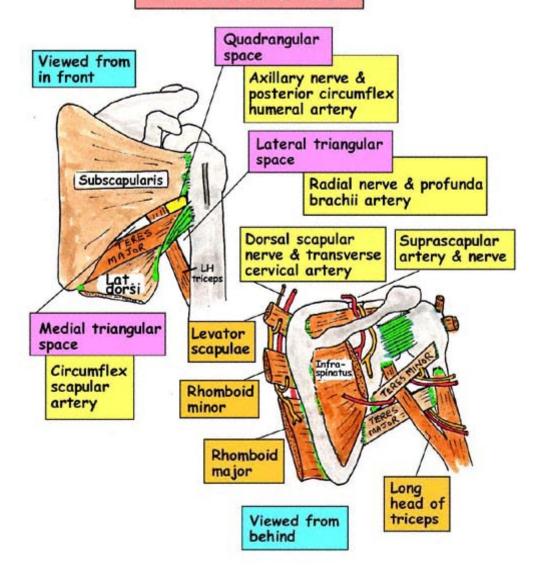


LLCNA - Lower lateral cutaneous nerve of arm PCNFA - Posterior cutaneous nerve of forearm

# QUADRANGULAR AND TRIANGULAR SPACES



### QUADRANGULAR AND TRIANGULAR SPACES



#### POSTERIOR ARM MUSCLES

#### TRICEPS

Origin: Long head -infraglenoid tubercle

Medial head - Medial spiral groove, posterior humerus, medial & lateral inter-

muscular septum

Lateral head - Superior/posterior humerus (linear)

Insertion: Long & lateral heads - flat tendon to posterior

olecranon

Medial head - deep part of flat tendon and posterior capsule of elbow

Action: Extends elbow, weak extensor of shoulder

Long head stabilises abducted shoulder

Nerve supply: Radial (C7,8) long -medial - lateral - medial

#### **ANCONEUS**

Origin: Lower lateral epicondyle

Insertion: Posterior/lateral ulna & olecranon

Action: Weak extensor. Abducts elbow in pronation

Nerve supply: Radial



#### POSTERIOR ARM MUSCLES

#### TRICEPS

Origin: Long head -infraglenoid tubercle

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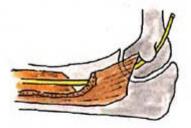
Nerve supply: Radial



#### ULNAR NERVE RELATIONSHIPS

#### IN ARM AND FOREARM

Passes backwards behind the axillary vessels to pass through the medial intermuscular septum with the superior ulnar collateral artery and the branch of the radial nerve to medial head of triceps. Lies between septum and medial head of triceps. Passes behind medial epicondyle, between two heads of flexor carpi ulnaris, against medial ligament of elbow. Under flexor carpi ulnaris but on flexor digitorum profundus with ulnar artery lateral to it. Emerges lateral to flexor carpi ulnaris tendon at wrist, then anterior (superficial) to flexor retinaculum. Gives off dorsal branch under flexor carpi ulnaris. Ends as superficial and deep branches, the latter passing over hook of hamate



#### IN HAND

Superficial branch: to palmaris brevis and digital nerves

to 11/2 fingers

Deep branch: Passes between origins of flexor and abductor digiti minimi, grooves hook

of hamate. Supplies all interossei, 3 hypothenar muscles, 2 lumbricals and 2 heads of adductor

pollicis

See page 122 Instant Anatomy for picture

# POSTERIOR INTEROSSEOUS AND SUPERFICIAL BRANCH OF RADIAL NERVES IN FOREARM AND HAND

#### Posterior interosseous

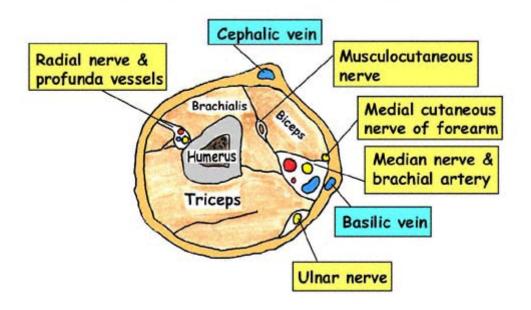
Off radial under brachioradialis, passes between two heads of supinator and into extensor compartment. Lies on abductor pollicis longus then interosseous membrane. Supplies all muscles (except anconeus, brachioradialis, and extensor carpi radialis longus) also sensory to membrane, periosteum, dorsal ligaments of carpus but no cutaneous branches.

#### Superficial branch of radial

Terminal branch of radial, lies under brachioradialis, over supinator, pronator teres and flexor digitorum superficialis. Passes out lateral/posterior to brachioradialis tendon, lateral to radial artery, posterior to radial styloid and then tendon of extensor pollicis longus as it forms the dorsal side of the snuff box. Several terminal branches to skin of back of hand - 3 1/2 fingers short of the nail beds

For diagrams see page 116 in Instant Anatomy

# AXIAL (CROSS) SECTION OF MID RIGHT ARM VIEWED FROM BELOW



#### RELATIONS OF BRACHIAL ARTERY

Medial: Upper half - ulnar nerve, basilic vein

Lower half - median nerve

Lateral: Upper half - median nerve, biceps

Lower half - biceps

Posterior: Upper third - triceps

Middle third - coracobrachialis

Lower third - brachialis

#### SUPERFICIAL CUBITAL FOSSA RIGHT SIDE

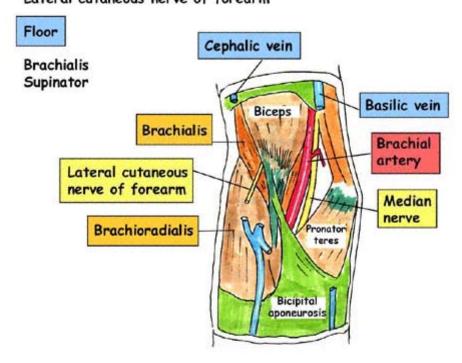
#### Boundaries

Triangular area between:

Pronator teres Brachioradialis Line between epicondyles

#### Roof

Deep fascia of forearm
Bicipital aponeurosis
Median cubital vein
Medial cutaneous nerve of forearm
Lateral cutaneous nerve of forearm



#### DEEP CUBITAL FOSSA RIGHT SIDE

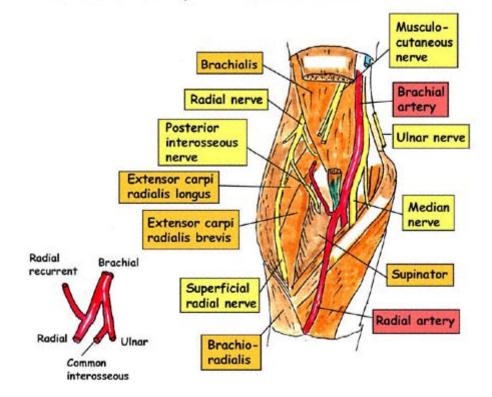
#### CONTAINS

- · Median nerve
- · Brachial artery
- Biceps tendon
- · Lymph nodes
- (laterally, under brachioradialis, radial & posterior interosseous nerves)

Mnemonic for order of structures from lateral to medial

#### TAN

(tendon-artery-nerve)



- Synovial
- Hinge
- Communicates with superior radio-ulnar joint
- Carrying angle 170° wider in female, flexes to mouth

#### Capsule

Attached superiorly above radial, coronoid, olecranon fossae. Inferiorly ulna, coronoid, olecranon

#### Nerve supply:

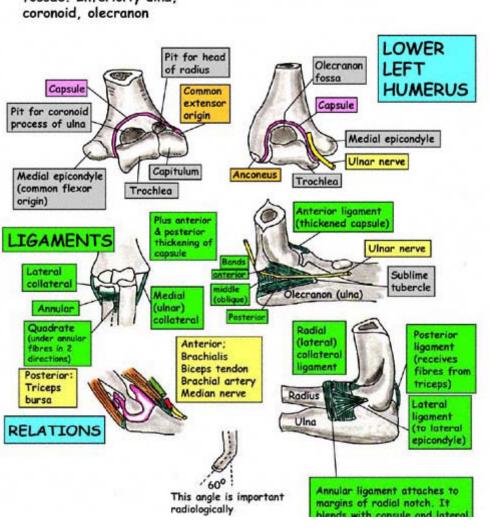
Musculocutaneous, radial, ulnar and median

#### Flexion:

Biceps, brachialis, (brachioradialis, common flexors, pronator teres)

#### Extension:

Triceps, anconeus



#### RADIO-ULNAR JOINTS

#### SUPERIOR

Continuous with elbow joint

#### Nerve supply:

Anterior & posterior interosseous & median

#### Annular ligament:

Around neck, attached to edges of radial notch on ulna, not attached to radius. Blends with capsule above

#### Quadrate ligament:

Neck of radius to supinator fossa of ulna. Crisscross fibres

#### Relations:

Anterior - Supinator & radial nerve Posterior - Supinator

#### INFERIOR

- Separated from wrist joint by triangle of fibrocartilage attached at its base to the radius and its apex to the ulnar styloid
- Loose capsule pouches upwards to give a sacciforn recess by pronator quadratus

#### PRONATION AND SUPINATION

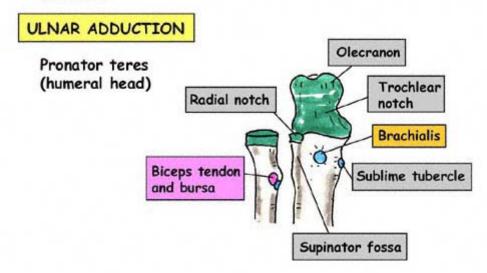
#### **AXIS**

#### RADIAL HEAD - ULNAR STYLOID - LITTLE FINGER

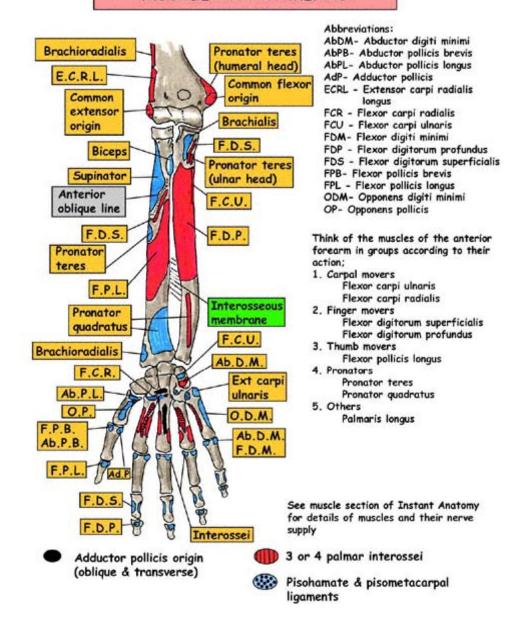
Note that the true axis of the forearm is through the mid intercondylar point and the mid interstyloid point. Thus, through the middle finger Therefore in FREE pronation and supination ulna is adducted and abducted whilst the radius rotates around it. This allows the hand to remain still in space

#### ULNAR ABDUCTION

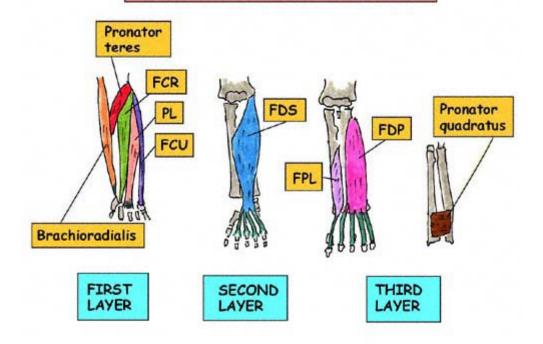
#### Anconeus



#### ANTERIOR FOREARM AND HAND MUSCLE ATTACHMENTS



#### ANTERIOR FOREARM MUSCLES



#### ABBREVIATIONS

FCR- Flexor carpi radialis
FCU- Flexor carpi ulnaris
FDP- Flexor digitorum profundus
FDS- Flexor digitorum superficialis
FPL- Flexor pollicis longus
PL- Palmaris longus

#### ORDER OF STRUCTURES AT WRIST

#### Ulnar (medial) side

Flexor carpi ulnaris

Ulnar nerve

Ulnar artery

Flexor digitorum superficialis

Palmaris longus

Median nerve

Flexor carpi radialis

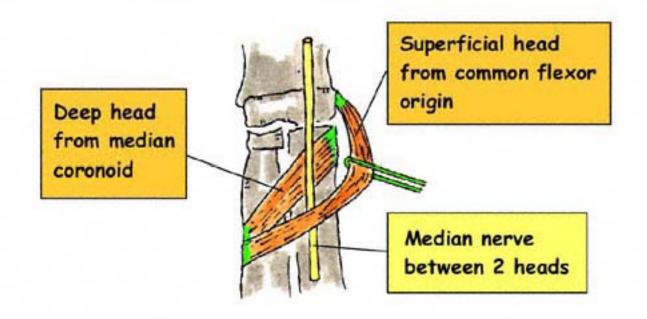
Radial artery

**Brachioradialis** 

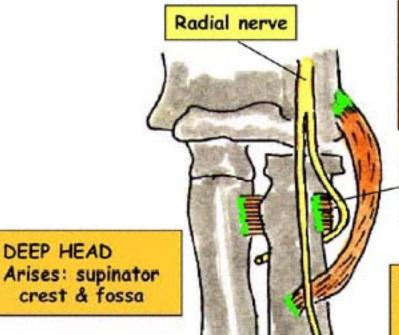
Superficial radial nerve

Radial (lateral) side

#### PRONATOR TERES & ITS RELATION TO MEDIAN NERVE



#### SUPINATOR AND ITS RELATION TO THE RADIAL NERVE



SUPERFICIAL HEAD Arises: lateral epicondyle & lateral & annular ligaments

Posterior interosseous nerve

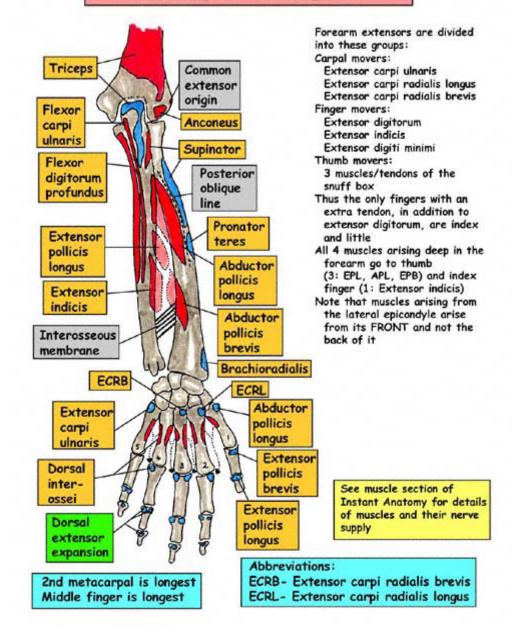
Inserts: neck & shaft of radius between anterior & posterior oblique lines

Action: Supinates. Best when arm is extended and biceps is not supinating

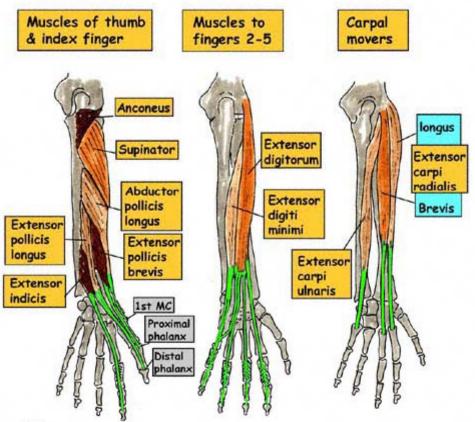
DEEP HEAD

Nerve: posterior interosseous from radial

#### POSTERIOR FOREARM AND HAND MUSCLE ATTACHMENTS



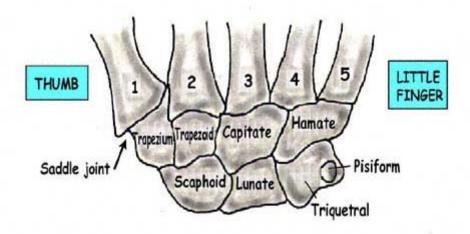
#### MUSCLES OF POSTERIOR FOREARM



#### Dulac

- Long extensors attach to the base of proximal phalanx whilst long flexors do not. On the flexor side it is the interossei and lumbricals that attach here and this accounts for clawed hand when these small muscles fail.
- All 4 deep muscles (see left hand drawing) all go to the index finger and thumb in a ratio of 1:3. The 3 muscles to the thumb attach in turn to 1st metacarpal (AbPL), the proximal phalanx (EPB) and the distal phalanx (EPL).
- Of the 4 fingers (excluding the thumb), two fingers have an extra tendon over and above that from extensor digitorum. These are the index and little fingers in the form of extensor indicis and extensor digiti minimi.

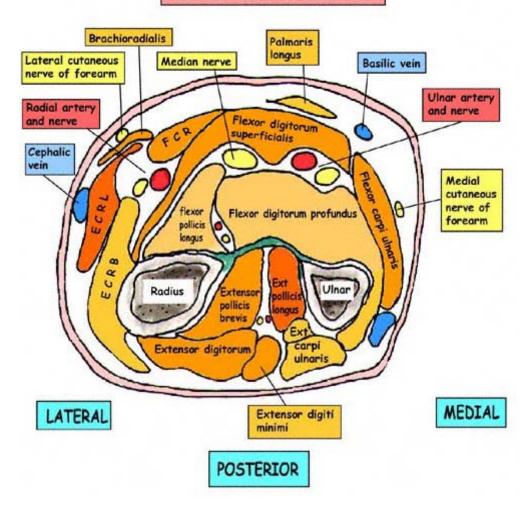
#### CARPAL BONES AND JONTS



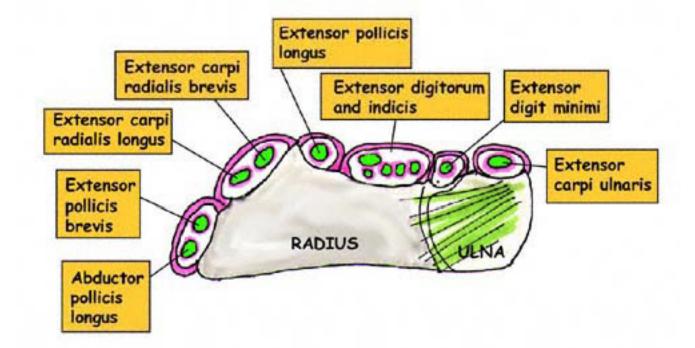
#### **JOINTS**

- Between 1st metacarpal and trapezium there is a saddle condyloid joint that allows flexion, extension, adduction, abduction and rotation. The rotation is not free and depends on the degree of opposition.
- 2. All the other joints in the carpus are plane joints.
- The carpometacarpal joints become progressively more mobile from thumb to little finger so that grip is more stable towards index finger and thumb.

## CROSS SECTION OF RIGHT MID FOREARM LOOKING UP



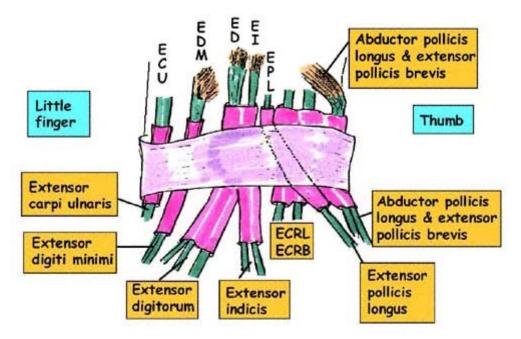
## SYNOVIAL SHEATHS UNDER EXTENSOR RETINACULUM



#### WRIST JOINT

- Proximal radius & fibrocartilage
- Distal Scaphoid, lunate (triquetral in extreme adduction)
- Synovial
- Triangular cartilage holds radius and ulna together and separates radiocarpal joint from inferior radio-ulnar joint
- Capsular ligaments thick collateral at sides
- Palmar radiocarpal ligaments radius to lunate capitate. Strong+
- Movements Flexion 80° Mostly midcarpal
   Extension 60° Mostly wrist
   Abduction 15°
   Adduction 60°

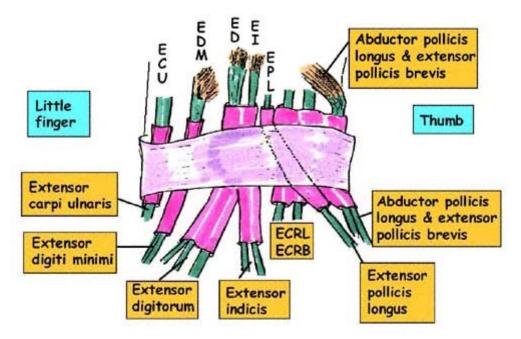
#### EXTENSOR RETINACULUM



ECRL - Extensor carpi radialis longus ECRB - Extensor carpi radialis brevis

- Ribbon-like band
- Oblique
- 2.5cm wide
- Attached from radial styloid to pisiform & triquetral (NOT ulna)
- Fibrous septa to give 6 compartments

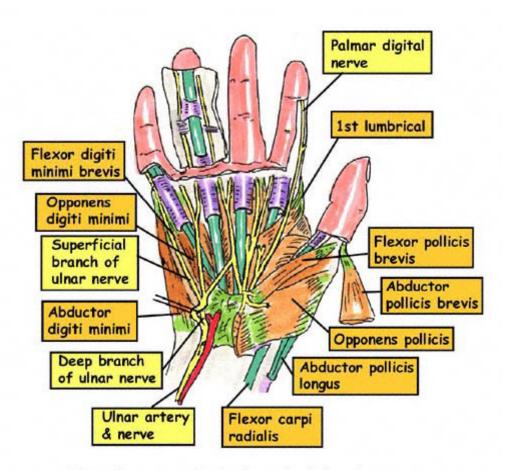
#### EXTENSOR RETINACULUM



ECRL - Extensor carpi radialis longus ECRB - Extensor carpi radialis brevis

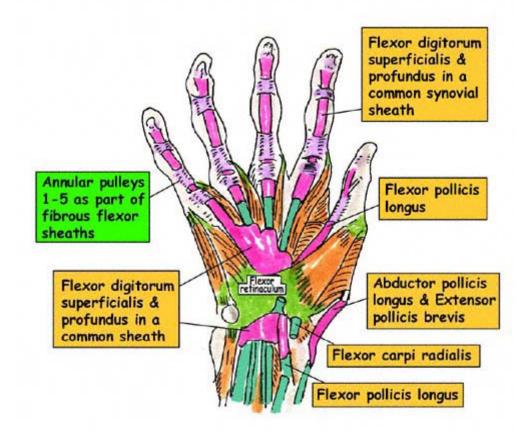
- Ribbon-like band
- Oblique
- 2.5cm wide
- Attached from radial styloid to pisiform & triquetral (NOT ulna)
- Fibrous septa to give 6 compartments

#### DISSECTION OF PALM TO SHOW NERVES & THENAR & HYPOTHENAR MUSCLES

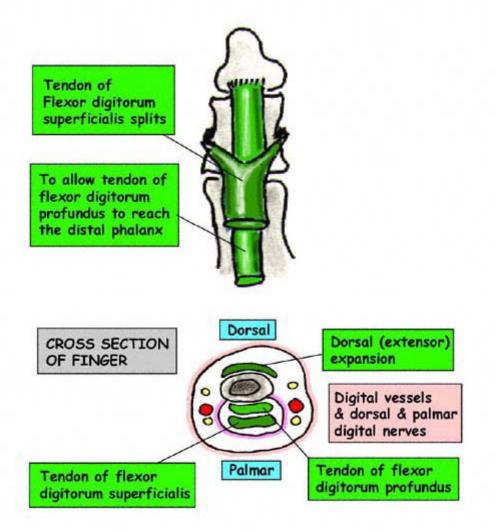


Note the communicating branch of the ulnar nerve with the median nerve in the palm

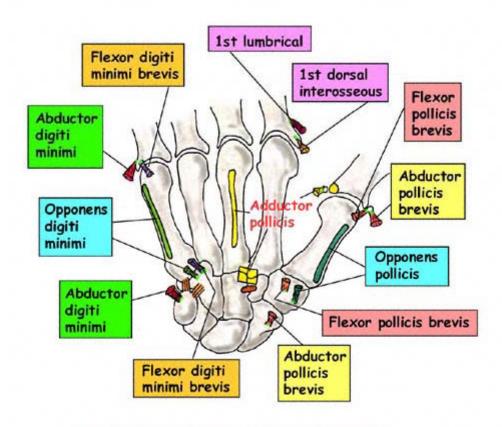
## SYNOVIAL SHEATHS IN PALM OF HAND



#### FINGER TO SHOW TENDONS AND DIGITAL NERVES & ARTERIES

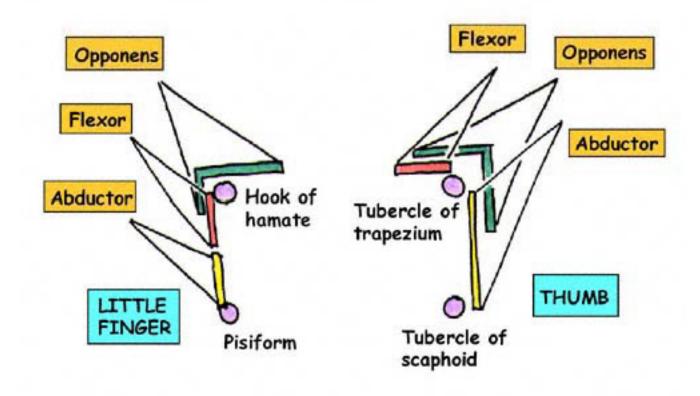


## ATTACHMENTS OF SMALL MUSCLES OF THE HAND

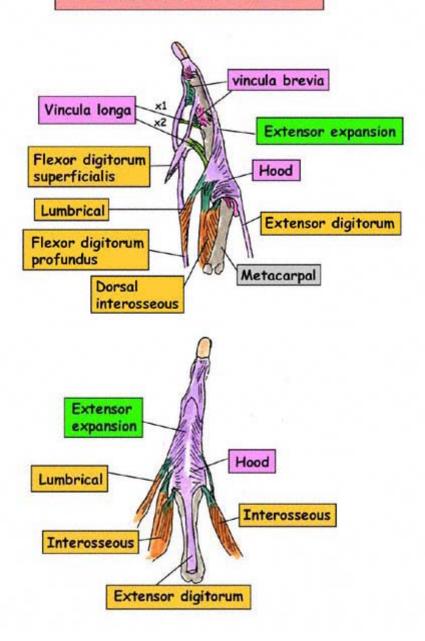


See muscle section of Instant Anatomy for more details of these small muscles

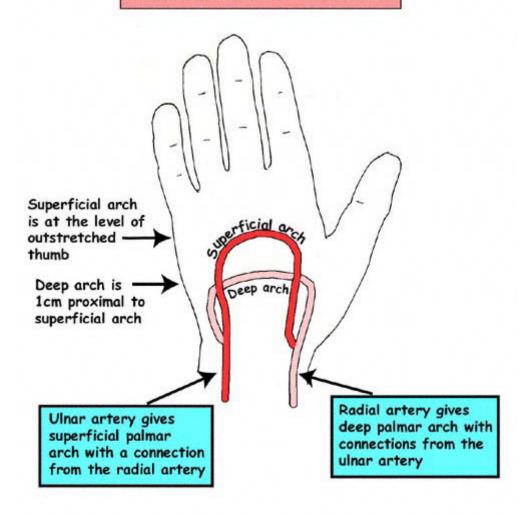
#### MUSCLE ATTACHMENTS TO FLEXOR RETINACULUM



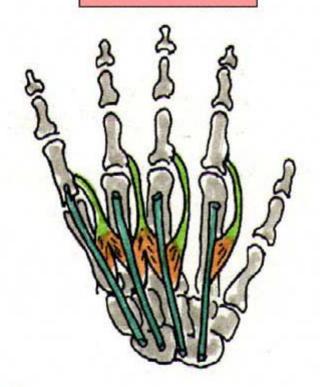
#### DETAILS OF LONG FLEXOR TENDONS IN FINGERS



#### PALMAR ARTERIAL ARCHES



#### LUMBRICALS



Origin:

4 tendons from flexor digitorum profundus radial 2 are unipennate, ulnar 2 bipennate

Insertion: Extensor expansion over dorsum of proximal phalanx, distal to insertion of interossei, on radial side of fingers 2-5. NO bony attachments

Action:

Flexion of metacarpophalangeal joints and extension of both interphalangeal joints of all 4 fingers

Nerve supply: Ulnar to ulnar 2, medial to radial 2 (can be 2:2, 3:1 or 1:3)

#### PALMAR APONEUROSIS & PALMAR BREVIS

#### Palmar aponeurosis

Extension of palmaris longus via flexor retinaculum Inserts into deep transverse liagment of palm and fibrous flexor sheaths Action: ties skin of palm and fingers down Central area is strong, thick and triangular

#### Palmaris brevis

Origin: Frexor retinaculum and medial border of proximal

palmar aponeurosis

Insertion: Dermis of ulnar side of hand

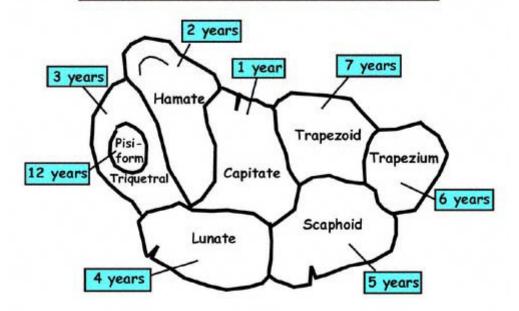
Action: Wrinkles skin

Nerve supply: Superficial branch of ulnar

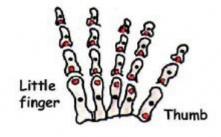
## USE OF HAND

Grip
Percussion
Agression/defence
Sensory
Expression

#### OSSIFICATION OF BONES OF HAND

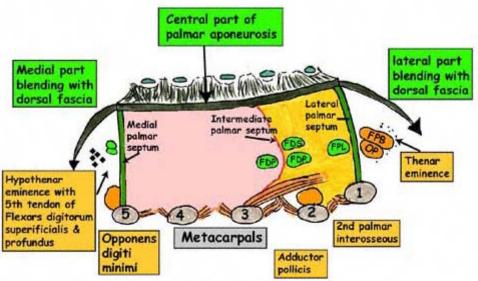


Roughly one centre appears per year from the age of 1 year to 7 years, anticlockwise in the right hand looking from the anterior surface



- Primary centres appear as indicated at 9th intra-uterine week.
- Secondary centres appear as indicated at 2 years. Note that the first metacarpal has its secondary centre at the base and not the heads as with the other metacarpals

#### PALMAR SPACES



MEDIAL AND LATERAL PALMAR SEPTA
Posterior extensions from palmar aponeurosis

Medial: origins - hook of hamate, pisohamate ligament & medial side of 5th fibrous flexor sheath pierced by - deep branch of ulnar nerve & artery Lateral: origins - tubercle of trapezium & lateral side of 2nd fibrous flexor sheath pierced by - Recurrent (muscular) branch of median nerve

#### MID PALMAR SPACE (MID CENTRAL PALMAR SPACE)

Contains: 3-5 flexor tendons, 2-4 lumbricals, superficial palmar arch, 3-5 digital vessels & nerves

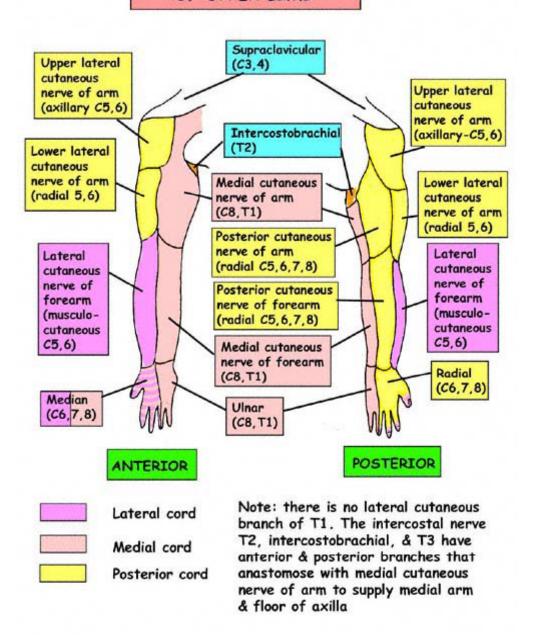
Communicates: Subcutaneous tissues at webs & extends dorsal to common flexor sheaths

#### THENAR SPACE (LATERAL CENTRAL PALMAR SPACE)

Contains: tendons of flexor pollicis longus, flexors digitorum superficialis & profundus to index finger, palmar digital nerves & vessels to thumb & radial side of index finger

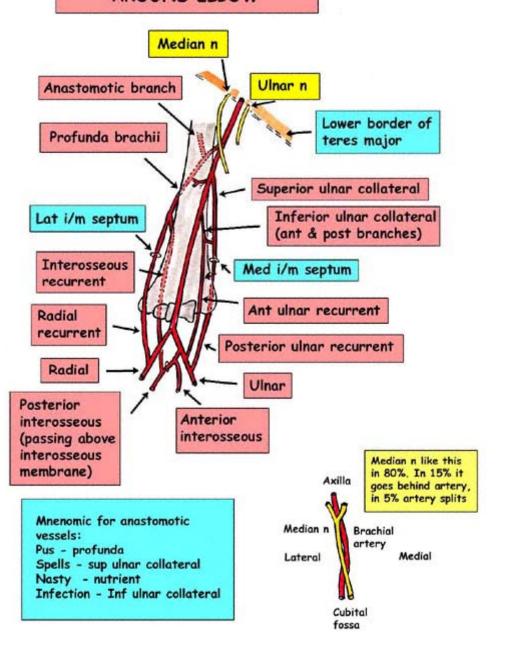
Communicates: Web of thumb & under flexor retinaculum

#### CUTANEOUS NERVES OF UPPER LIMB



# UPPER LIMB DERMATOMES ANTERIOR POSTERIOR Note the axial lines that separate non consecutive dermatomes

### ARTERIAL ANASTOMOSIS AROUND ELBOW



#### RADIAL ARTERY

STARTS: midline in cubital fossa

ON TO: supinator & tendon of pronator teres, flexor pollicis longus, insertion of pronator quadratus & lower radius

LATERAL TO: flexor digitorum superficialis

UNDER: flexor carpi radialis, brachioradialis, snuff box tendons

ON: trapezium

BETWEEN: heads of 1st dorsal interosseous & adductor pollicis

MEDIAL TO: radial n in forearm

See pages 24 in Instant Anatomy for branches

#### **ULNAR ARTERY**

STARTS: Midline in cubital fossa

PASSES DEEP TO: 2 heads of pronator teres &

fibrous arch of flexor digitorum

superficialis

ON: flexor digitorum profundus

LATERAL TO: ulnar nerve

OVER: flexor retinaculum

#### ANTERIOR INTEROSSEOUS ARTERY

BETWEEN: flexor digitorum profundus &

flexor pollicis longus

SUPPLIES: deep flexor muscles and bones

PASSES: posterior to supply extensor muscles

ENDS: as dorsal carpal anastomosis

See pages 26 in Instant Anatomy for branches

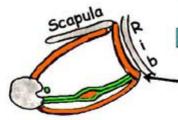
## AXILLA Between arm & thorax)

A truncated cone



Subscapularis
Teres major
Latissimus





#### Medial wall

Serratus anterior to 4th rib

dorsi

#### Lateral wall

Intertubercular (bicipital) groove Biceps tendon

#### Anterior wall

Pectoralis major Pectoralis minor Clavipectoral fascia

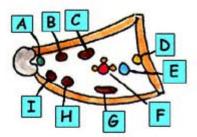
#### Apex

Clavicle Scapula Outer 1st rib

#### Floor

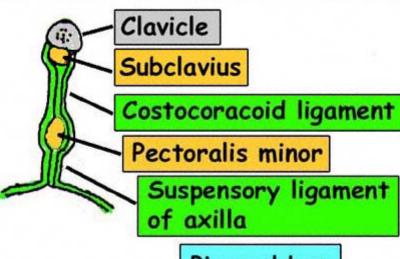
Axillary fascia which is held by suspensory ligament & lies between anterior & posterior axillary folds, deep fascia of arm & serratus anterior

#### CONTENTS



- A Long head of biceps
- B Latissimus dorsi
- C Teres major
- ) Long thoracic nerve
- E Axillary vein
- F Axillary artery & cords
- 6 Pectoralis minor
- H Coracobrachialis
- I Short head of biceps
- + lymph nodes

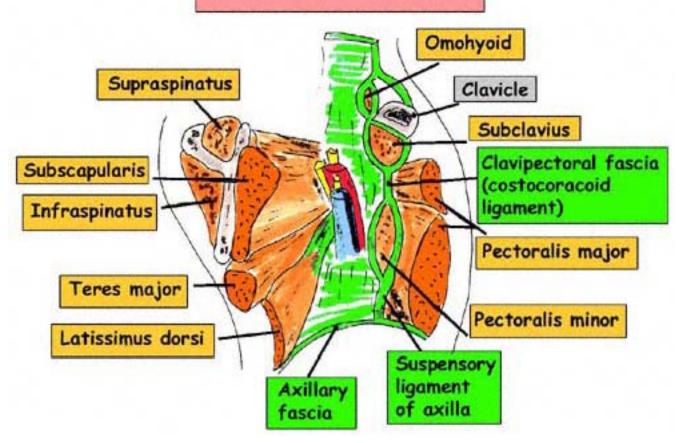




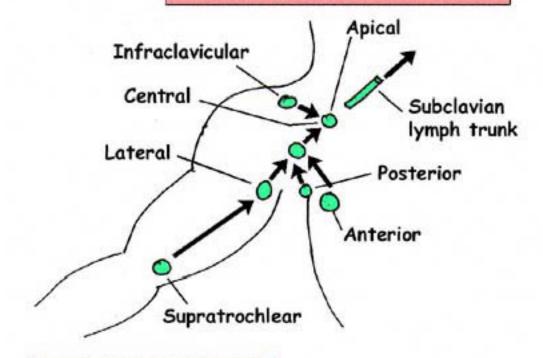
# Pierced by:

- Acromiothoracic trunk
- · Cephalic vien
- Lateral pectoral n
- Lymphatics

# LEFT AXILLA LOOKING LATERALLY



#### UPPER LIMB LYMPHATICS



# Mnemonic for axillary lymph nodes:

- A anterior
- P posterior
- I infraclavicular
- C central
- A apical
- L lateral

See page 69 in Instant Anatomy for details of drainage areas for each group of nodes

#### MUSCULOCUTANEOUS NERVE

Passes: Between conjoined heads of coracobrachialis then deep to biceps on brachialis

Supplies:

Elbow joint & its muscles

Gives: Lateral cutaneous nerve of forearm by emerging on lateral side of biceps

See page 118 Instant Anatomy for its branches

### RADIAL NERVE

Leaves: Axilla via lateral triangular space with profunda brachii artery

Spirals: Around behind upper fibres of medial head of triceps, against humerus only in lower groove

Covered by: Upper fibres of brachialis

Passes through: Lateral intermuscular septum to reach anterior compartment between brachialis and brachioradialis

To lie: Laterally in cubital fossa

See page 116 Instant Anatomy for its branches

#### **ULNAR NERVE**

On: Coracobrachialis

Enters: Posterior compartment via medial

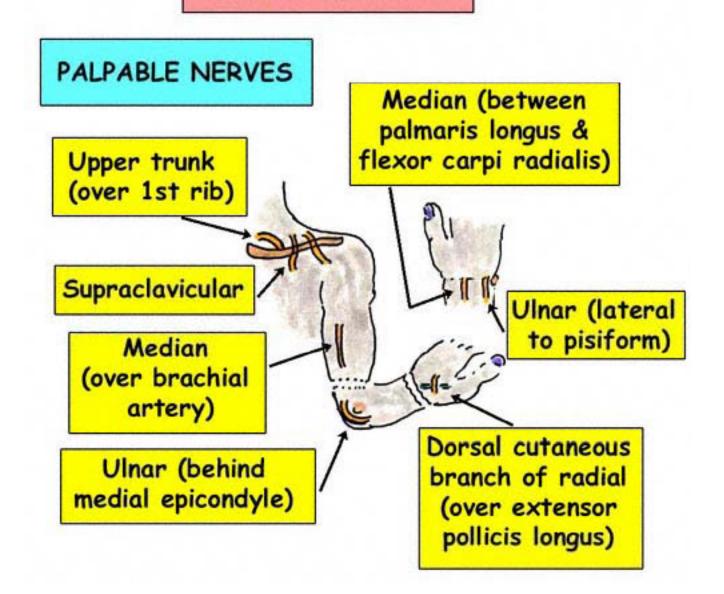
intermuscular septum

Passes: Posterior to medial epicondyle and between 2 heads of flexor carpi ulnaris

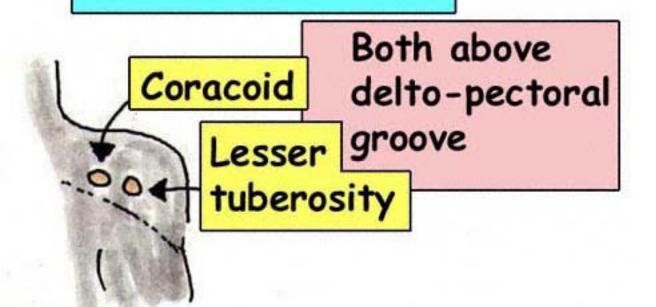
Lies: On flexor digitorum profundus and under flexor digitorum superficialis with ulnar artery on its lateral side

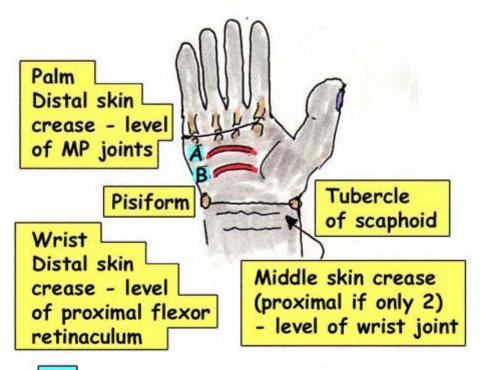
Enters: The hand by passing superficial to flexor retinaculum

See page 122 in Instant Anatomy for branches



# Bony prominences





- A Superficial palmar arch
  - Level with outstretched thumb
  - Made by ulnar artery
  - 1/2 way between distal palmar crease and distal wrist crease
- B Deep palmar arch
  - Made by radial artery
  - 1cm short of superficial arch

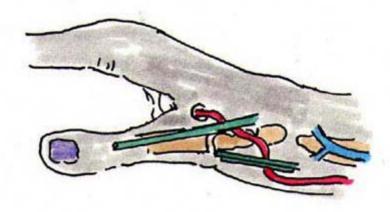
# SNUFF BOX

#### Boundaries

Extensor pollicis longus Extensor pollicis brevis Abductor pollicis longus

#### Contents

- Trapezium
- Scaphoid
- Radial artery
- · Cephalic vein



#### MEDIAN NERVE

Formed: By 2 heads anterior to 3rd part of axillary artery

Crosses: Brachial artery from lateral to medial

Lies: medial to brachial artery in cubital fossa

On: coracobrachialis then brachialis

Passes between: 2 heads of pronator teres

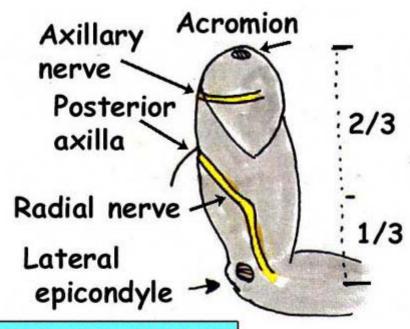
Lies between: flexor digitorum superficialis and profundus then deep to the flexor retinaculum

See page 120 in Instant Anatomy for branches



Henry's method for finding posterior interosseous nerve

3 fingers below radial head as it runs into supinator

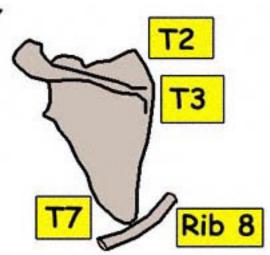


# RADIAL NERVE

From the junction of the posterior axilla and arm to a point 2/3 down a line from acromion to lateral epicondyle then anterior to the lateral epicondyle

# Scapula

- · Covers half ribs 2-7
- · 8th first rib below
- Upper border T2
- Medial spine T3
- · Lower border T7



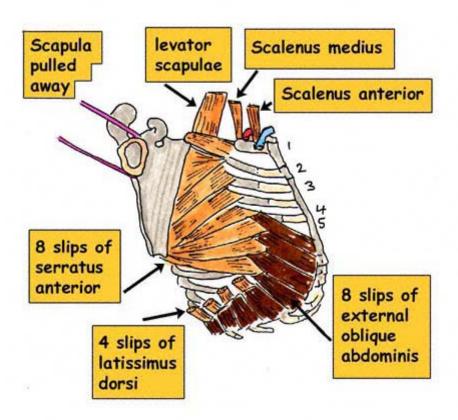
## Palpable structures

- Acromioclavicular joint
- Medial & lateral epicondyles
- Olecranon
- Head of radius
- Anconeus (post. to above)
- Radial & ulnar styloids
- Dorsal (Lister's) tubercle of radius
- Hook of hamate
- Biceps tendon & aponeurosis
- Brachial & radial pulses

# Function of any bone

- To give form
- Muscle attachments (not talus!)
- Movement
- Protection
- Metabolic
  - Ca, P
  - Haemopoiesis

## MUSCLES ATTACHED TO RIBS



#### PECTORALIS MAJOR

Clavicular head

Origin: Medial half of clavicle

Insertion: Anterior lamina (of trilaminar insertion) & lateral lip of bicipital groove, deep fascia, anterior lip of deltoid tuberosity



Anterior

Clavicular

Posterior Lowest

fibres

Highest fibres

Sternocostal

Sternocostal head

Origin: Anterior & lateral manubrium, body of sternum, aponeurosis of external oblique, upper 7 costal cartilages (not always 1st or 7th)

Insertion: Manubrial fibres to intermediate lamina. Sternocostal fibres to posterior lamina with highest fibres into capsule of shoulder

Action: Flexion, adduction, internal rotation

Nerve supply: Lateral & medial pectoral nerves

#### TRAPEZIUS

Origin:

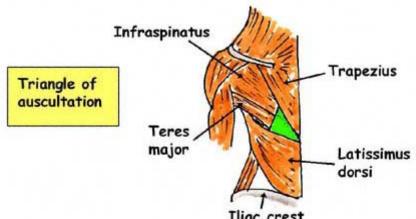
Superior nuchal line & crest, occiput, nuchal ligament, spines & supraspinous ligaments T1-12

Insertion: Lateral 1/3 clavicle, medial acromion, spine of scapula around to deltoid tubercle

Action:

Lateral rotation, elevation, depression & retraction of scapula (lower fibres elevate body when arm is fixed. Upper fibres extend & laterally flex head & neck. Rotation is aided by serratus anterior)

Nerve supply: Spinal root of accessory (XI)





Superior nuchal

line

T12

### LATISSIMUS DORSI

Origin:

Spines & supraspinous ligaments T7 down to sacrum, lumbar fascia, posterior 1/3 iliac crest, last 4 ribs & inferior angle of scapula

Insertion:

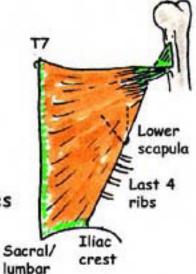
Flat tendon into floor of bicipital groove

Action:

Adducts, extends & medially rotates shoulder. Aids both inspiration & expiration

Nerve supply:

Thoracodorsal from posterior cord



fascia

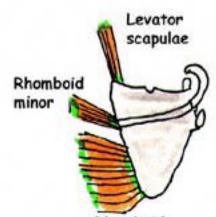
## RHOMBOID MAJOR

Origin: Spines of T2-5 & supraspinous ligaments

Insertion: Lower 1/2 posterior medial scapula

Action: Retracts & rotates scapula to rest position

Nerve supply: Dorsal scapular (C5 from root)



Rhomboid

#### RHOMBOID MINOR

Origin: Spines C7 & T1 and lower ligamentum nuchae

Insertion: Posteromedial scapula level with spine

Action: Retracts & rotates scapula to rest

Nerve Supply: Dorsal scapular (C5 from root)

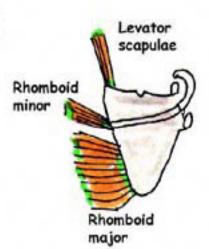
### LEVATOR SCAPULAE

Origin: Posterior tubercles of transverse processes C1-4

Insertion: Upper medial border of scapula

Action: Raises medial end of scapula

Nerve supply: Dorsal scapular (C5 root)



# PECTORALIS MINOR

Origin: Ribs 3,4,5

Insertion: Coracoid process

Action: Protracts scapula with serratus anterior

Nerve Supply: Medial & lateral pectorals

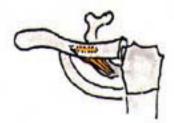
# SUBCLAVIUS

Origin: 1st rib, costochrondral junction

Insertion: Subclavian groove inferior middle clavicle

Action: Stabilises clavicle

Nerve supply: Nerve to subclavius (C5,6 off roots)



#### SERRATUS ANTERIOR

Origin:

Upper 8 ribs and intercostal membranes

Insertion: Inner, medial border of scapula

Action:

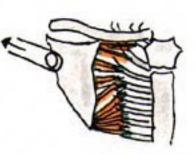
Protraction & lateral rotation of scapula

Nerve supply: Long thoracic nerve of Bell

C5 to slips 1 & 2

C6 to slips 3 & 4

C7 to slips 5,6,7,8



1st slip visible in posterior triangle of neck

### DELTOID

Origin:

Lateral 1/3 clavicle, acromion, Spine of scapula to deltoid tubercle

Insertion: Deltoid tubercle of humerus

Action:

Abducts arm. Anterior fibres flex & medially rotate. Posterior fibres extend & laterally rotate

Nerve supply:

Axillary (C5,6 posterior cord)



Anterior fibres



Posterior fibres

#### Special note

It is easy to see from the drawing that the way that the anterior & posterior fibres cross the joint, they will prevent the muscle from initiating abduction. But once supraspinatus has lifted the arm to 15 degrees all the deltoid fibres will become abductors.

#### TERES MAJOR

Origin: Oval area on lower 1/3
lateral side of inferior

angle of scapula

Insertion: Medial lip of bicipital groove

Action: Medial rotation, adduction, stabilisation of shoulder

Nerve supply: Lower subscapular (posterior cord C5,6)

TERES MINOR

Origin: Middle 1/3 lateral border of scapula

Insertion: Inferior facet of greater tuberosity & joint capsule

Action: lateral rotation & stabilisation of shoulder

Nerve supply: Axillary (C5,6 [posterior cord)



Posterior



Anterior



Teres minor

## SUBSCAPULARIS

Origin: Medial 2/3 subscapular fossa

Insertion: Lesser tuberosity of humerus, 1/2 medial lip of bicipital groove and joint capsule

Action: Medial rotation & stabilisation

Nerve supply: Upper & lower subscapular (C6,7 posterior cord)

#### SUPRASPINATUS

Supra-

spinatus

Infraspinatus

Origin:

3/4 supraspinous fossa and upper spine of scapula

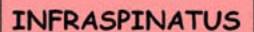
Insertion: Superior facet of greater tuberosity of humerus & joint capsule

Action:

Nerve supply:

Abducts and stabilises shoulder

Suprascapular (C5,6 upper trunk)



Origin:

Medial 3/4 infraspinous fossa & intermuscular septa

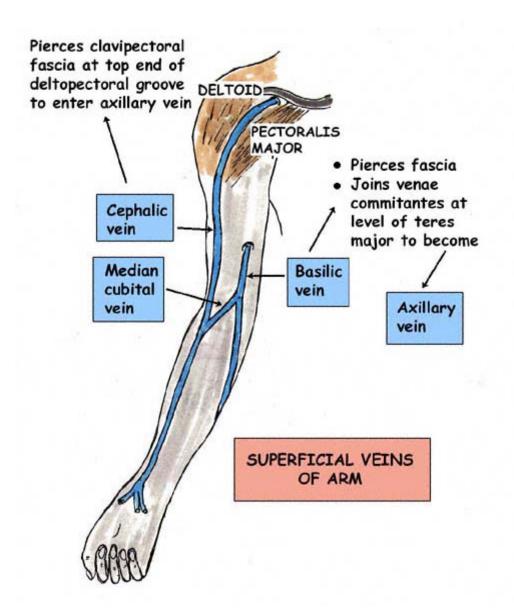
Insertion:

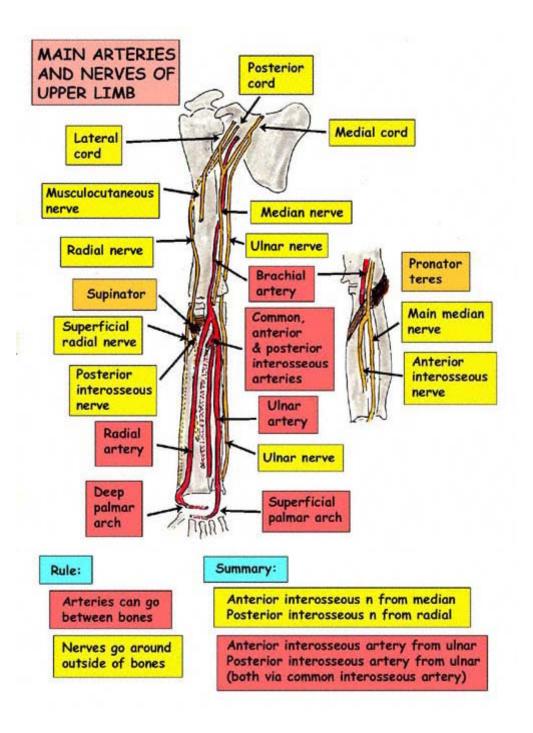
Medial facet of greater tuberosity of humerus and joint capsule

Action:

Lateral rotation & stabilisation

Nerve supply: Suprascapular (C5,6 upper trunk)





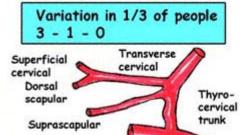
1st part
Medial to scalenus anterior
Arches over suprapleural
membrane

Branches (3):

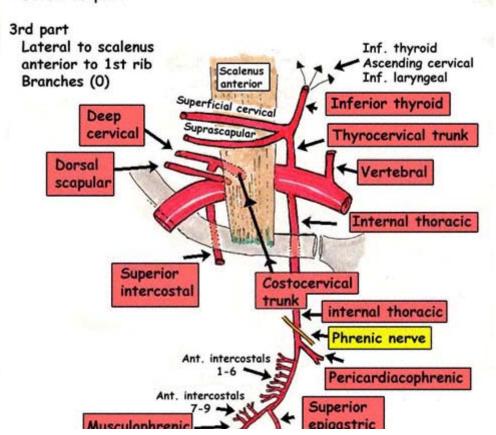
- Vertebral
- Internal thoracic
- Thyrocervical trunk

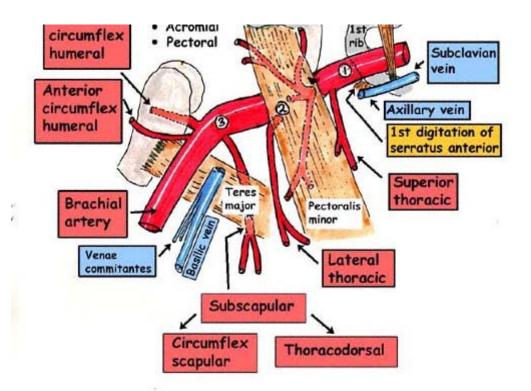
2nd part
Behind scalenus anterior
Branches (2):

- Costocervical
  - Deep cervical
  - Superior intercostal
- Dorsal scapular



It is only called "transverse cervical" if it gives origin to "dorsal scapular artery", instead of it arising from 2nd part of subclavian artery





1st part: Outer border 1st rib to medial edge of pectoralis minor

1 branch: SUPERIOR THORACIC

Relations: ant: subclavius, pectoralis minor, clavipectoral fascia

post: long nerve of Bell

med: axillary vein

lat: 3 cords of brachial plexus

2nd part: Behind pectoralis minor

2 branches: THORACO-ACROMIAL, LATERAL THORACIC

Relations:

ant: pectoralis major, pectoralis minor post: posterior cord, subscapularis

med: medial cord, axillary vein

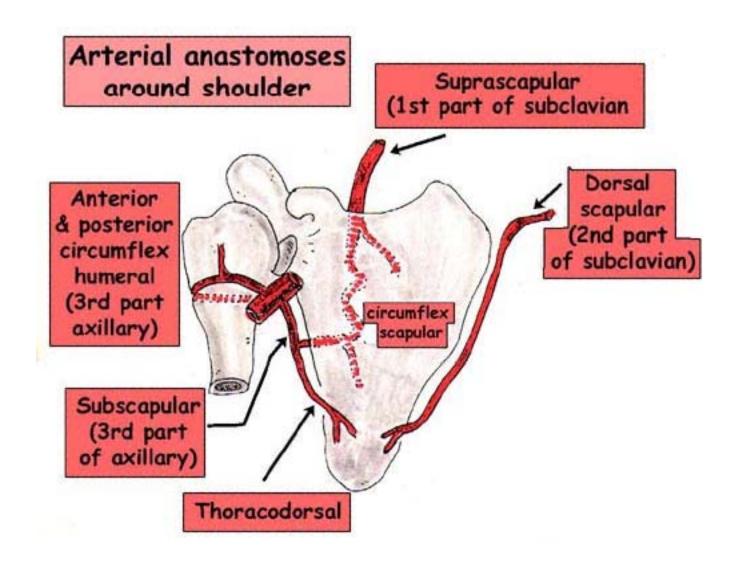
lat: lateral card

3rd part: lateral edge pect minor to lower border of teres major 3 branches: SUBSCAPULAR, ANT CIRCUMFLEX HUMERAL POSTERIOR CIRCUMFLEX HUMERAL

Relations:

ant: pectoralis major, median n





#### SUMMARY OF CRANIAL NERVES

I OLFACTORY SMELL

II OPTIC SIGHT

III OCULOMOTOR EYE MOVEMENTS

IV TROCHLEAR EYE MOVEMENTS

V TRIGEMINAL SENSORY (motor for mastication)

VI ABDUCENT EYE MOVEMENTS

VII FACIAL MOTOR (facial expression)

VIII VESTIBULOCOCHLEAR HEARING/BALANCE

IX GLOSSOPHARYNGEAL SENSORY TO TONGUE &

PHARYNX (single muscle motor)

X VAGUS PARASYMPATHETIC

XI ACCESSORY CRANIAL ROOT JOINS VAGUS

SPINAL ROOT motor TO

TRAPEZIUS & STERNOCLEIDO-

MASTOID

XII HYPOGLOSSAL MOTOR TO TONGUE

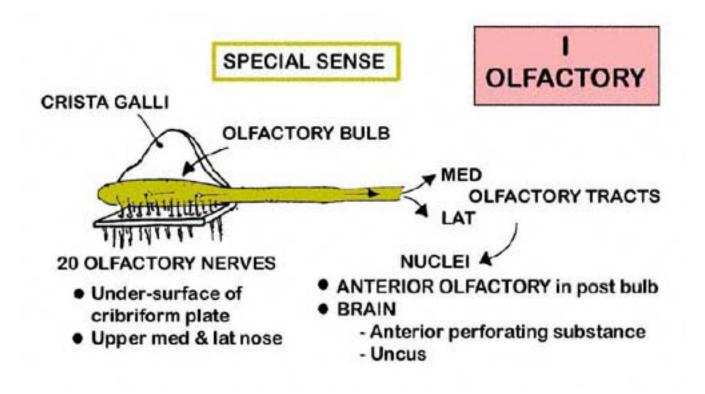
Special senses

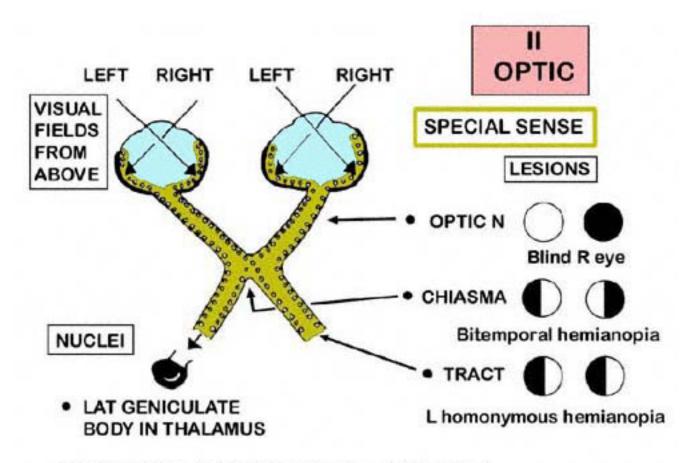
Motor-somatic or branchial

General sensory

Parasympathetic

This is a very simplified outline of the cranial nerves. Several of them carry sympathetic and parasympathetic fibres

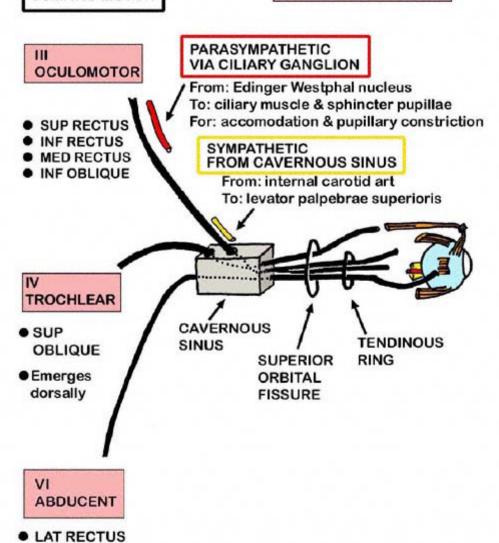


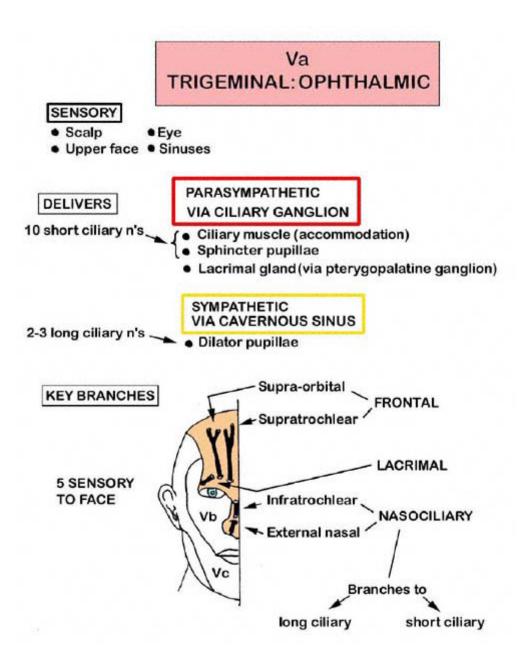


- PRETECTAL NUCLEUS: "Pupillary light reflex"
- SUP COLLICULUS: "Near reflex"
  - Accommodation
  - Pupillary constriction
  - Convergence

# III, IV, VI EYE MUSCLES

#### SOMATIC MOTOR





# Vb TRIGEMINAL: MAXILLARY

#### SENSORY

- Middle face
- Sinuses
- Palate
- Nasopharynx/nose

#### **DELIVERS**

# PARASYMPATHETIC VIA PTERYGOPALATINE GANGLION

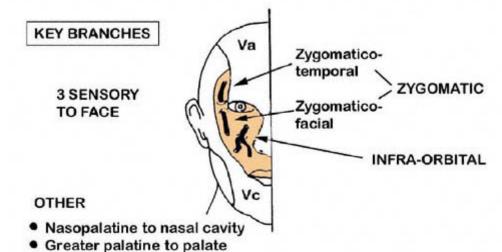
- Lacrimal gland
- Mucous glands of sinuses, nose, palate, nasopharynx

#### CARRIES

Lesser palatine to palate
Pharyngeal to nasopharynx
Alveolar to upper teeth

#### TASTE

Hard & soft palate



#### SENSORY

- Lower face
- Hairy temple
- Ant 2/3 tongue

#### BRANCHIOMOTOR

- Muscles of mastication
- Tensors tympani & palati

#### **DELIVERS**

# PARASYMPATHETIC VIA SUBMANDIBULAR & OTIC GANGLIA

Vc TRIGEMINAL: MANDIBULAR

(1st arch)

- Parotid gland
- Submandibular/sublingual glands
- Mucous glands floor of mouth, gums & sides of tongue

#### CARRIES

#### TASTE

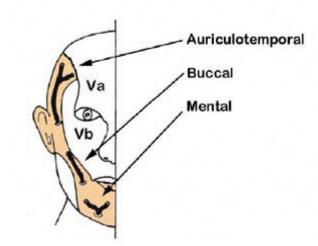
Ant 2/3 tongue

#### KEY BRANCHES

3 SENSORY TO FACE

#### OTHER

- Lingual
- Muscular



#### BRANCHIOMOTOR

VII FACIAL (2nd arch)

- Muscles of facial expression
- Stapedius
- Post belly digastric, stylohyoid, occipitofrontalis

#### SENSORY (via nervus intermedius)

Small contribution to external acoustic meatus

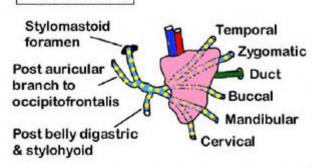
#### PARASYMPATHETIC (via nervus intermedius)

- Greater petrosal to pterygopalatine ganglion then to hay fever glands via Vb
- Chorda tympani to submandibular ganglion then to submandibular & sublingual glands via Vc

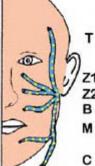
#### TASTE (via nervus intermedius)

- Palate via greater petrosal
- Ant 2/3 tongue via chorda tympani

#### **KEY BRANCHES**

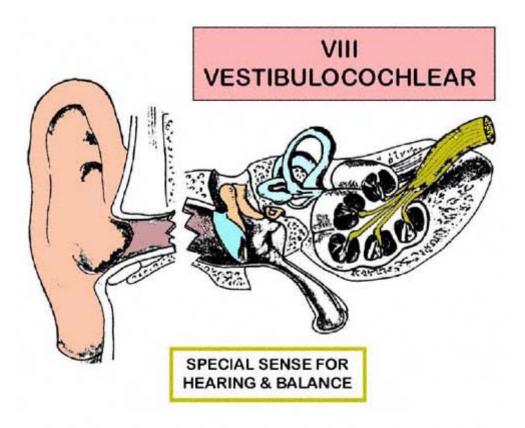


6 motor to muscles of facial expression



#### OTHER

- Greater petrosal
- Chorda tympani
- · Small sensory br
- N to stapedius



#### **COCHLEAR DIVISION - HEARING**

- From organ of Corti in cochlea
- Hair cells to cell bodies in spiral ganglion (in modiolus)
- To 2 cochlear nuclei (ventral & dorsal)

#### **VESTIBULAR DIVISION - BALANCE**

- From semicircular canals, utricle & saccule
- Cell bodies in vestibular ganglion in outer part of internal acoustic meatus
- To 4 vestibular nuclei (medial, lateral, superior & inferior)

#### SENSORY

- Oropharynx
- Post 1/3 tongue
- Tonsil
- Middle ear

# IX GLOSSOPHARYNGEAL (3RD ARCH)

#### SPECIAL VISCERAL SENSORY

Carotid body/sinus

#### BRANCHIOMOTOR

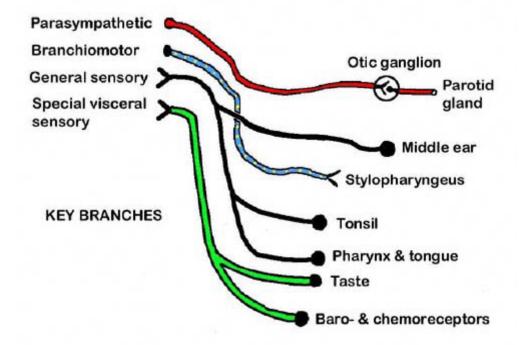
Stylopharyngeus

#### PARASYMPATHETIC

• Lesser petrosal n to otic ganglion to parotid gland via Vc

#### TASTE

Post 1/3 tongue & oropharynx



#### PARASYMPATHETIC

- Cardiac branches
- Thorax &abdomen

#### VISCERAL SENSORY

Thorax & abdomen

#### TASTE

Valleculae

BARO/CHEMO-RECEPTORS

## X VAGUS (4th & 6th arches)

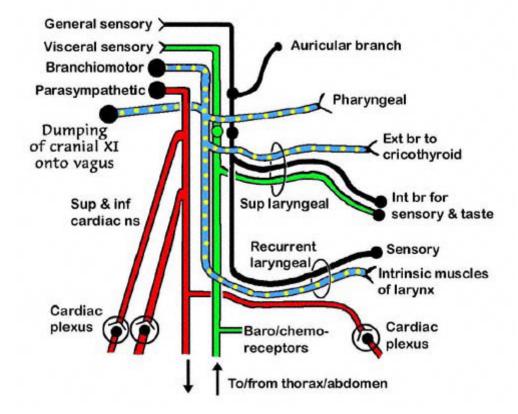
#### BRANCHIOMOTOR

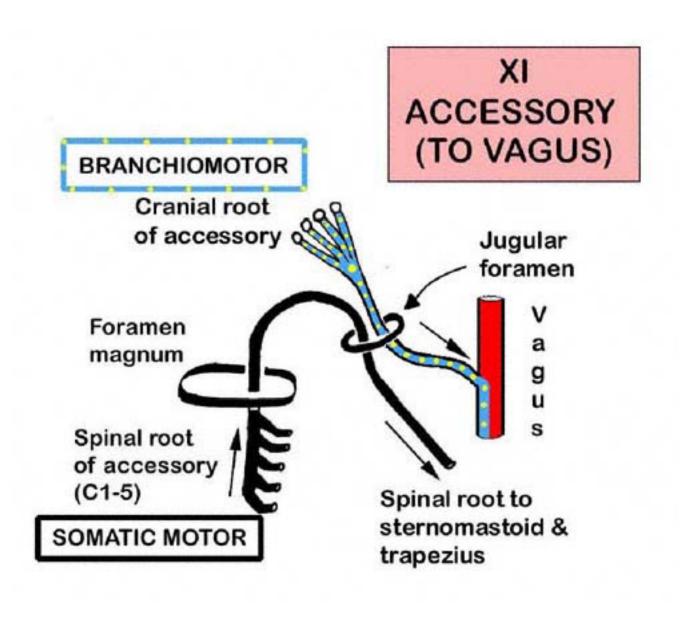
(from cranial accessory)

 Muscles of pharynx,larynx, palate & upper oesophagus

#### SENSORY

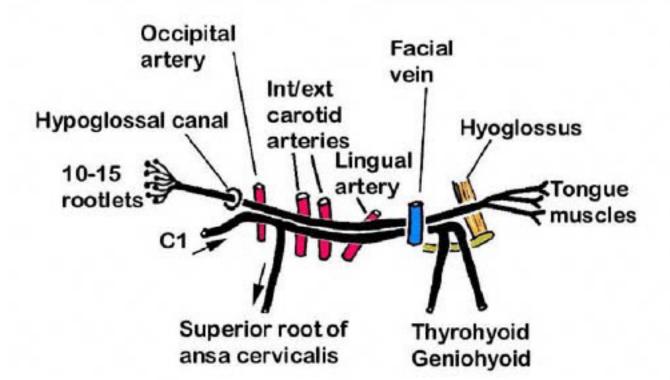
- Larynx, laryngopharynx, valleculae
- Small areas of skin: ext auditory meatus, eardrum & behind ear



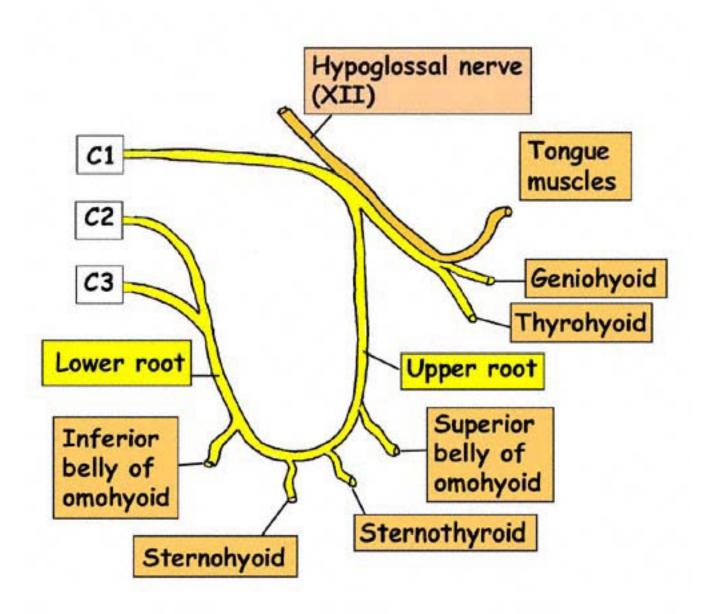


# SOMATIC MOTOR

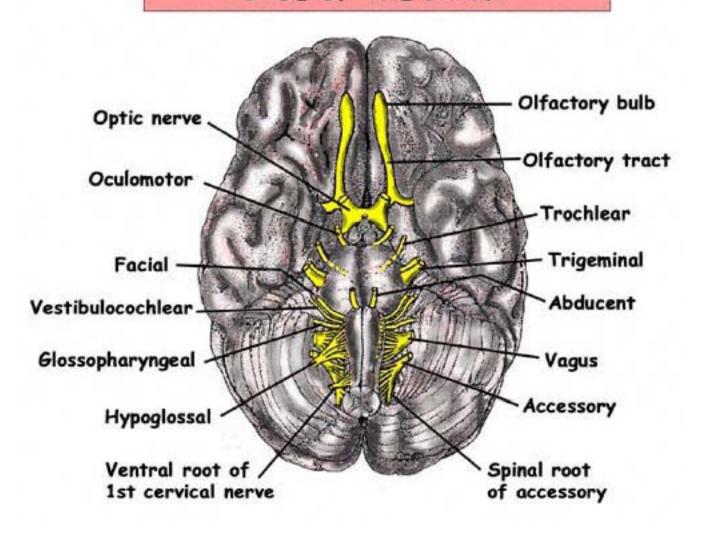
# XII HYPOGLOSSAL



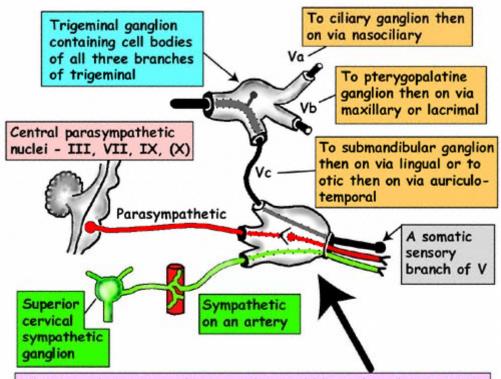
# ANSA CERVICALIS



# CRANIAL NERVES EMERGING FROM BASE OF THE BRAIN



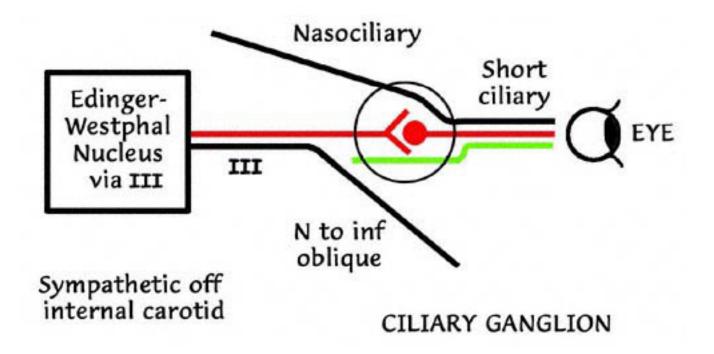
#### GENERAL PATTERN OF PARASYMPATHETIC GANGLIA

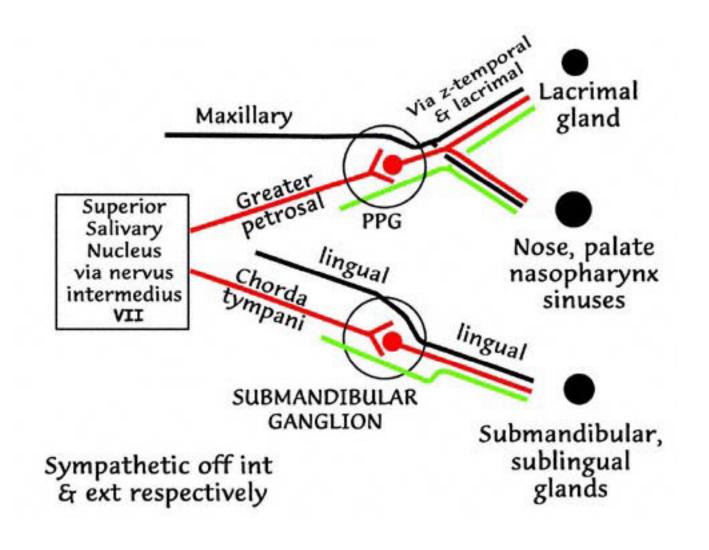


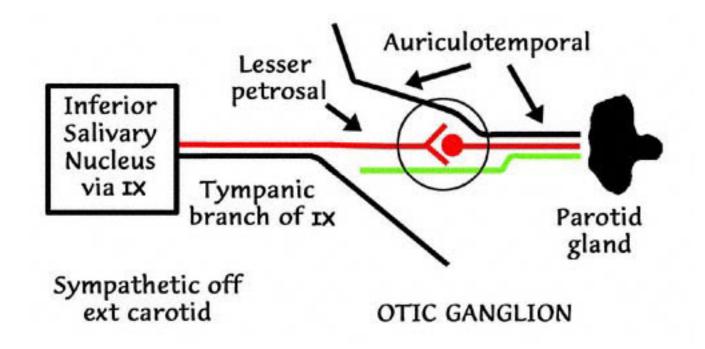
This typical parasympathetic ganglion could be either the CILIARY, OTIC, SUBMANDIBULAR OR PTERYGOPALATINE. Irrespective which one it is, there is always a parasympathetic nerve from either III, VII, or IX synapsing within it. Passing through it, and carrying the parasympathetic on to its end organ, is always a branch of the trigeminal.

Here we see a branch of Vc but it could have been a branch of Va or Vb.

Also through each ganglion passes a branch of the sympathetic from the superior cervical ganglion via an appropriate artery (internal carotid for the ciliary and pterygopalatine ganglia and external carotid for the submandibular and otic ganglia)

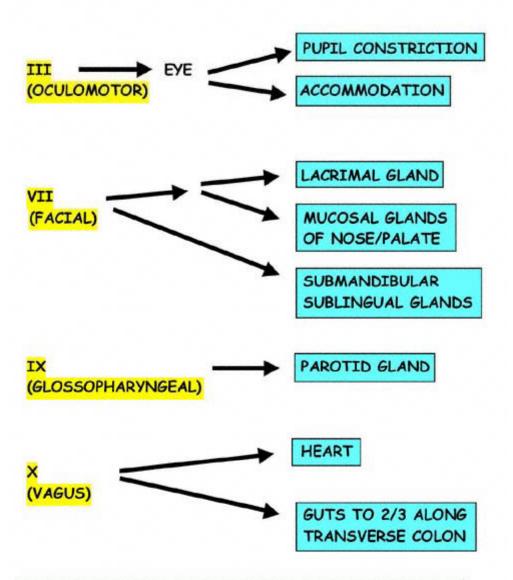






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## SUMMARY OF CRANIAL NERVES THAT CARRY PARASYMPATHETIC



(S 2,3,4 PELVIC OUTFLOW FOR PELVIC ORGANS & GUT BELOW VAGAL DISTRIBUTION)

#### GREATER PETROSAL NERVE

#### TEAR AND HAY FEVER

Nucleus:

Secretomotor - Superior salivary

Taste - Tractus solitarius

Nervus intermedius. Into internal auditory meatus with VII & VIII. Joins VII just before geniculate ganglion

Greater petrosal nerve emerges from geniculate ganglion & passes forwards & medially at 45 degrees through petrous temporal bone. Emerges in middle cranial fossa. Runs in a groove under the dura & under the trigeminal ganglion to reach foramen lacerum, on or near the internal carotid artery

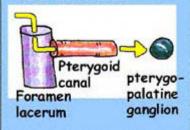
At geniculate ganglion.
Parasympathetic passes
through, incoming taste
have cell bodies here



Here it is joned by the deep petrosal nerve (sympathetic) off the artery & superior cervical ganglion. Greater petrosal + deep petrosal = nerve of pterygoid canal

Pterygoid canal opens into the pterygopalatine fossa. The nerve enters the pterygopalatine ganglion. Parasympathetics synapse, sympathetics & taste pass trhough unchanged. All nerves distributed with branches of Vb to nose, sinuses, hard/soft palate, nasopharynx, lacrimal gland

Nerve of pterygoid canal enters its canal via a hole in the anterior wall of the upper end of the foramen lacerum





#### LESSER PETROSAL NERVE

#### TO PAROTID GLAND

Nucleus: Inferior salivary.
Tympanic branch (also known as Jacobson's nerve) of IX
(glossopharyngeal nerve) leaves it just below the IX ganglion

Enters middle ear via the petrous temporal bone onto promontry where it mixes with sympathetic & parasympathetic from VII

It runs under the dura to reach foramen ovale where it exits the skull to reach the otic ganglion which hangs off the nerve to tensor tympani

Leaves middle ear high up on anteromedial wall as lesser petrosal nerve to enter middle cranial fossa via the petrous temporal bone

The parasympathetic in the lesser petrosal nerve synapses in the otic ganglion. Sympathetics which joined the nerve from the middle meningeal artery, pass right through

The postganglionic fibres join the auriculotemporal nerve (Vc) which carries them to the parotid gland

#### Note on Frey's Syndrome

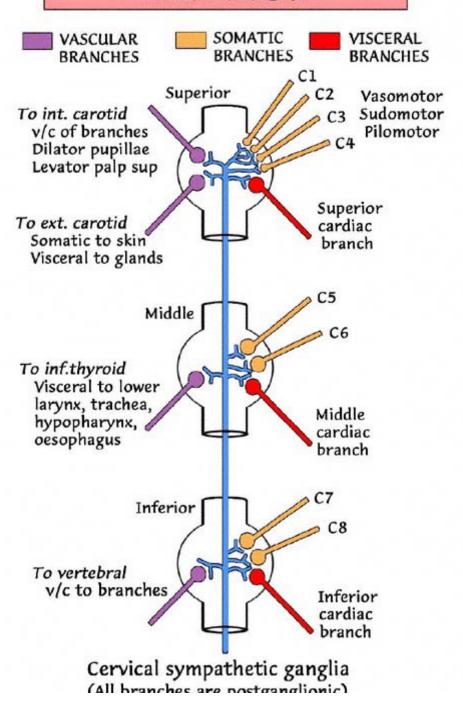
During parotid surgery the parasympathetic secretomotor fibres in the auriculotemporal nerve can be damaged. When they regenerate they sometimes grow up the sheaths of the sympathetic nerves that supply the sweat glands on the hairy temple. As sweat glands have cholinergic receptors these parasympathetic fibres are able to stimulate the sweat glands inappropriately and this gives "qustatory sweating"

#### CHORDA TYMPANI

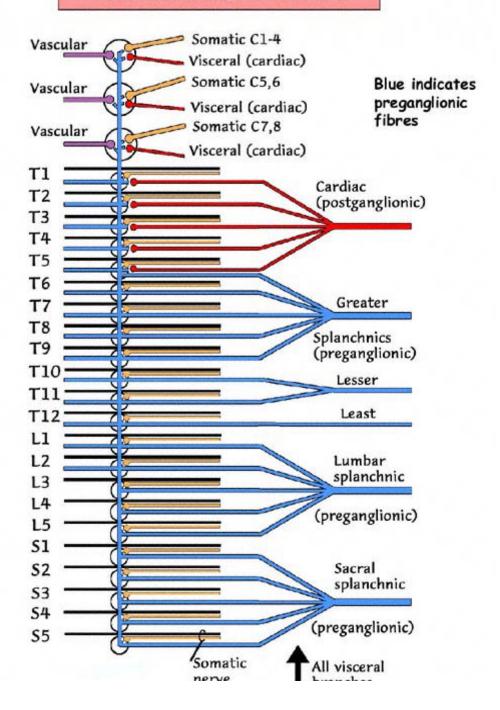
SECRETOMOTOR FOR SUBMANDIBULAR AND SUBLINGUAL GLANDS TASTE FROM ANTERIOR 2/3 TONGUE

Nervus intermedius. Into Nucleus - Superior salivary internal auditory meatus Taste - Tractus solitarius with VII & VIII. Joins VII just before geniculate ganglion Chorda tympani leaves the facial nerve (VII) 6mm obove At geniculate ganglion. the stylomastoid foramen, below the floor of the middle Parasympathetic passes through, incoming taste ear. It passes back into the have cell bodies here middle ear via its posterior wall It leaves the middle ear via the anterior canaliculus in the It passes across the handle anterior wall, through the of the malleus and the pars petrous temporal bone & flaccida of the tympanic exits via the petrotympanic membrane, under the mucosa fissure It leaves the lingual nerve to reach the submandibular In the infratemporal fossa it ganglion where parasympathetic passes medial to, & grooves the fibres synapse before supplying spine of the sphenoid. It then the submandibular & sublingual passes antero-inferior, deep salivary glands. Returning taste to lateral pterygoid to join the from the anterior 2/3 of tongue lingual nerve 2cm below skull keep with the lingual nerve. Sympathetic fibres pass through the ganglion from the facial artery

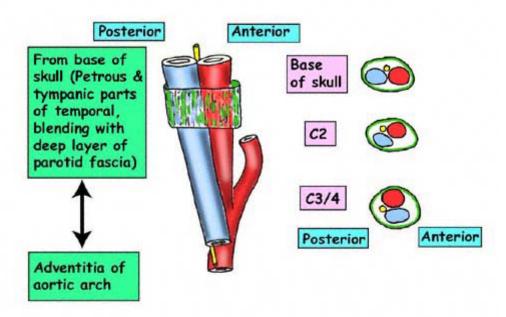
### CHAIN IN NECK



# OVERVIEW OF CONNECTIONS TO SYMPATHETIC CHAIN



#### CAROTID SHEATH

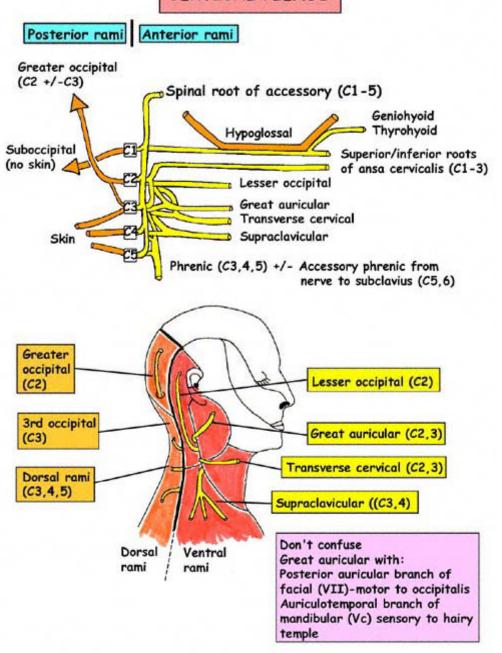


- It fuses with pretracheal fascia and the investing fascia under sternocleidomastoid
- The ansa cervicalis is in the carotid sheath over the internal jugular vein
- Escaping from the upper sheath are: glossopharyngeal (IX), superior laryngeal branch of vagus (X), spinal root of accessory (XI) and hypoglossal (XII) nerves

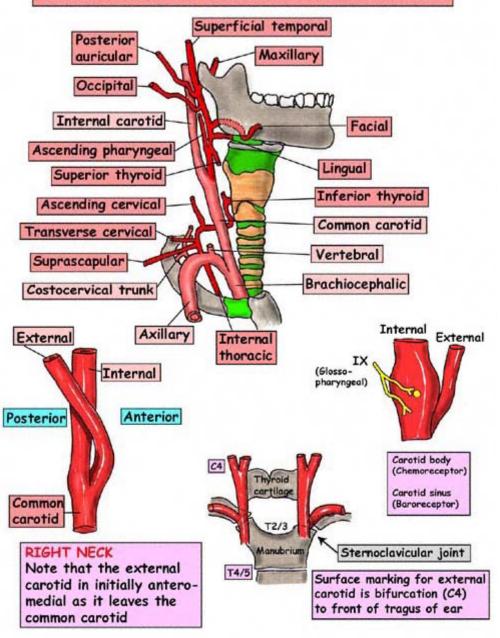


Sheath is thinnest over vein

## CERVICAL PLEXUS

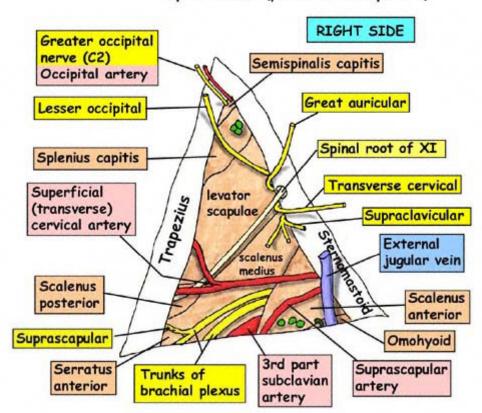


# RIGHT EXTERNAL CAROTID ARTERY AND BIFURCATION OF COMMON CAROTID ARTERY



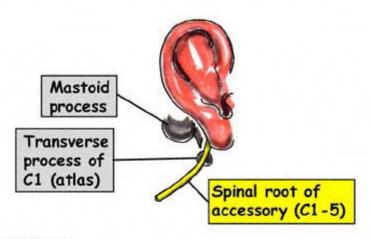
#### POSTERIOR TRIANGLE OF NECK

- Boundaries: Posterior border of sternocleidomastoid, anterior border of trapezius, mid 1/3 clavicle
- · Shape: Spiral
- Roof: Investing fascia, platysma, external jugular vein
- Floor: Prevertebral fascia covering muscles, subclavian artery, trunks of brachial plexus & cervical plexus
- · Contents:
  - · Arteries: Occipital, superficial cervical, suprascpular
  - · Veins: Transverse cervical, suprascapular, external jugular
  - Nerves: Branches of cervical plexus, spinal root of accessory
  - · Muscle: Omohyoid with its sling
  - Lymph nodes: Occipital (rubella/scalp infections)
     Supraclavicular (part of the deep chain)



#### SPINAL ROOT OF ACCESSORY NERVE

#### SURFACE MARKINGS



#### Method one

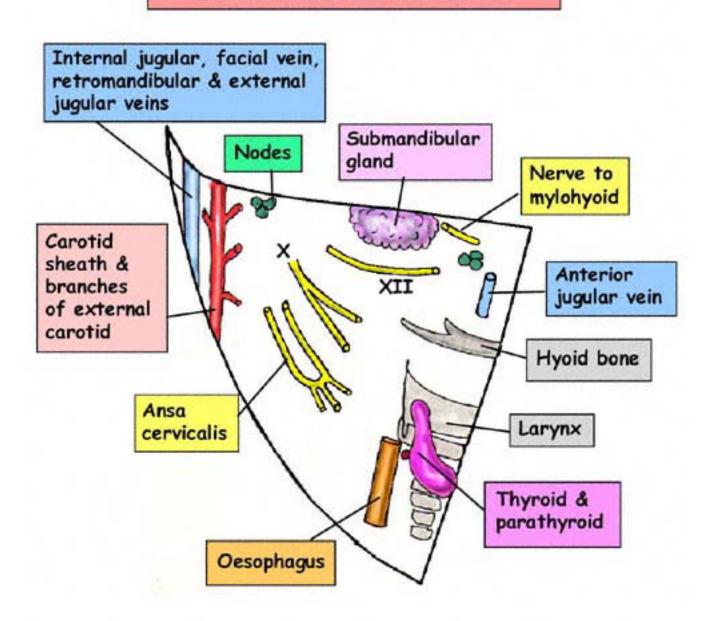
- Find transverve process of atlas just anterior mastoid process
- 2. Draw a line to anterior border of trapezius, 5cm above the clavicle
- This is the line of the nerve through sternocleidomastoid and posterior triangle

#### Method two

- Draw a line from a third of the way down the posterior border of sternocleidomastoid to a third of the up the anterior border of trapezius
- This is the line of the nerve through sternocleidomastoid and posterior triangle

For details of sternocleidomastoid, see muscle section of Instant Anatomy

# ANTERIOR TRIANGLE OF NECK DIAGRAM OF CONTENTS



## NECK MUSCLES 1



#### OMOHYOID

Transverse suprascapular ligament via clavicle to hyoid

Nerve: Ansa cervicalis (C1-3)



#### STYLOHYOID

Base/back of styloid process to hyoid Nerve: Facial nerve (VII)



#### STERNOHYOID

superior/lateral/posterior manubrium to hyoid

Nerve: Ansa cervicalis (C1-3)



#### THYROHYOID

Oblique line on thyroid cartilage to hyoid

Nerve: C1 fibres on hypoglossal



#### MYLOHYOID

Mylohyoid line on inner mandible. 3/4 into midline raphe, rest into hyoid Nerve: Nerve to mylohyoid (Vc)

Fuller details in muscle section of Instant Anatomy

## NECK MUSCLES 2



#### GENIOHYOID

Inferior mental (genial) spine on mandible to hyoid

Nerve: C1 fibres on hypoglossal



#### DIGASTRIC

Digastric notch on mastoid, via sling on hyoid to digastric fossa on back of anterior mandible Nerve: Anterior belly - nerve to mylohyoid (Vc) Posterior belly - facial nerve (VII)



#### STERNOTHYROID

Posterior manubrium to oblique line on thyroid cartilage

Nerve: Ansa cervicalis (C1-3)



#### PLATYSMA

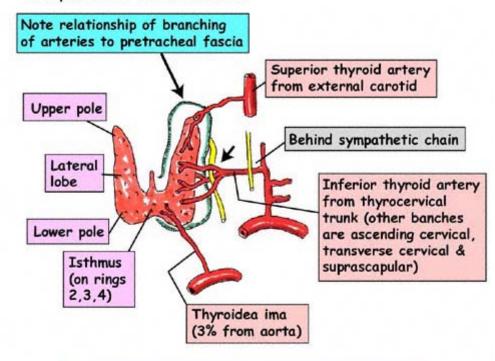
(Panniculus carnosus) Deep fascia under breasts to inferior border of mandible

Nerve: Cervical branch of facial (VII)

Fuller details in muscle section of Instant Anatomy

#### THYROID GLAND - GENERAL & BLOOD SUPPPLY

Bilobed, lobulated & 5cm long, extending to tracheal ring 6 Sheild shaped & lies on corotid sheath Limited extension upwards by sternothyroid Can pass below into mediastinum



Note intimate relationship of branches of the inferior thyroid artery to the recurrent laryngeal nerve

### THYROID GLAND - SURGICAL ASPECTS







NORMAL

PARTIAL THYROIDECTOMY

SUBTOTAL THYROIDECTOMY

#### **HYPERTHYROIDISM**

80% Graves' disease (auto-immune) 10% Multinodular goitre 5% Toxic adenoma

#### INDICATIONS FOR SURGERY(subtotal or nodule excision)

Failed medical treatment
Poor drug compliance
Large goitre/nodule
Compression - trachea, oesophagus, superior vena cava
Retrosternal extension

#### RISKS OF SURGERY

To parathyroids
To recurrent laryngeal/superior laryngeal nerves (1%)

Note that right recurrent laryngeal nerve can enter larynx directly from vagus and not pass around subclavian artery

## THYROID GLAND - AXIAL SECTION AT C7

## Relations of thyroid gland

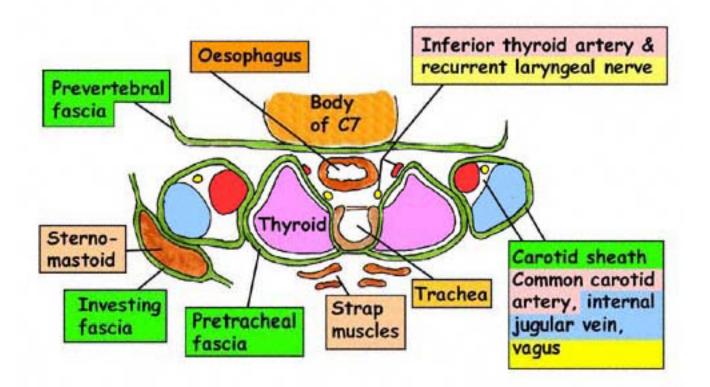
Posterior: Prevertebral fascia, carotid sheath, parathryoids,

trachea

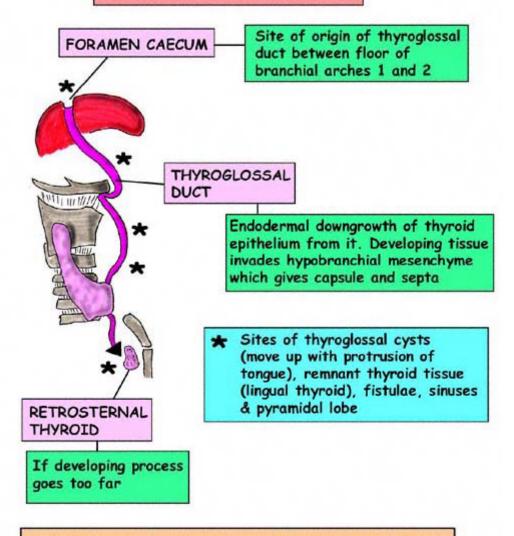
Medial: Recurrent laryngeal nerve, trachea, larynx, oesophagus

Anterior: Pretracheal fascia, sternohyoid, sternothyroid

venous arch

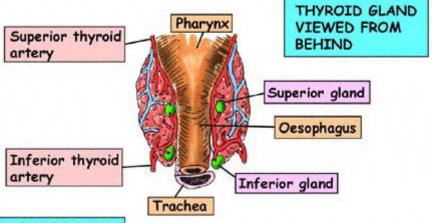


#### THYROID - DEVELOPMENT

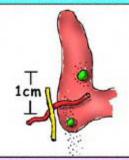


Note: The ultimobranchial bodies (5th pouch) give "C" cells

#### PARATHYROID GLANDS



NORMAL POSITIONS AND VARIATIONS



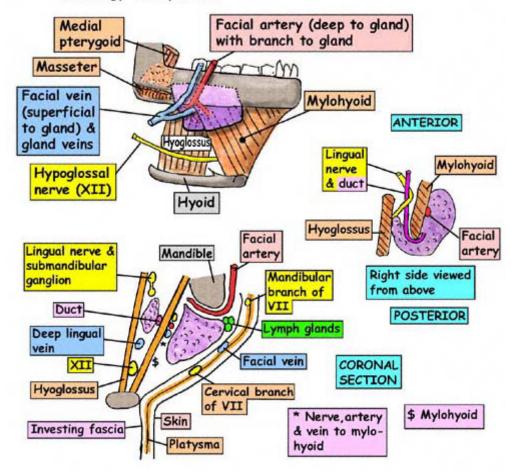
Recurrent laryngeal nerve crossing behind & in amongst the branches of the inferior thyroid artery

- 4 (3-6) pinkish/brown glands
- Weighing 50mg & 6x3x2mm each
- Usually lie within pretracheal fascia
- Superior (develops from endoderm of dorsal diverticulum of 4th arch).
   Less variation in position
- Inferior (Is dragged down with thymus from 3rd pouch). More variation even into upper mediastinum
- Blood supply: Inferior thyroid arteries
- Nerves: Sympathetics on arteries for vasoconstriction
- Histology:
- Homogeneous
- · Very vascular
- · Small round cells
- No follicles
- Irregular columns

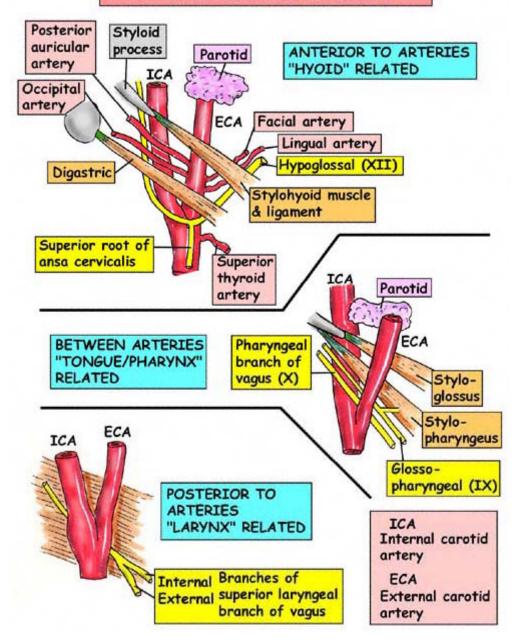
Function: Produces parathormone (PTH)
 Increases tubular reabsorption of calcium
 Decreases tubular reabsorption of phosphate/bicarbonate
 Mobilises calcium from bones to give hypercalcaemia
 and hypercalciuria

#### SUBMANDIBULAR GLAND

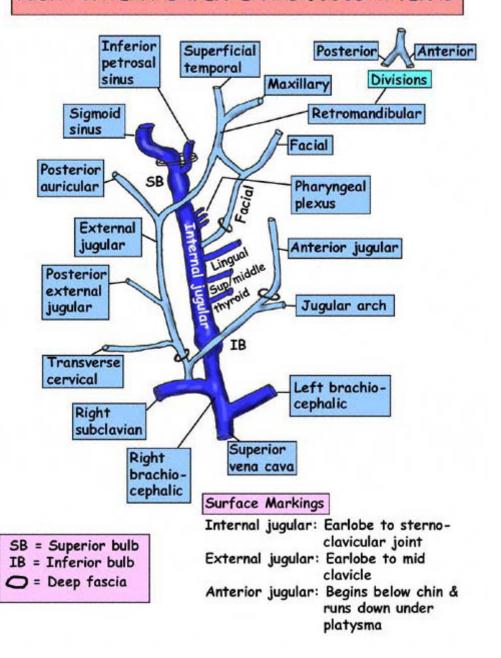
- · Mixed mucous and serous
- 2 parts Superficial: larger. Deep: smaller. Join behind posterior edge of mylohyoid
- Duct: (Wharton's) 5cm long. First between mylohyoid & hyoglossus, then between sulingual gland and geniohyoid.
   Opens in floor of mouth beside frenulum. Develops in ectoderm from a groove in the floor of mouth
- · Produces 70% of the saliva
- Lymph nodes in it and on it. Drain to submandibular glands
- Histology: See parotid



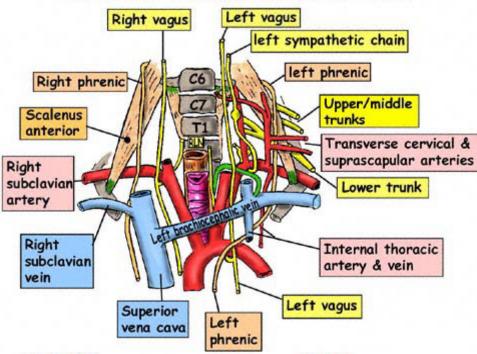
# RELATIONS OF THE BIFURCATION OF THE CAROTID ARTERIES



# RIGHT INTERNAL & EXTERNAL JUGULAR VEINS



### RELATIONS TO SCALENUS ANTERIOR



#### ANTERIOR

- Phrenic nerve (Under prevertebral fascia)
- · Ascending cervical artery
- Transverse cervical/suprascapular arteries
- Carotid sheath
- Vagus
- Thoracic duct
- Lower belly of omohyoid
- Deep cervical notes

#### POSTERIOR

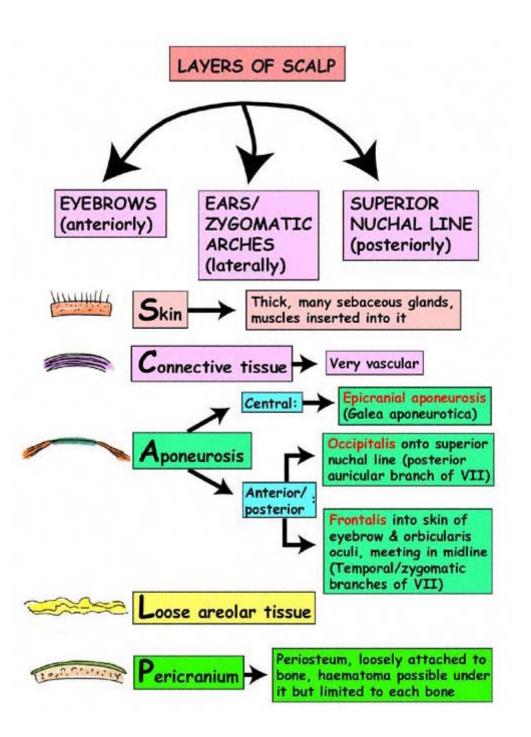
- 2nd part subclavian artery
- Anterior rami C3-T1
- Costocervical trunk
- Superior intercostal & deep cervical arteries
- Scalenus Medius

#### MEDIAL

- longus coli
- Carotid tubercle
- Pyramidal space
- Carotid sheath
- Stellate ganglion
- Vertebral artery
- Middle cervical ganglion
- Inferior thyroid artery
- 1st part subclavian artery
- Ansa subclavia
- Thyrocervical trunk
- Vertebral vein

#### LATERAL

- · Trunks of brachial plexus
- 3rd part subclavian artery



# TEMPORAL FOSSA

The space beneath temporalis muscle

Above: Superior (A) & inferior (B) temporal lines

Roof: Temporalis fascia

Posterior: Supramastoid crest (C)

Floor: Skull - pterion (D)

Anterior: Zygoma (E), zygomatic process of frontal bone (F) &

zygomatic process of maxilla (G)

Below: Zygomatic arch & zygomatic process of temporal bone (H) Contains: Temporalis, deep temporal arteries (maxillary), deep

temporal nerves (Vc)

Superficial temporal artery (I) from external carotid

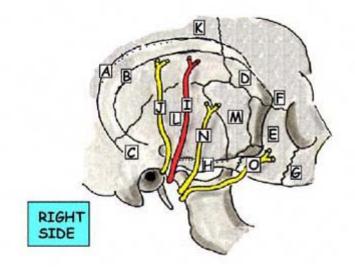
Auriculatemporal nerve (J) from Vc

Temporalis: See muscle section of Instant Anatomy

Other structures shown: Parietial bone (K), temporal bone (L),

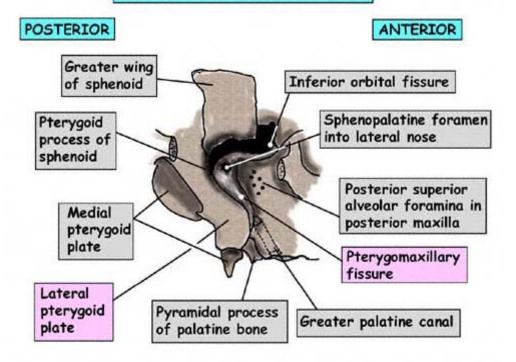
greater wing of sphenoid (M), Temporal branch of VII (N)

zygomatic branch of VII (O)



## PTERYGOPALATINE FOSSA 2

#### LOOKING INTO THE RIGHT SIDE



Lateral access into the fossa is via the pterygomaxillary fissure. Other entry and exit sites are shown on a separate illustration

# EXTERNAL NOSE

Breathing. Stops during swallowing

• Warming air

Moistening air

Filtering air

• Smell

Conchae & sinuses increase the

surface area, the epithelium is

vascular, there are cilia and mucus is secreted

EXTERNAL NOSE is cartilage and fibrofatty tissue

Nerve supply: External nasal (terminal anterior ethmoidal) Va
 Supratrochlear (frontal) Va
 Infratrochlear (nasociliary) Va
 Infra-orbital (maxillary) Vb

Blood supply: Dorsal nasal (ophthalmic)
 External nasal (anterior ethmoidal)

Facial (lateral nasal & septal branches)

# NASAL CAVITY BOUNDARIES & CORONAL VIEW

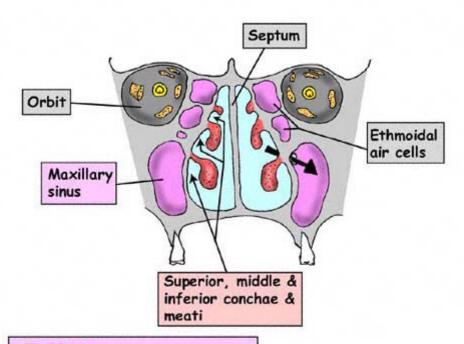
• Nasal cavity extends from nares to choanae (posterior septum)

• Floor: Hard palate

• Roof: Sphenoid and ethmoid

· Medial wall: Septum

· Lateral wall: medial orbit, ethmoidal air cells, maxillary sinus



## MUCOSA

Olfactory nerve Vestibular - skin & hair Respiratory - Pseudostratified ciliated columnar

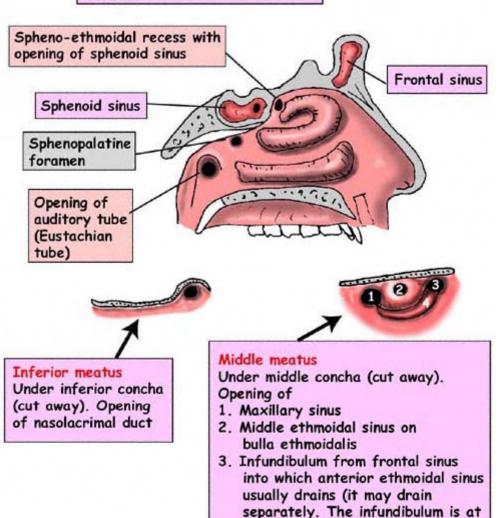
## LATERAL WALL OF LEFT NASAL CAVITY

#### Superior meatus

Under superior concha (cut away).

Opening of posterior ethmoidal
air cells

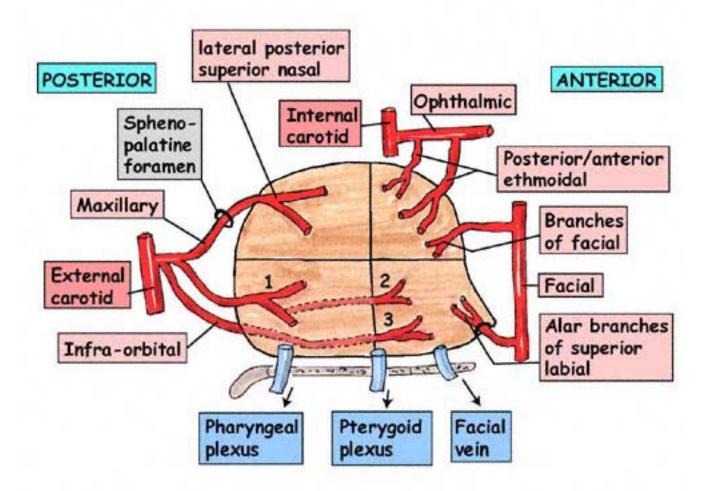




the anterior end of the

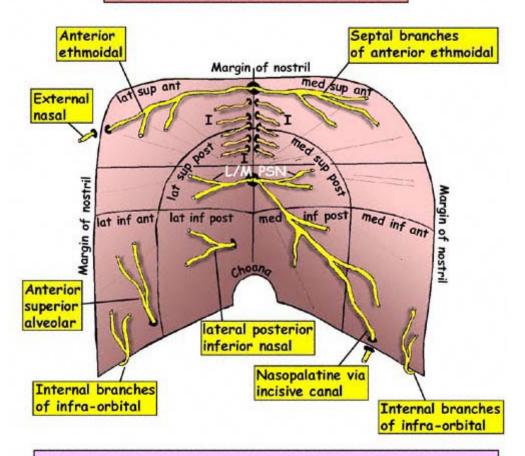
4. Hiatus semilunaris

# BLOOD SUPPLY OF LATERAL WALL OF NOSE



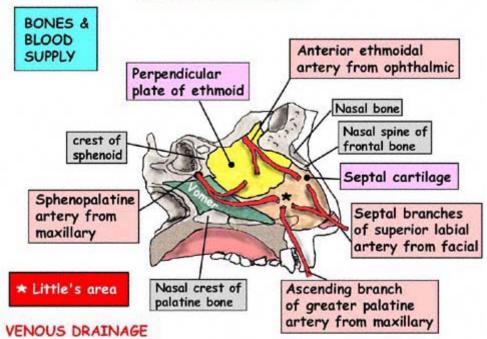
- 1. Branch of greater palatine
- 2. Perforating branches of greater palatine
- 3. Anterior superior alveolar from infra-orbital

# NASAL CAVITY - NERVE SUPPLY VIEW UP RIGHT NOSTRIL



L/M PSN = Lateral & medial posterior superior nasal, from
nasopalatine, from Vb, from pterygopalatine ganglion
Anterior ethmoidal from nasociliary, from Va
Lateral posterior inferior nasal, from greater palatine, from Vb,
from pterygopalatine ganglion
Nasopalatine from Vb, from pterygopalatine ganglion
Anterior superior alveolar, from infra-orbital, from Vb
Infra-orbital, from Vb

## NASAL SEPTUM



Anterior - to face

Posterior - to pterygoid plexus. Also via ethmoidal veins to ophthalmic and inferior cerebral veins. 1% via foramen caecum to superior sagittal sinus

#### LYMPHATIC DRAINAGE

Lateral wall and septum. Posterior: to retropharyngeal and to anterior/superior deep cervical. Anterior: to submandibular

#### LINING

Respiratory epithelium - pseudostratified ciliated columnar with mucous cells and very vascular

Olfactory epithelium - ciliated nerve cells, yellowish, on roof & septum, under superior concha & in spheno-ethmoidal recess





# PARANASAL SINUS - GENERAL

- 4 pairs
- · Lined by respiratory epithelium
- · Communicate with nose via ostia
- Abundant sensory nerve supply at ostia
- Mucus is drained by cilia
- Function unknown but they lighten the skull, warm & moisten the air, resonate the voice

MAXILLARY ETHMOIDAL SPHENOIDAL

FRONTAL

AT BIRTH

Small

Absent (appear at 2y)

6-7 YEARS (2ND DENTITION)

Enlarge

Enlarge

POST PUBERTY BONE GROWTH

Large

large

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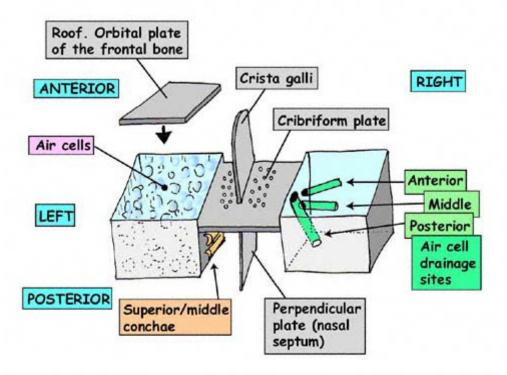
POST PUBERTY BONE GROWTH

Large

large

### ETHMOIDAL SINUSES

Diagrammatical representation of the ethmoid bone to show the left and right ethmoidal sinus joined by the cribriform plate. The roof of the air cell containing sinuses on each side is the orbital plate of the frontal bone. Anterior to the ethmoid bone is the lacrimal bone & posterior is the sphenoid bone



Ethmoidal sinuses lie between the orbit & nose in the lateral (labyrinthine) part of the bone

Septa lie between 3-18 lots of air cells

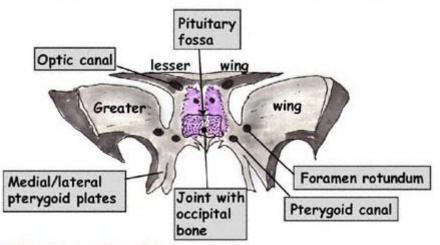
Blood supply: Supra-orbital, anterior/posterior ethmoidal,

sphenopalatine

Lymph drainage: Submandibular and retropharyngeal

Nerve: Supra-orbital (Va), Anterior ethmoidal (Va), lateral posterior superior nasal (Vb), posterior ethmoidal (Va)

# SPHENOID BONE VIEWED POSTERIORLY TO SHOW SINUSES



#### SPHENOIDAL SINUSES

Paired in body of sphenoid Septum: Asymmetrical

If small: Then anterior to pituitary fossa

If large: Then beneath pituitary fossa, extending

posteriorly to basi-occiput and laterally into

greater wing

Ostium: In anterior wall opening into spheno-ethmoidal recess

Laterally: Cavernous sinuses, internal carotid artery and

maxillary nerve

Posteriorly: Posterior cranial fossa and pons

Inferiorly: Roof of nasopharynx, nerve of pterygoid canal

and palatovaginal canal (containing pharyngeal

branch of Vb)

Walls: Indented by pterygoid & palatovaginal canals,

internal carotid artery and maxillary nerve (Vb)

Nerve supply: Posterior ethmoidal (Va) & branches of

pterygopalatine ganglion

Blood supply: Posterior ethmoidal & sphenopalatine branches of

maxillary artery

Lymph drainage: Retropharyngeal

# MOUTH - GENERAL

From lips to palatoglossal fold (anterior pillar of fauces)

Vestibule is between teeth/gums and cheek. Emptied by buccinator

Roof is hard palate

Floor is tongue

Functions are eating, talking and extra airway

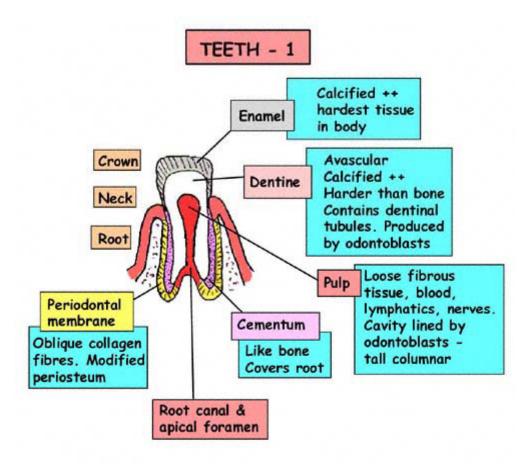
Sensations are taste, temperature, touch. Tongue/lips assess

Mucous membrane is stratified squamous. Nerve supply is Vb & Vc

(buccal, mental, infra-orbital). Contains salivary glands,

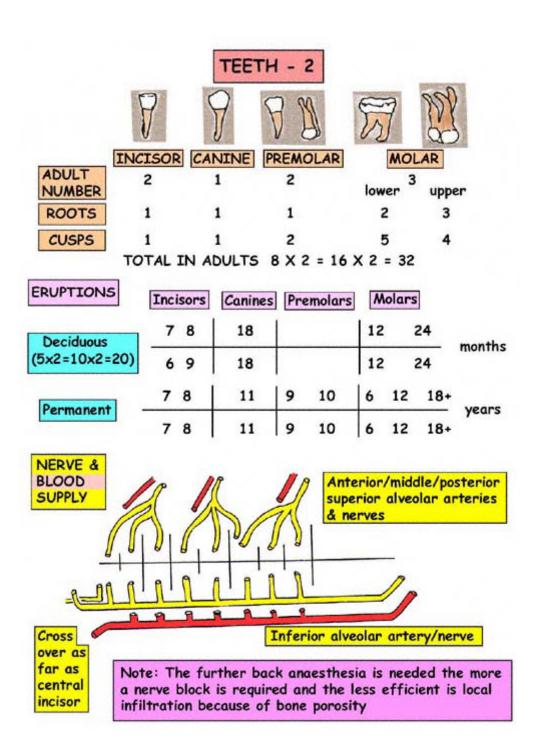
pierced by parotid duct (2nd upper molar tooth) and ducts

of glands



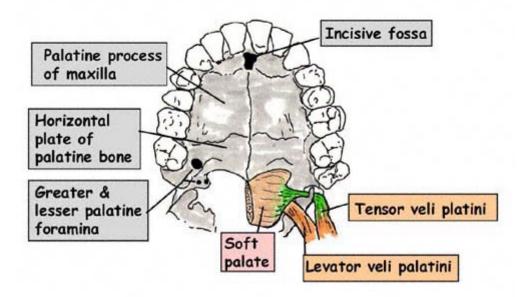
#### Development

- · Budding of mouth ectoderm gives enamel
- Mesoderm is evoked to produce dentine & cementum
- Ameloblasts give enamel
- Mesoderm gives dental papillae which give odontoblasts which give dentine
- Dental papilla also gives pulp



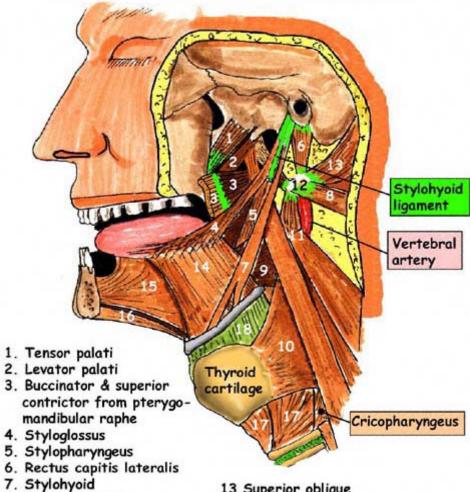
# HARD PALATE

- Mucoperiosteum (mucosa + periosteum)
- · Sharpey's fibres into pits on bone
- Blood supply: Greater palatine artery
- Venous drainage: Pterygoid plexus
- Lymph: Retropharyngeal and deep cervical nodes
- Nerve supply: Greater palatine and nasopalatine



See muscle section of Instant Anatomy for details of Tensor and Levator Veli Palatini

# MUSCLES OF TONGUE, MOUTH & NECK



13 Superior oblique

8. Inferior oblique

9. Middle constrictor

11 Transverse process

12 Transverse process

10 Thyropharyngeus

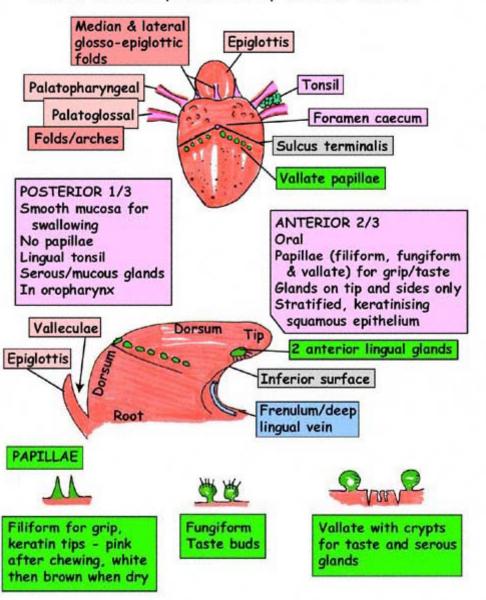
of axis

of atlas

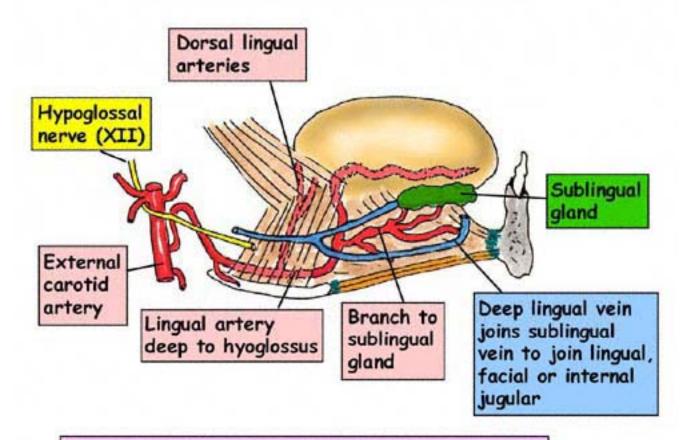
- 14 Hyoglossus
- 15 Genioglossus
- 16 Geniohyoid/mylohyoid
- 17 Cricothyroid
- 18 Thyrohyoid membrane

### TONGUE - GENERAL TOPOGRAPHY

The tongue is a mass of skeletal muscle covered by mucous membrane. It is divided functionally and embryologically into an anterior 2/3 and a posterior 1/3 by the sulcus terminalis



# TONGUE - LINGUAL ARTERY



## LYMPH

Tip to submental glands bilaterally Dorsum to submandibular mostly unilaterally Posterior to jugulo-omohyoid & deep cervical

# TONGUE - MUSCLES

Hyoglossus

Hypoglossal nerve (XII)

Genioglossus

Hypoglossal nerve (XII)

Styloglossus

Hypoglossal nerve (XII)

Palatoglossus

Pharyngeal plexus (IX, X & sympathetic)

Intrinsic muscles

Superior/inferior longitudinal, transverse & vertical

Not attached to bone

Hypoglossal nerve (XII)

Note: All muscles are supplied by hypoglossal nerve except palatoglossus

For details of these muscles see muscle section of Instant Anatomy

# TONGUE - SENSATION & TASTE

## SUMMARY OF NERVE SUPPLY TO TONGUE

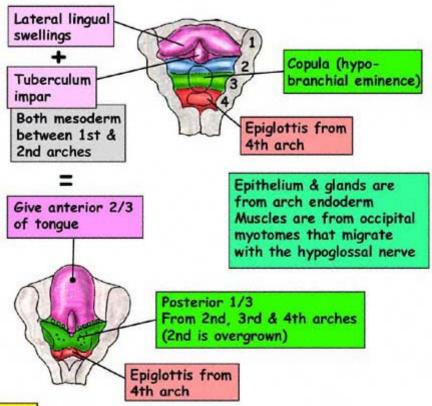
	SOMATIC SENSATION	TASTE	SECRETOMOTOR
ANTERIOR 2/3	Lingual (Vc)	Chorda tympani (VII)	Chorda tympani (VII) (anterior lingual glands)
POSTERIOR 1/3 + vallate papillae	Glosso- pharyngeal (IX)	Glosso- pharyngeal (IX)	Glosso- pharyngeal (IX)
VALLECULAE	Glosso- pharyngeal (IX)	Internal branch of superior laryngeal nerve (X)	Glosso- pharyngeal (IX)

Note: Sympathetic supply to tongue is from superior cervical ganglion via lingual artery

For summary of TASTE please see page 83 in Instant Anatomy

## TONGUE - DEVELOPMENT

# FLOOR OF PHARYNX (PHARYNGEAL ARCHES)



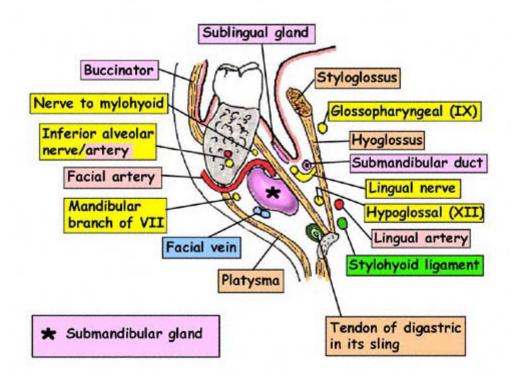
#### NERVES

Anterior 2/3 Mandibular division of trigeminal (Vc). 1st arch nerve Chorda tympani for taste. Only remnant of 2nd arch

Posterior 1/3 Glossopharyngeal (IX). 3rd arch nerve
Internal branch of superior laryngeal branch of
vagus which is 4th arch nerve

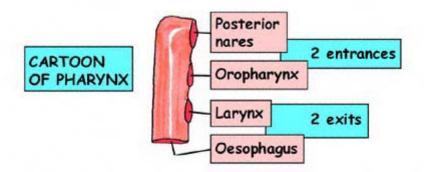
# SUBLINGUAL GLAND

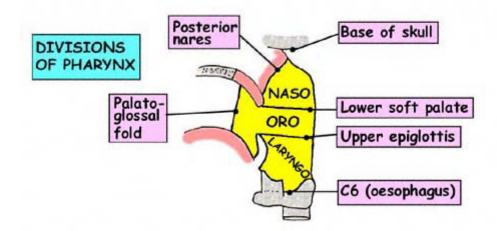
- Mucous gland
- · Between mylohyoid and genioglossus
- 15 ducts 1/2 into submandibular duct 1/2 into sublingual fold
- Nerve supply secretomotor via submandibular ganglion general sensation via lingual (Vc)
- Blood supply Lingual artery & branches of submental artery
- Develops from a groove in floor of mouth that becomes a tunnel Blind end proliferates (ectodermal) to give secreting acini
- (Note: all salivary glands develop from epithelial Ining of mouth)



# PHARYNX - DIVISIONS

- 5" (13cm) long fibromuscular tube
- Suspended from skull & anterior to prevertebral fascia
- Extends from nose to C6 (oesophagus)
- · Like a mask applied to back of face
- Walls are mucous membrane, fibrous submucosa, muscle & thin buccopharyngeal fascia
- · Muscles are:
  - 3 constrictors
  - Stylopharyngeus, palatopharyngeus, salpingopharyngeus
  - · Note: levator palati is wholly intra-pharyngeal

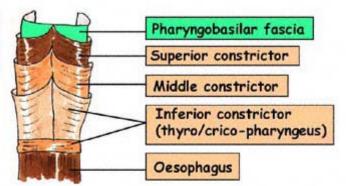




# PHARYNX -CARTOON OF MUSCLES & PHARYNGOBASILAR FASCIA



LIKE 4 STACKED CUPS



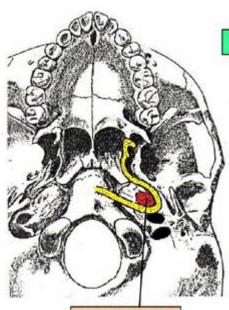
# PHARYNGOBASILAR FASCIA (a rigid membrane with cartilage

(a rigid membrane with cartilage of auditory tube passing just above it. Shown in yellow)

Arises: Pharyngeal tubercle, back of foramen lacerum, petrous temporal anterior to carotid foramen, cartilage of auditory tube, medial pterygoid plate, pterygoid hamulus then across to opposite side

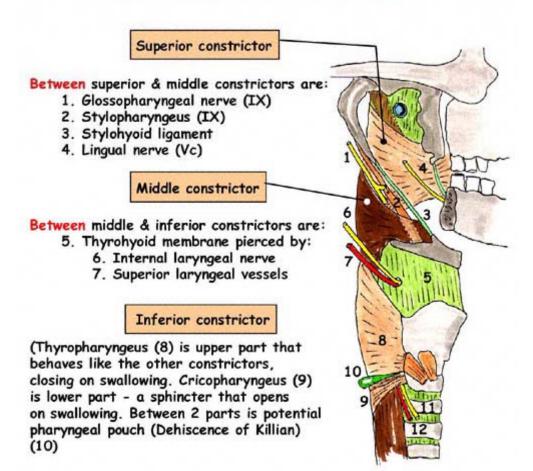
Lower border: Junction of hard and soft palates (Passavant's ridge)

Note: Levator palati arises within pharynx



Levator palati

## PHARYNX - MUSCLES & STRUCTURES ENTERING IT

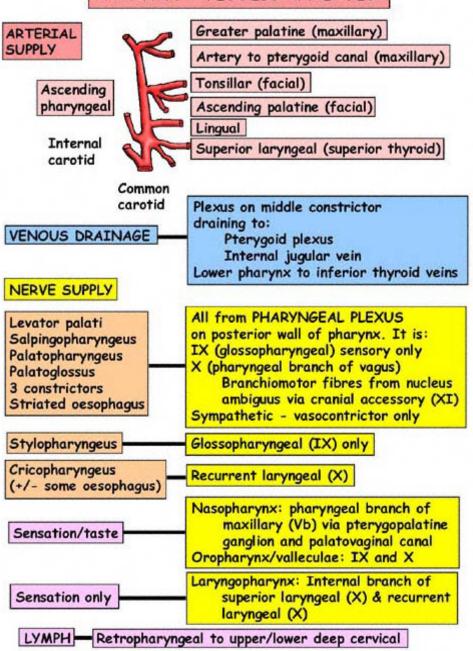


Below inferior constrictor and passing upwards are:

- 11. Recurrent laryngeal nerve
- 12. Inferior laryngeal vessels

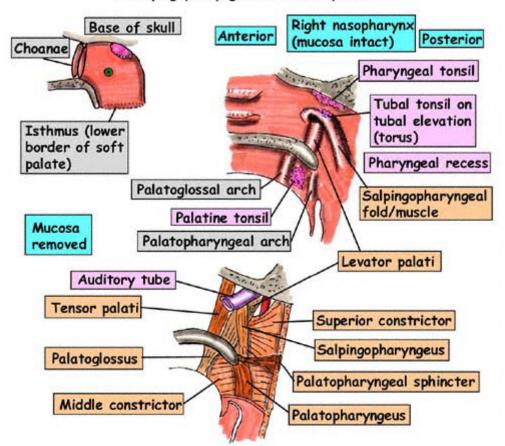
For details of these muscles see muscle section of Instant Anatomy

### PHARYNX - VESSELS & NERVES



### NASOPHARYNX

- From CHOANAE to LOWER BORDER OF SOFT PALATE
- · Back and sides: pharyngobasilar fascia
- Posterior: prevertebral space/fascia, body of C1 vertebra
- Anterior: choanae & back of soft palate
  Inferior: Soft palate & pharyngeal isthmus
- Superior: Pharyngeal tonsil (adenoid), sphenoid & occiput
- · Epithelium: Ciliated columnar
- Features: Opening of auditory tube
  - · Pharyngeal tonsil
  - · Tubal tonsil
  - Pharyngeal recess (of Rosenmuller)
  - · Salpingopharyngeus & levator palati



# **OROPHARYNX**

• From: lower border of soft palate

• To: upper border of epiglottis

• Anterior: posterior aspect of tongue & palatoglossal arch

• Posterior: 3 constrictors & C2/C3 vertebrae

• Inferior: back of tongue, lingual tonsil & valleculae

 Lateral: palatoglossal/palatopharyngeal arches, constrictors & palatine (the) tonsil

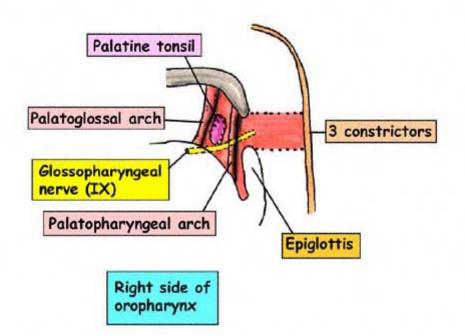
· Lining: squamous epithelium

 Nerves: glossopharyngeal (IX) & internal laryngeal (X) in valleculae

• Features: • Palatine tonsils (see separate illustration)

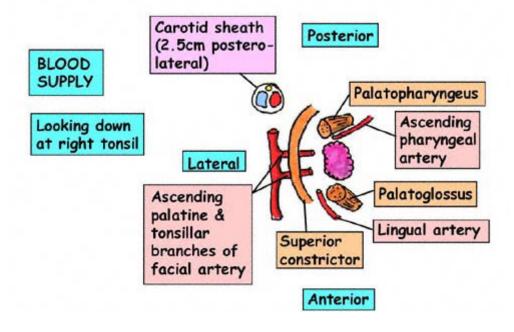
Lingual tonsils

Valleculae



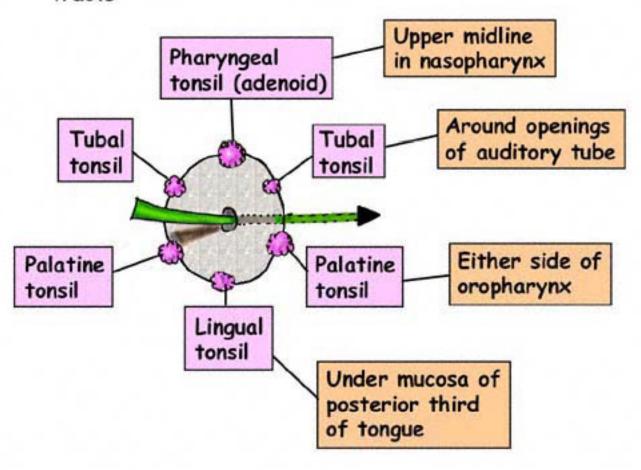
### PALATINE TONSIL

- · Lymphoid tissue in tonsillar fossa
- Anterior/posterior: palatoglossal/palatopharyngeal arches
- · Superior: soft palate
- Inferior: tongue
- Medial: mucosa & 20 tonsillar crypts, intratonsillar cleft (this is a large crypt from 2nd pharyngeal pouch)
- Bed: submucosa (capsule), superior constrictor, facial artery & its branches
- Lymph: to deep cervical & jugulodigastric
- Veins: plexus in capsule to pharyngeal venous plexus. Also external palatine (paratonsillar) from soft palate
- Nerves: tonsillar branch of glossopharyngeal (IX) hence referred pain to the middle ear. Also lesser palatine (maxillary via pterygopalatine ganglion)
- Development: 2nd pharyngeal pouch endoderm gives mucosa & crypts
  - Surrounding mesenchyme gives lymphoid tissue
- · Surface marking: medial to lower masseter



# WALDEYER'S RING

An interrupted circle of protective lymphoid tissue at the upper ends of the respiratory and alimentary tracts



# LARYNGOPHARYNX

Extends from: tip of epiglottis - C3

• To: start of oesophagus - C6

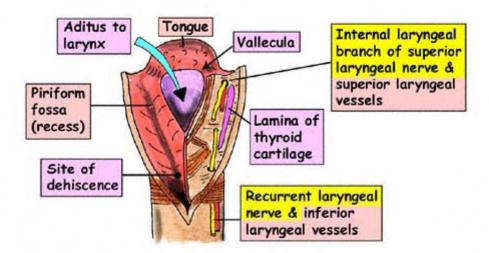
Anterior: larynx, aditus, epiglottis

 Posterior: 3 overlapping constrictors, dehiscence of Killian, cricopharyngeus, vertebrae C4,5,6

 Nerve supply: internal laryngeal branch of superior laryngeal nerve (X) & recurrent laryngeal nerve (X).
 Note that there is some overlapping of supply in the laryngopharynx unlike in the larynx

Lining: squamous non-keratinising epithelium

• Features: aditus to larynx & piriform fossa



### Piriform fossa

Medial: quadrangular membrane Lateral: thyrohyoid membrane & lamina of thyroid cartilage

### Hypopharynx

A clinical term for that part of the laryngopharynx below the aditus Anterior: arytenoid cartilages Posterior: dehiscence of Killian

# SWALLOWING

- 1. FOOD BOLUS MOVED BY TONGUE TO OROPHARYNX
  - Mylohyoid (Vc) lifts tongue Tongue (XII) Styloglossus
  - Muscles of mastication (Vc) Buccinator (VII)
- 2. NASOPHARYNX CLOSES
  - Superior constrictor (PP- pharyngeal plexus) Passavant's ridge (PP) • Tensor palati (Vc) • Levator palati (PP)
- 3. AUDITORY TUBE OPENS
  - Levator palati (PP) Tensor palati (Vc) Salpingopharyngeus (PP)
- 4. PHARYNX & LARYNX MOVE UP TO HYOID

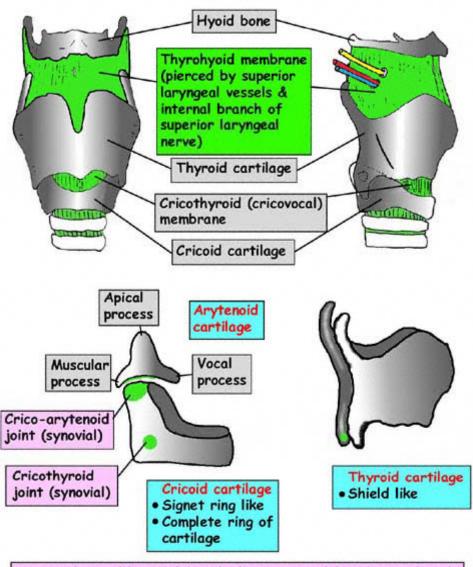
Happens before bolus arrives • Stylopharyngeus (IX)

- Salpingopharyngeus (PP)
   Palatopharyngeus (PP)
- Inferior constrictor (PP)
- 5. OROPHARYNX KEPT CLOSED
  - Palatoglossus (PP) Intrinsic muscles of tongue (XII)
  - Styloglossus (XII)
- 6. LARYNX CLOSES
  - Aryepiglotticus (X-RLN) Cords close (X-RLN) Epiglottis flaps
- 7. HYOID ELEVATES BRINGING PHARYNX/LARYNX UP MORE
  - Stylohyoid (VII)
- 8. HYPOPHARYNX OPENS
  - Cricopharyngeus/upper oesophagus relax (X-RLN)
- 9. HYOID, LARYNX & PHARYNX MOVE DOWN TOGETHER
  - · Elastic recoil
- 10.LARYNX & PHARYNX MOVE DOWN FROM HYOID
  - · Elastic recoil
- 11.PERISTALSIS
  - Striated muscle then smooth muscle of oesophagus (3-5cm/sec) (X-RLN)

### ORDER OF EVENTS IN SUMMARY



# LARYNX - BONES/CARTILAGES

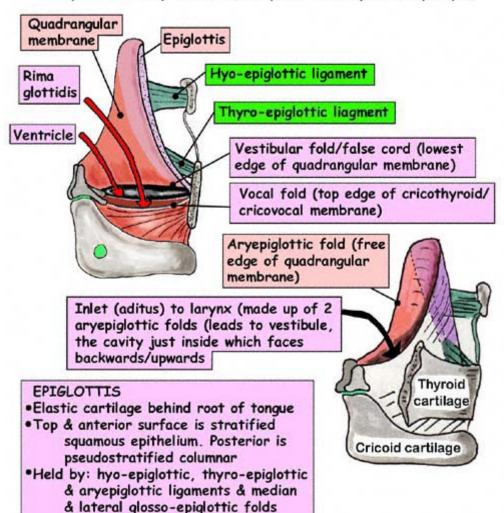


Larynx elevated by: Mylohyoid, digastric, stylohyoid, geniohyoid, thyrohyoid, stylopharyngeus, palatopharyngeus, salpingopharyngeus, inferior constrictor

### LARYNX - INLET & EPIGLOTTIS

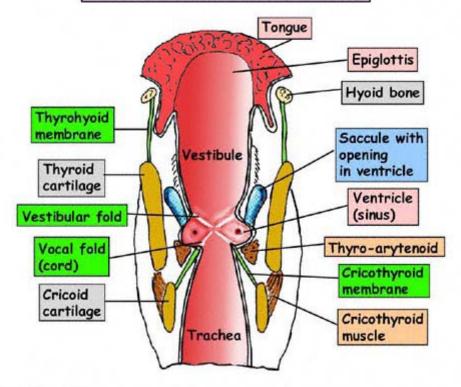
### Inlet:

- Extends from tip of epiglottis to C6
- Open for respiration, partially closed for speaking, closed for coughing, straining and swallowing
- Hangs from hyoid bone via tongue/mandible (hyoglossus, mylohyoid geniohyoid, digastrics, middle constrictor. Some effect on it by 3 of 4 strap muscles (omohyoid, sternohyoid & thyrohyid)



# LARYNX - CORONAL SECTION

Viewed from behind so looking arteriorly



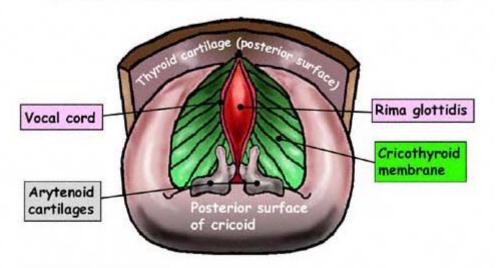
Blood supply: Superior & inferior laryngeal arteries
Mucosa: Pseudostratified ciliated columnar. Mucous glands in sinus
(cords & top of epiglottis - stratified squamous)

- Nerve supply:
  - · Sensory above cords Interni branch of superior laryngeal n
  - · Sensory below cords Recurrent laryngeal n
  - Motor to muscles From nucleus ambiguus via cranial accessory
    - to: Cricothyroid: External branch of superior laryngeal n
    - to: All other laryngeal muscles, including upper oesophagus
       & cricopharyngeus recurrnet laryngeal nerve

### Lymphatic drainage:

Above cords - upper deep cervical nodes Below cords - lower deep cervical nodes

### VOCAL CORDS/CRICOTHYROID MEMBRANE

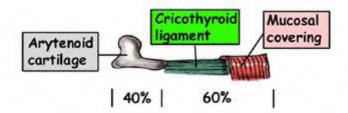


TRUE VOCAL CORDS are the free upper edges of the cricothyroid membrane (conus elasticus) where it is thickened to become the cricovocal liagment and covered with mucosa. The mucosa is pearly white and has no submucosa and thus cannot become oedematous

40% of the vocal cord is arytenoid cartilage

60% is membrane

The cricothyroid membrane is attached around the inside of the ring of cricoid cartilage and has a free upper margin that is attached to the arytenoid cartilages posteriorly and to the back of the thyroid cartilage anteriorly

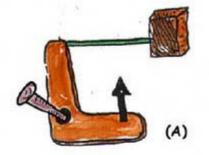


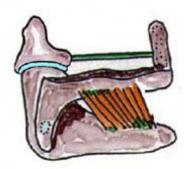
### LARYNX - CRICOTHYROID MUSCLE

CRICOTYROID has 3 special features that makes it different from other laryngeal muscles. These are:

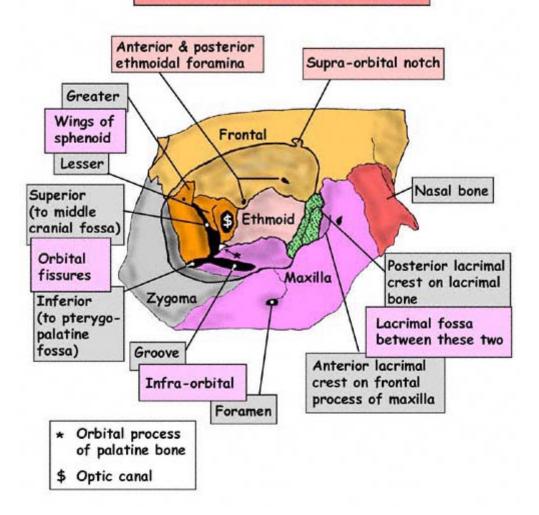
- It is the only muscle that tightens the cords
- It is supplied the external branch of the superior laryngeal nerve and not the recurrent laryngeal
- It is the only intrinsic muscle of the larynx which on the outside of larynx

It is not initially obvious how this muscle tighens the cords but the illustration below helps with the understanding. If you can imagine a block of wood attached to the wall (A) with a strong piece of very slightly elastic string joining the block to the top of an angle-iron. The angle-iron can rotate on a nail in such a way that lifting the other end of it will tighten the string. The equivalent situation in the larynx (B) it that the cricothyroid muscle does the lifting of the angle-iron (cricoid) to tighten the cords. The thyroid cartilage is not fixed as is the block of wood in (A) so that both cartilages are tilted when the cords are tightened. Note that the cords are attached to the back of the thyroid cartilage and the vocal processes of the arytenoids

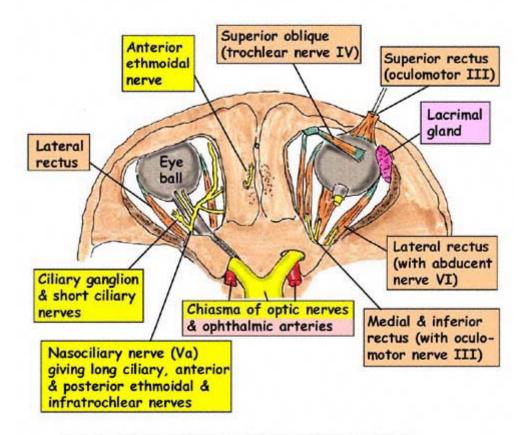




# EYE - BONES OF RIGHT ORBIT



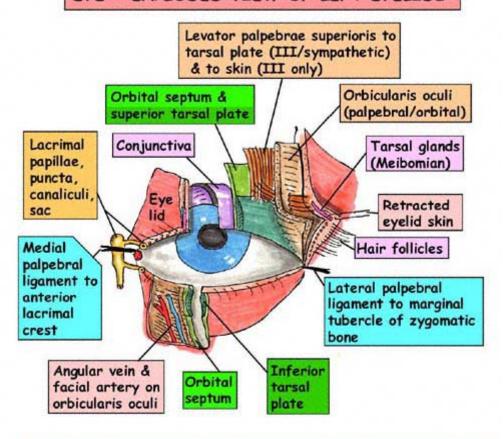
# EYE - ORBITS FROM ABOVE



### Note:

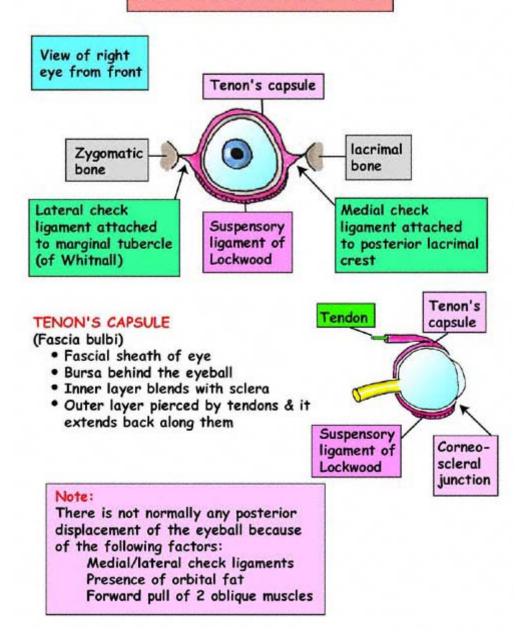
- Medial orbital walls are parallel
- Lateral walls are at right angles
- Orbital fascia is the periostium of orbit which is continuous with dura over optic nerve

### EYE - EXPLODED VIEW OF LEFT EYELIDS

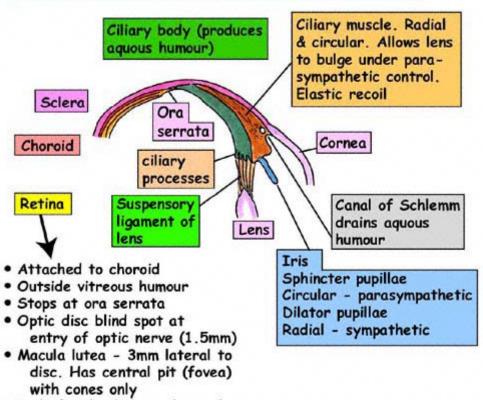


Orbital septum: Anterior lacrimal crest and margins of orbit
Tarsal plates: Fibrous thickening of orbital septum
Meibomian glands: In tarsal plates, modified sebaceous glands
secreting oil
Blood supply: Of lids - palpebral branches of ophthalmic artery
Nerves: Upper skin/conjunctiva
Lacrimal, Supra-orbital, supra- & infratrochlear
Lower skin/conjunctiva
Infra-orbital

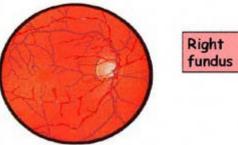
### EYE - FASCIAL COVERINGS



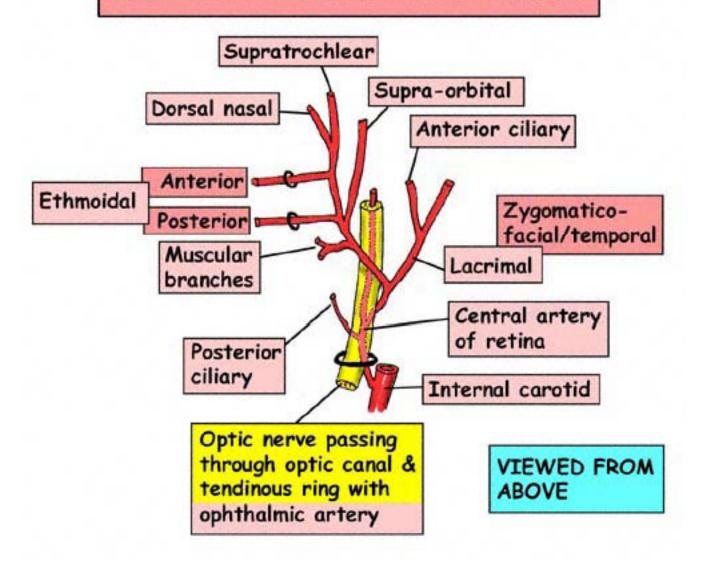
# EYE CILIARY BODY AND ANTERIOR EYEBALL



- Rods for dim light and no colour
- · Cones for colour. Very sensitive
- Fundus is what is seen with ophthalmoscope at back of eye
- Blood supply: central artery of retina. Cental veins to superior ophthalmic veins

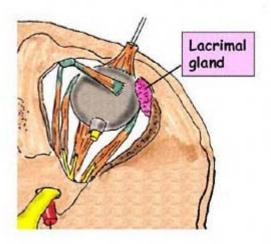


# EYE - RIGHT OPHTHALMIC ARTERY



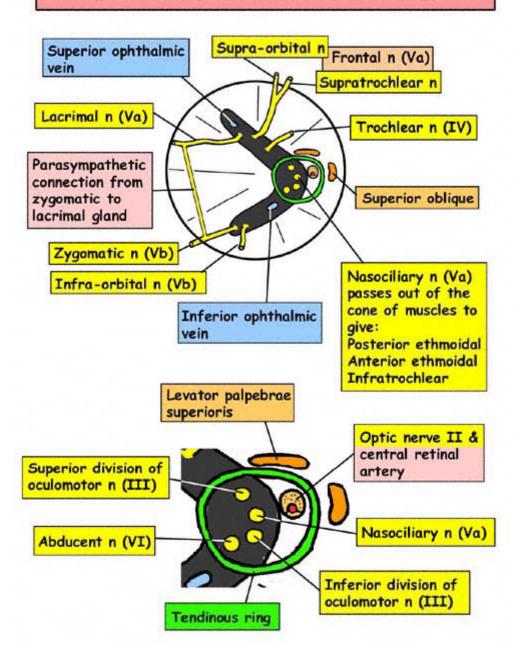
# LACRIMAL GLAND

Looking down into right orbit

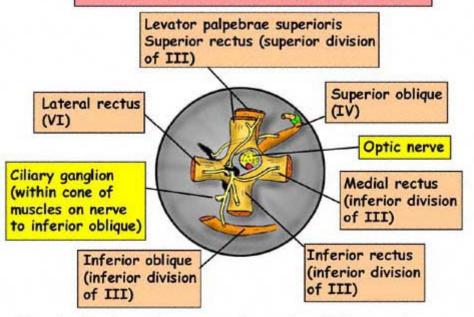


- · Serous gland
- In lacrimal fossa (lateral roof of orbit)
- 10-12 ducts draining into lateral/superior fornix of conjunctiva
- Tears swept medially by progressive lid closure
- Nerve supply secretomotor. Superior salivary nucleus to facial nerve to greater petrosal nerve to pterygopalatine ganglion to zygomatic branch of maxillary division of trigeminal (Vb) to zygomaticotemporal nerve to connecting branch in orbit to lacrimal nerve (Va) to gland
- Blinking achieved by palpebral part of obicularis oculi (no tear spill)
- Screwing up achieved by orbital part of obicularis oculi (tear spill and squeezes lacrimal sac)
- Lacrimal sac lies between anterior & posterior lacrimal crests with palpebral fibres of orbicularis oculi inserting into its walls to draw it open & suck in tears
- · Lacus lacrimalis (lacrimal lake) lies above it.
- Nasolacrimal duct is 2cm long, drains into inferior meatus of lateral wall of nose & its mucosal folds are valvular to stop air

# EYE - STRUCTURES PASSING THROUGH RIGHT SUPERIOR/INFERIOR ORBITAL FISSURES

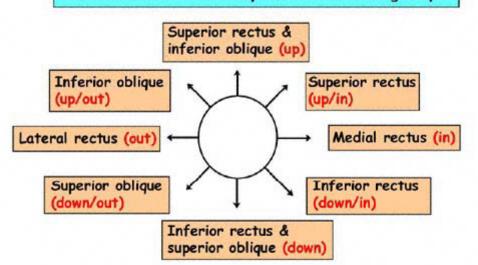


# EYE -VIEW INTO RIGHT ORBIT TO SHOW EXTRINSIC EYE MUSCLES

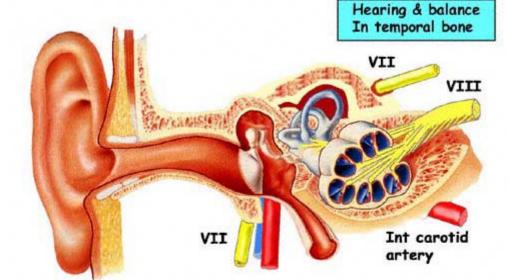


For details of muscles see muscle section of Instant Anatomy

Eye movements produced by the action of single or combinations of extrinsic eye muscles of the right eye



# EAR - OVERVIEW



### EXTERNAL

### Pinna

- Amplification
- Localisation
- Elastic cartilage
- Vascular

### Ext meatus

- · 3cm long
- · 2/3 bone
- 1/3 cartilage
- Curves forwards
- Hairs
- Glands
  - · Sebaceous
  - Ceruminous

Outer eardrum

### MIDDLE

### Ossicles

Facial n

Chorda tympani

Inner eardrum Auditory tube

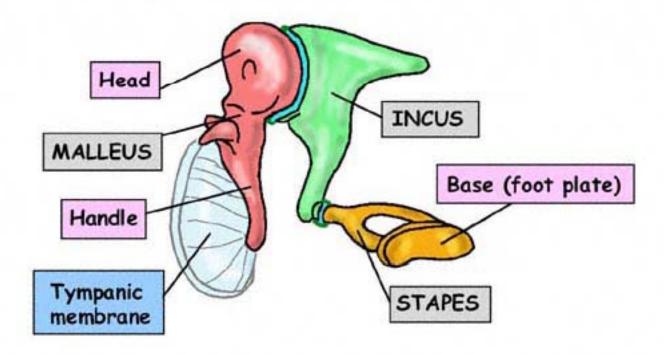
- · Opens on swallowing to equalise pressure
- · 3.5cm long
- 1/3 bone
- 2/3 cartilage
- 30 degrees down
- · 45 degrees ant/med
- · Tubal tonsil at exit in nasopharynx
- Mucosa valvelike
- · Sensory Ns Vb & IX (referred pain)

# INTERNAL

### Labyrinth

- · Cochlea
- Semicircular canals

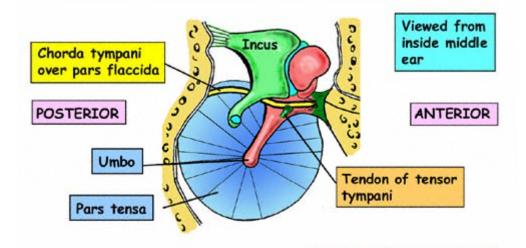
# MIDDLE EAR - OSSICLES



They increase the amplitude of the vibrations 15-20 times because of leverage and the eardrum to oval window ratio

Synovial joints between them

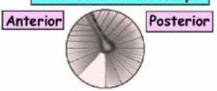
### MIDDLE EAR - LEFT TYMPANIC MEMBRANE



### TYMPANIC MEMBRANE

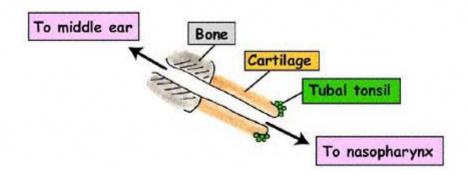
- 3 layers
  - Inner low columnar
  - Middle fibrous
  - Outer stratified squamous
- 1cm diameter
- Pearly grey & shiny
- 55 degrees to horizontal
- Concave outwards
- Faces downwards, forwards & laterally
- Pulled inwards by tensor tympani
- Sensory supply
  - Inner glossopharyngeal (IX)
  - Outer auriculotemporal (Vc)
- · Vibrates with incoming sound
- Needs equal air pressure on each side of it (see auditory tube)

# View down an auroscope



Cone of light (antero-inferior)

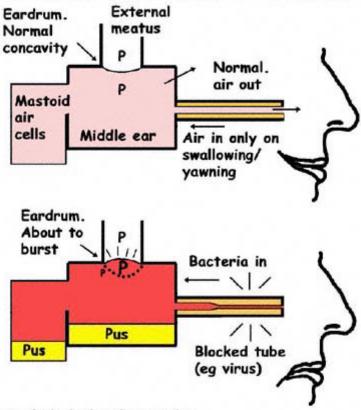
# MIDDLE EAR - AUDITORY (EUSTACHIAN) TUBE - TOPOGRAPHY



### NOTES

- · Develops from 1st pharyngeal pouch
- 3-3.5cm long
- Blood supply from ascending pharyngeal & middle meningeal
- 30 degrees downwards, 45 degrees anteromedially
- Tubal tonsil at exit in nasopharynx
- 1/3 bone
- 2/3 cartilage
- Opens on swallowing to equalise pressure
- · Mucosa is valvelike
- Sensation via pharyngeal branch of maxillary nerve (Vb) in lower part and glossopharyngeal (IX) in upper part (hence referred pain to middle ear from tonsils and oropharynx)
- · Bony part in petrous temporal bone has columnar epithelium
- Cartilaginous part in squamotympanic fissure has ciliated columnar epithelium
- Muscles opening it are:
  - · Salpingopharyngeus
  - Levator palati
  - Tensor palati

# MIDDLE EAR - AUDITORY (EUSTACHIAN) TUBE - EFFECT OF BLOCKAGE



Effects of blocked auditory tube:

- 1. At first air is still absorbed drum sucked in more
- 2. Giving poor ossicle/drum movement deafness
- 3. Then viral/bacterial exudate gets infected
- 4. Middle ear +/- mastoid air cells fill with pus (otitis media)
- 5. Then pressure rises drum bulges outwards +/- bursts
- Infection may spread to inner ear, venous sinuses, extradural, subdural, meninges, brain abscess
- 7. THEN EITHER:

Drains and heals

Becomes chronic, +/- glue ear or cholesteatoma Persistent perforation of drum, +/- necrosis of ossicles

### VERTEBRAL COLUMN - FEATURES & CURVATURES

#### VERTEBRAE

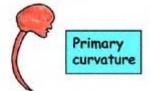
7 cervical (atlas, axis & C7 are atypical)
12 thoracic
5 lumbar
5 sacral (fused)
4 coccygeal (3-5)

#### **FUNCTIONS**

Weight bearing Movement of trunk Support for limbs Protection of spinal cord Production of blood Metabolic reserves (Calcium, etc)

### WEIGHT BEARING

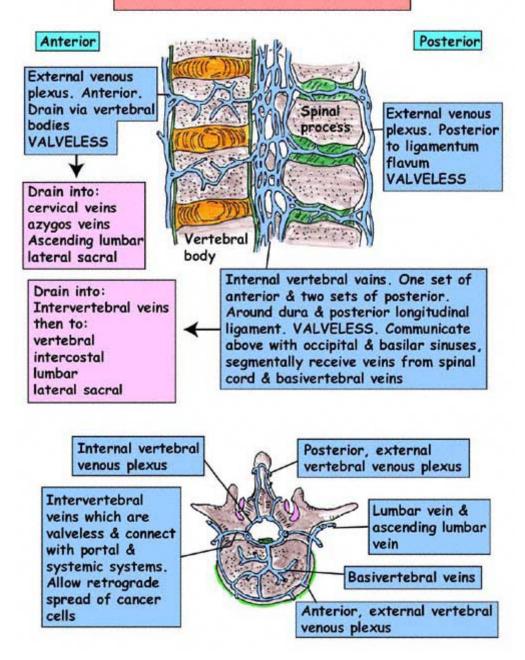
Aided by secondary lordosis
40% bony wedge
60% disc wedge
Caused/held by
Extensor spinal muscles
Aided by intervertebral discs
Dampeners, resiliant, compressible





Neck & lumbar secondary curvatures

# VERTEBRAL VENOUS PLEXUSES



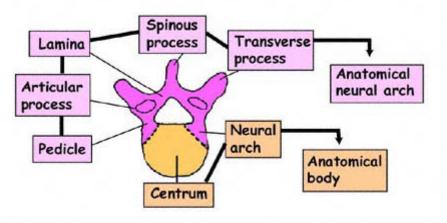
### A TYPICAL VERTEBRA

Each vertebra has: A BODY: anteriorly

A VERTEBRAL ARCH: posteriorly

Each arch has:

2 pedicles, 2 laminae, a spinous process, a transverse process & a vertebral foramen



### OSSIFICATION

Primary centres (•) appear at 8-10 weeks intra-uterine. There are 3: 1 in the centrum & 1 in the base of each transverse process. From the latter, ossification spreads to pedicle, lamina, spinal process, body & facets

Secondary centres (1111) appear at puberty. 5: spinous process, transverse processes, each annular epiphyseal rings

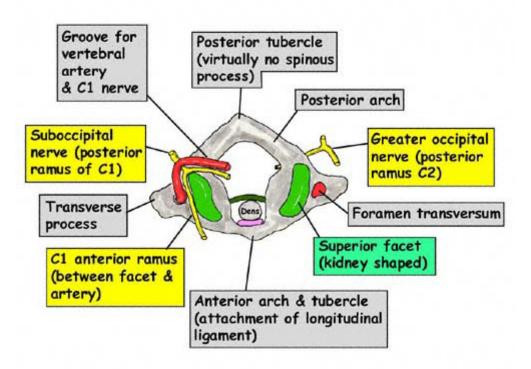
#### Fusion

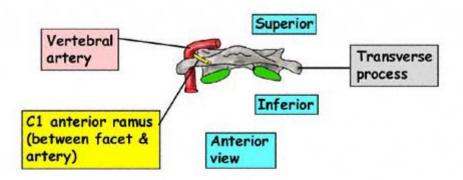
Arches by 2 years Arch/centrum by 7yrs Secondary centres by 25yrs



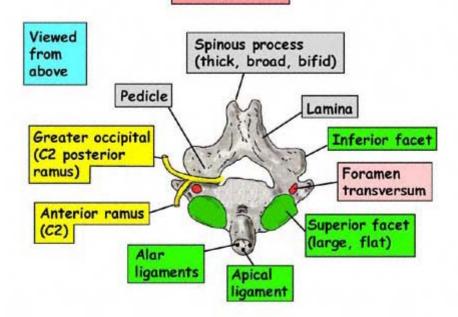


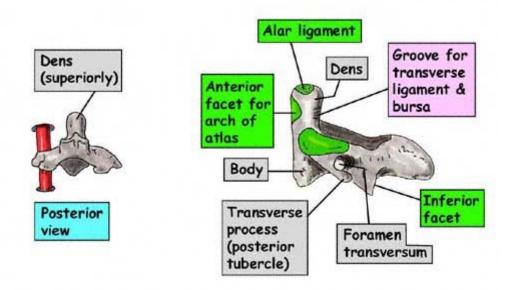
# ATLAS - C1



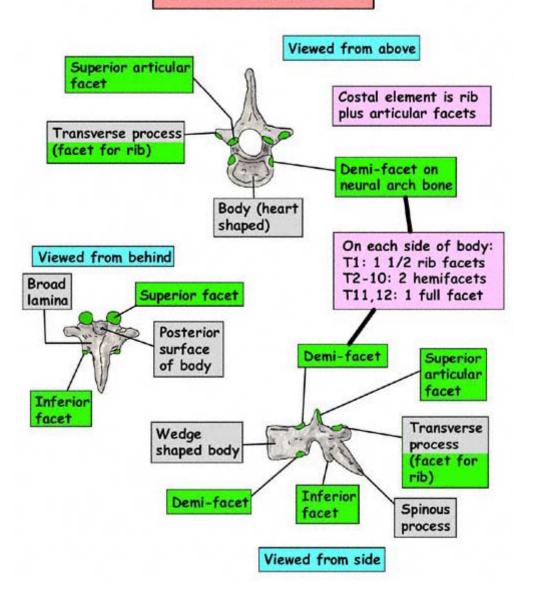


# AXIS - C2

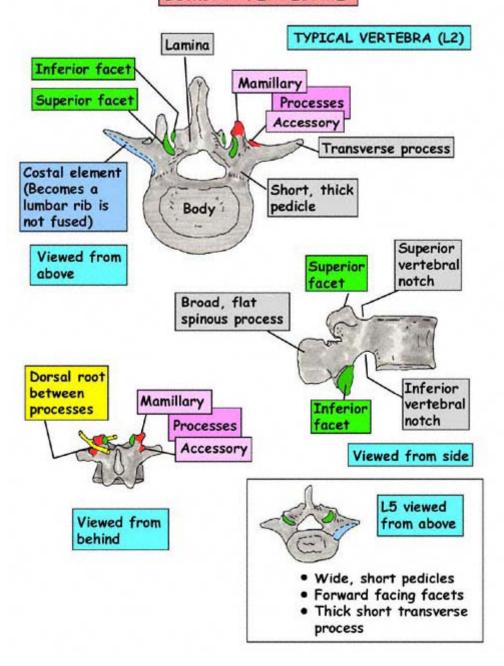




# THORACIC VERTEBRAE



# LUMBAR VERTEBRAE



### VERTEBRAL COLUMN - JOINTS & LIGAMENTS

### **JOINTS**

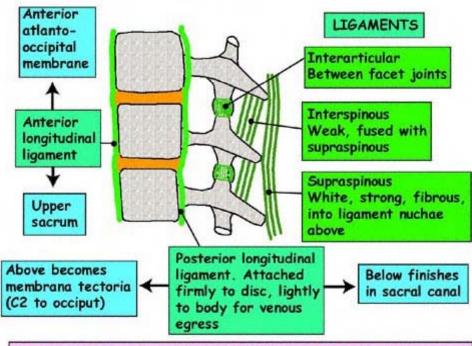
### ARTICULAR FACET (zygapophyseal)

Plane, synovial, nerve supply by nerves above and below NEUROCENTRAL (uncovertebral) JOINTS OF LUSCHKA Cervical & T1 only, small on lateral side of body, between uncinate process and side of body. Probably degenerative ATLANTO-OCCIPITAL

Synovial, weak anterior/posterior atlanto-occipital membrane. Nodding movement

#### ATLANTO-AXIAL

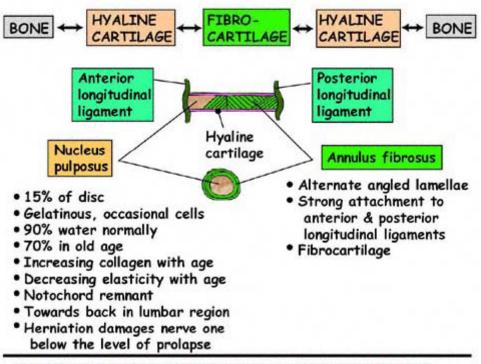
Synovial, head pivoting. Ligaments are apical, alar, cruciform. Posterior longitudinal ligament becomes membrana tectoria

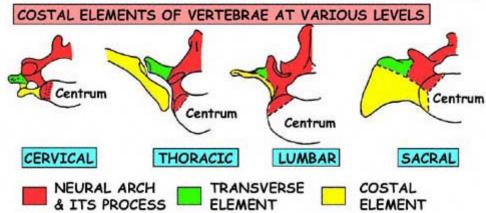


2 other ligaments are: LIGAMENTUM FLAVUM between laminae like tiles on a roof - under surface of one above to outer surface of one below. Also INTERTRANSVERSE - between transverse processes - weak

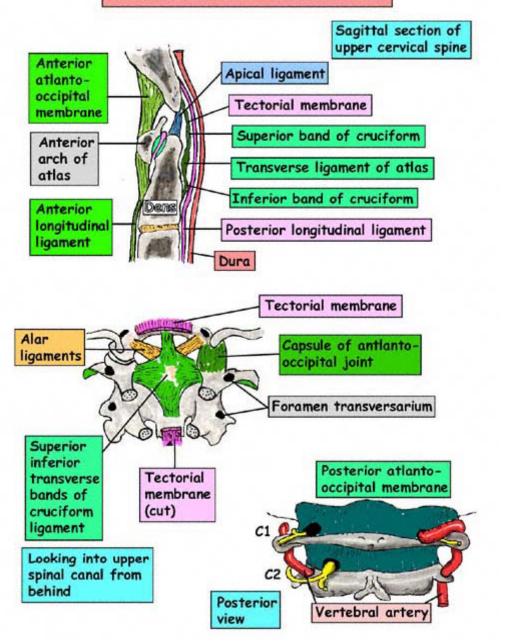
# INTERVERTEBRAL DISCS & COSTAL ELEMENTS

Intervertebral joint is secondary cartilaginous (symphysis)-

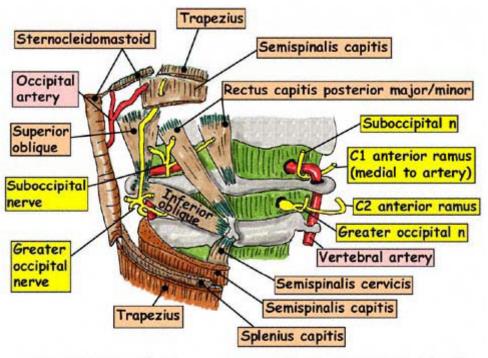




# ATLANTO-AXIAL & ATLANTO-OCCIPITAL JOINTS



### SUBOCCIPITAL TRIANGLE



#### SUBOCCIPITAL NERVE

- Posterior ramus of C1
- . No skin distribution
- Rectus capitis posterior major/minor
   Superior/inferior obliques
- Semispinalis capitis

### GREATER OCCIPITAL NERVE

- Posterior ramus of C2
- Semispinalis capitis
- Splenius capitis
- Inferior oblique via connection to C1
- . Skin of posterior scalp

### SUBOCCIPITAL TRIANGLE

Boundaries: Superior oblique, inferior oblique & rectus capitis

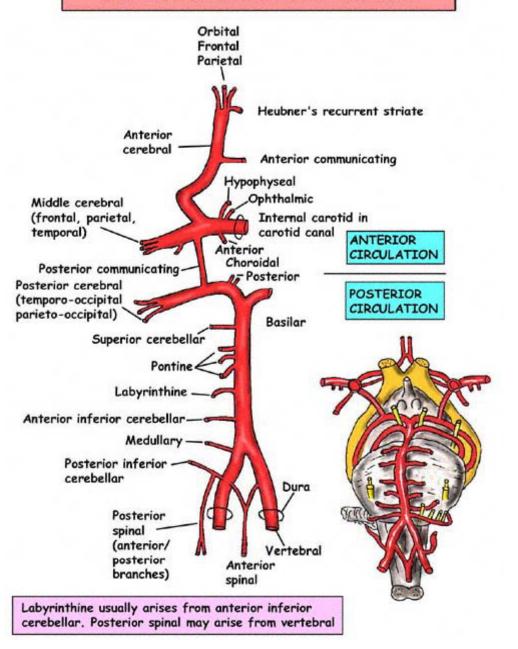
posterior major

Floor: Posterior atlanto-occipital membrane, posterior arch of atlas

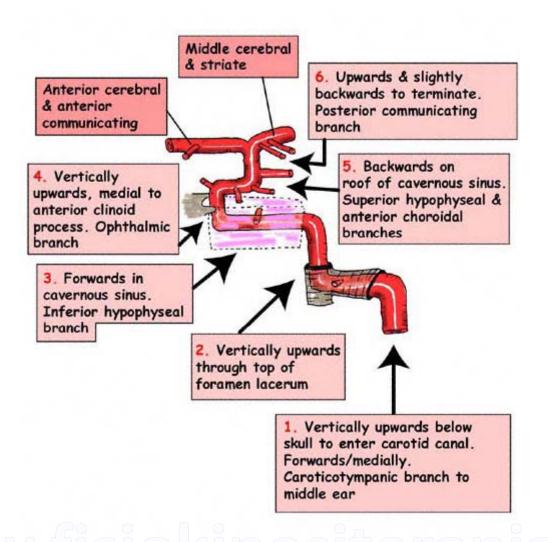
Contains: Vertebral artery & suboccipital nerve In roof: Greater occipital nerve & occipital artery

See muscle section of Instant Anatomy for details of muscles

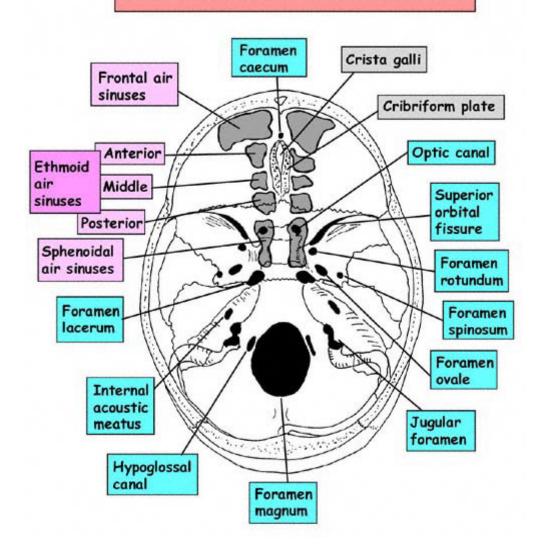
# INTERNAL CAROTID, VERTEBROBASILAR SYSTEMS AND CIRCLE OF WILLIS



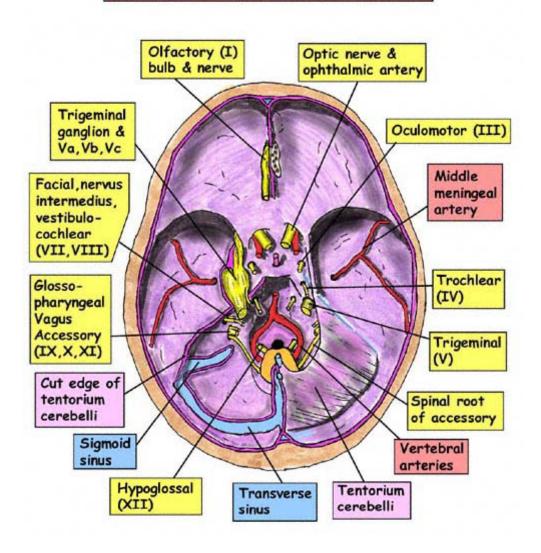
### INTERNAL CAROTID ARTERY IN SKULL



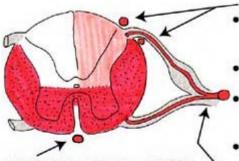
# INTERNAL VIEW OF BASE OF SKULL TO SHOW SINUSES AND FORAMINA



# STRUCTURES PIERCING THE DURA IN THE BASE OF THE SKULL



### BLOOD SUPPLY OF SPINAL CORD



#### ANTERIOR SPINAL ARTERY

- Single artery that arises from each vertebral artery at foramen magnum to run length of cord
- Usually bigger than posterior spinal arteries but may be quite small.
- Supplies whole cord anterior to posterior grey columns, bilaterally

#### OTHER VESSELS

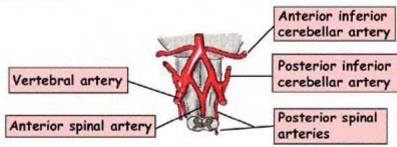
From vertebrals, deep & ascending cervicals, intercostals, lumbars & lateral sacrals. Note that all vessels anastomose under the pia mater in the periphery of the cord

#### POSTERIOR SPINAL ARTERIES

- Arise at foramen magnum from posterior inferior cerebellar arteries (or vertebral)
- Lie anterior & posterior to posterior rootlets
- Run length of cord but poor anastomosis except at lower end of cord
- Supply own side of grey & white posterior columns

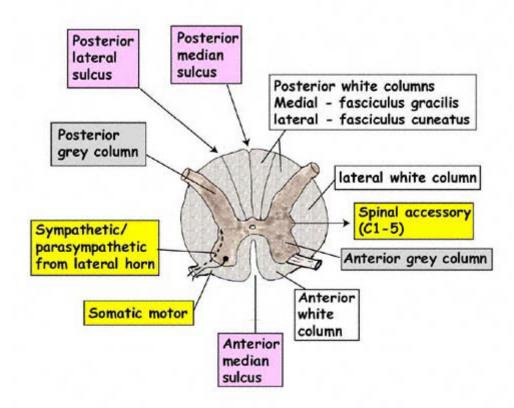
#### RADICULAR (FEEDER) ARTERIES

- Enter via intervertebral foramina and reinforce anterior & posterior spinal arteries & supply dorsal root ganglia
- Variable number at variable levels but largest is Arteria Radicularis Magna, usually at T10 or 11 (artery of Adamkiewicz)



## SPINAL CORD - GENERAL

- · Cord begins at lower medulla of brain stem
- Cord finishes at lower border of L1 vertebra
- 45cm long



## CRANIAL NERVES WITH MOTOR SUPPLY TO MUSCLES OF BRANCHIAL ORIGIN

	BRANCHIOMOTOR (MUSCLES OF BRANCHIAL ORIGIN)		
v	Nucleus: Motor of trigeminal  M of mastication, mylohyoid, ant digastric, tensors palati & tympani		
VII	Nucleus: Facial  M of facial expression, buccinator, post digastric, stylohyoid, stapedius		
IX	Nucleus: Ambiguus Stylopharyngeus		
x	Nucleus: Ambiguus  M of pharynx, upper oesophagus, palate, larynx (from cranial XI)		
XI	Nucleus: Ambiguus  M of palate & pharynx via vagus		

Cranial nerves V, VII, IX, X are the nerves to the branchial (pharyngeal) arches 1, 2, 3, 4/6 respectively. In addition the cranial part of XI dumps its fibres on the vagus to be distributed with it

1st arch. Nerve: mandibular division of trigeminal

2nd arch. Nerve: Facial

3rd arch. Nerve: glossopharyngeal

4th & 6th arches. Nerve: vagus

# PARASYMPATHETIC FIBRES

	PARASYMPATHETIC (GENERAL VISCERAL MOTOR)
	Nucleus: Edinger-Westphal
III	Ciliary ganglion
	Ciliary body & muscle,
	Sphincter pupillae
	Nucleus: Superior salivary
	Pterygopalatine & submandibular ganglia
VII	Lacrimal, submandibular, sublingual & palatine glands
	Nucleus: Inferior salivary
IX	Otic ganglion
	Parotid, glands in post 1/3 tongue & oropharynx
	Nucleus: Dorsal motor of vagus
X	Cardiac & visceral muscle in thorax & abdomer

Cranial nerves III, VII, IX and X all carry parasympathetic fibres from the various central parasympathetic nuclei and they take these fibres to their respective parasympathetic ganglion where they synapse and then are distributed via a branch of the trigeminal to the end organ

# CRANIAL NERVES THAT SUPPLY SOMATIC FIBRES TO SKELETAL MUSCLES

	SOMATIC MOTOR	
	TO SKELETAL MUSCLE	
	Nucleus: Oculomotor	
III	Recti (Sup, med, inf), inf oblique, levator palpebrae superioris	
IV	Nucleus: Trochlear	
	Sup oblique	
VI	Nucleus: Abducent	
	Lat rectus	
XI	Nucleus: Lat roots C1-5	
	Sternocleidomastoid & trapezius	
THE STATE OF	Nucleus: Hypoglossal	
XII	M of tongue (not palatoglossus)	

Cranial nerves III, IV, VI, XI and XII carry somatic nerve fibres to head and neck muscles that have NOT originated from the branchial arches

## CRANIAL NERVES THAT CARRY SOMATIC SENSORY FIBRES

	SOMATIC SENSORY
	Nucleus: Sensory of V
V	Mesencephalic: proprioception
	main: touch
	Spinal: pain & temperature
	For V (face, orbit, tongue)
	Nucleus: Sensory of V
VII	Some skin of ext auditory
	Meatus & tympanic Membrane
	Nucleus: Sensory of V
IX	Posterior 1/3 tongue, palate,
	pharynx, tonsil, middle ear
	Nucleus: Sensory of V
×	Skin of posterior/inferior auricle,
	external auditory meatus; pharynx; larynx
	Cell bodies outside central nervous
NB	system except mesencephalic nucleus

The trigeminal nerve is the main sensory nerve for the head. Note that whichever nerve carries the sensation, the fibres all eventually reach the sensory nucleus of the trigeminal nerve. Remember that the Facial Nerve (VII) is essentially a motor nerve even though it does have a small sensory component

## CRANIAL NERVES FOR SPECIAL SENSES

	SPECIAL SENSES
I	SMELL
	Limbic system
II	SIGHT
	Lateral geniculate body
VIII	HEARING: 2 nuclei
	EQUILIBRIUM: 4 nuclei

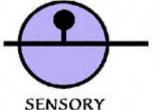
## CRANIAL NERVES CARRYING GENERAL AND SPECIAL SENSORY FIBRES

	GENERAL VISCERAL SENSORY	SPECIAL VISCERAL SENSORY
VII		Nucleus: Solitarius Chorda tympani Taste: ant 2/3 tongue
ıx		Nucleus: Solitarius Taste: post 1/3 tongue vallate papillae, oropharynx; baro & chemoreceptors
×	Nucleus: Solitarius or dorsal sensory of Vagus. From heart, lungs & abdominal viscera	Nucleus: Solitarius Taste: vallecula & epiglottis; baro & chemoreceptors
NB	From heart, lungs & gut	Taste; baro & chemoreceptors

Note that in the case of the vagus the sensation travels with this parasympathetic nerve but the fibres are really general visceral sensory and not parasympathetic.

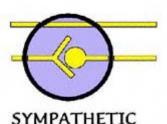
Special visceral sensory comprises taste and baroreception

## GANGLIA



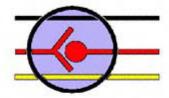
Somatic sensory cell bodies

Posterior (dorsal) root Trigeminal Geniculate Glossopharyngeal Vagal



Sympathetics either synapse or pass through to synapse later

Sympathetic chain Sympathetic peripheral eg Coeliac Sup mesenteric Renal



Parasympathetic synapse Somatic sensory & sympathetic pass through

Ciliary Pterygopalatine Submandibular Otic

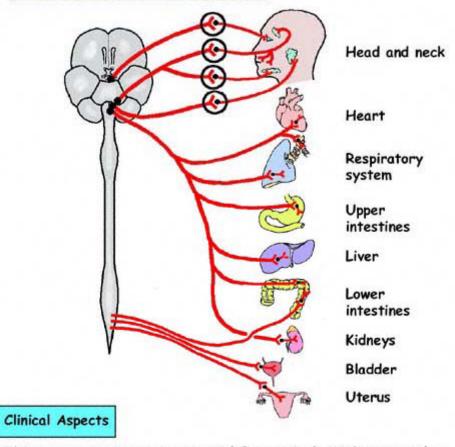
PARASYMPATHETIC

Each nerve has a cell body. For the sensory system this cell body is in the dorsal root ganglion or the equivalent for the sensory cranial nerves. There are no synapses in such ganglia.

In the sympathetic ganglia there are two alternatives. For those nerves that synapse there are cell bodies belonging to the post-ganglionic fibres. Others pass through without synapsing (gut & adrenal).

In the parasympathetic ganglia in the head and neck there is always a synapse with a post-ganglionic cell body.

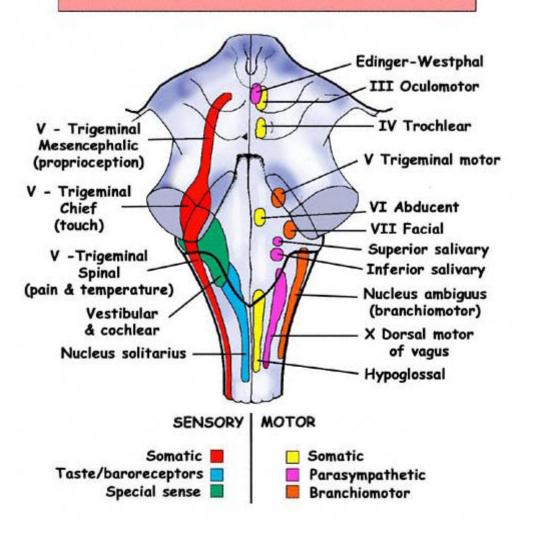
## PARASYMPATHETIC CRANIOSACRAL OUTFLOW



The autonomic system is essential for survival. Without vascular tone we would faint every time we stood up. There would be no intestinal activity to digest and absorb food and no increase in heart rate with exercise. Without sexual activity there would be no continuation of the species!

Deliberate destruction of the nerves is sometimes necessary. For instance in excessive sweating the sympathetic chain can be cut selectively or the parasympathetics (vagus nerves) can be cut to decrease acid production in the stomach. Referred pain, for example from the appendix or gonads, is explicable in terms of general visceral sensory fibres in the autonomic system.

### CRANIAL NERVE NUCLEI IN BRAIN STEM



## SUMMARY AND KEY POINTS OF PARASYMPATHETICS

NON - EMERGENCY (at rest and quiet activity)
Stimulates glands (salivary, mucus) to secrete
Slows the heart & minimises blood pressure
Bronchial constriction to lessen dead space
Stimulates gut peristalsis & opens sphincters
Contracts the bladder & uterus
Causes erection of penis and clitoris
Special in Head & neck
Constricts the pupil
Accommodates the eye (lens) for near vision

#### KEY POINTS

- Parasympathetic output in the body is only from cranial nerves III(oculomotor), VII(facial), IX(glossopharyngeal) and X(vagus) & sacral segments 2,3,4.
- In the head & neck it constricts the pupil, accommodates the eye & makes the salivary & lacrimal glands secrete. The vagus supplies the whole trunk down to the left side of the transverse colon. Below that the supply is from 52,3,4 output.
- Each vagus nerve has two branches in the neck destined for the heart. There are separate vagal branches to the heart & respiratory system as the vagi pass through the chest & there are branches throughout the abdomen as defined above after they pass through the oesophageal opening of the diaphragm.
- The parasympathetics from the 2,3,4 sacral segments arise from cell bodies in the lateral horn of the spinal cord but emerge with the somatic motor nerves via the ventral horn. They join the pelvic plexus as the pelvic splanchnic nerves.
- True parasympathetic nerves are all motor. Sensory nerves within
  the parasympathetic system are general visceral sensory nerves that
  simply run with the parasympathetics and are not strictly part of the
  system.
- The vagus nerves & the output from \$2,3,4 are all preganglionic fibres which all synapse in small peripheral ganglia on or near the organs of distribution. In the head there are four special parasympathetic ganglia for synapsing.
- There is no parasympathetic supply to limbs or gonads.

## SUMMARY AND KEY POINTS OF SYMPATHETICS

EMERGENCY Fight, Flight, Fright HOMEOSTATIC

KEY POINTS

Selectively constricts blood vessels (vasomotor) (eg. redirects blood from gut to heart and muscles) Temperature regulation Stimulate sweat glands (sudomotor) Erects hairs in skin (pilomotor)

#### SPECIFIC

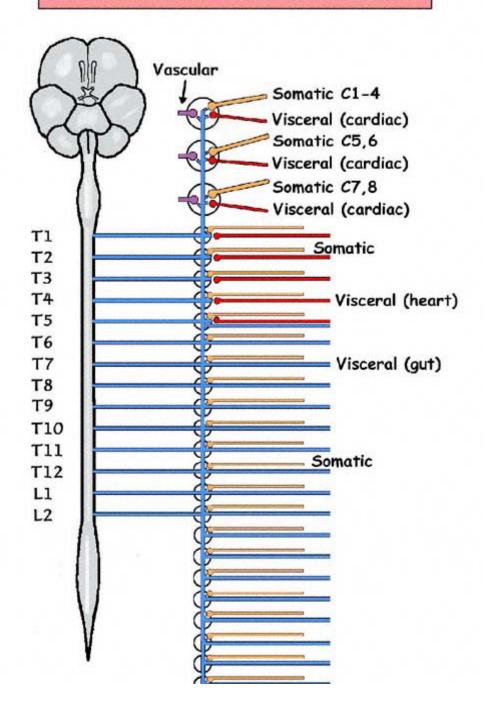
Stimulates suprarenal gland
Speeds the heart & increases
blood pressure
Bronchial dilatation to maximise
air intake
Inhibits the gut, dries
secretions & closes sphincters
· Stimulates ejaculation

Special in head & neck

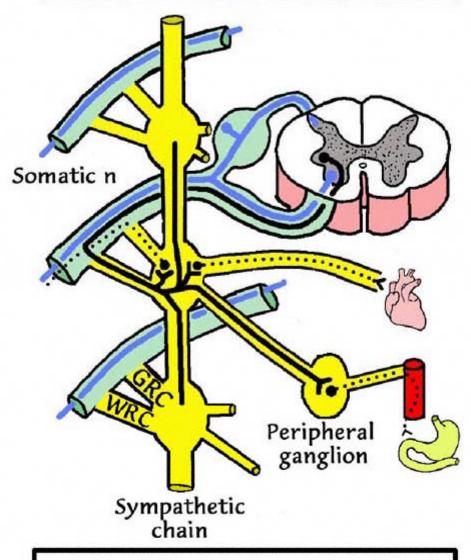
· Dilates the pupil

- Only output is between T1 and L2 cord levels. They pass up & down the sympathetic chain to reach parts of the body beyond these levels. The chain extends the whole length of the body.
- True sympathetic nerves are all motor. General visceral sensory nerves run with them. They detect distension, hunger, pain etc.
- They arise from cell bodies in the lateral horn of the spinal cord & emerge with the somatic motor nerves from the ventral horn. They leave the somatic nerve to reach the sympathetic ganglia via a white (myelinated) ramus communicans.
- Within each ganglion some sympathetic nerves always synapse and their secondary neurones (unmyelinated) then pass back onto the same somatic nerve via a grey ramus communicans to supply sudomotor, pilomotor and vasomotor activity to the distribution of that somatic nerve.
- Visceral fibres leave the ganglia (either the one they entered or others above or below) as visceral branches. RULE: Visceral branches always synapse in the ganglion from which they leave unless they supply gut (bowel, liver spleen, etc) or adrenal gland. If they have not synapsed in the ganglion then they will do so in peripheral ganglia nearer the organ that they supply. From each cervical ganglia a visceral branch goes to the heart (6 branches altogether).
- From the cervical ganglia there are grey rami communicantes to the somatic cervical nerves (C1-8). But each cervical ganglia also has an vascular branch to distribute sympathetics to the neck & into the head on arteries. These vascular branches reach the eye for pupil dilatation for vision in dark surroundings & emergency situations. They also supply the eyelids for opening the eyes widely.
- Sympathetic supply to the gonads controls vascular tone only.

## SYMPATHETICS FROM SPINAL CORD



## CHAIN TO SPINAL CORD



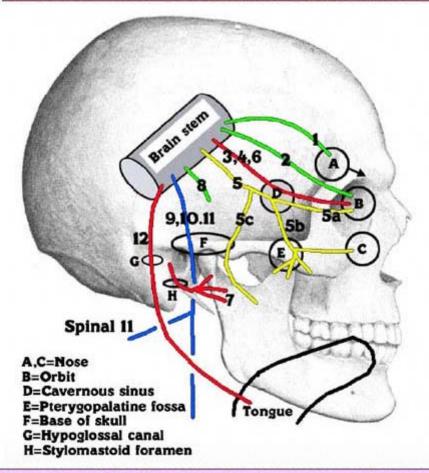
WRC = (white ramus communicans)

GRC = (Grey ramus communicans)

- = Preganglionic sympathetic

••••• = Postganglionic sympathetic

### DIAGRAMATIC SUMMARY OF COURSES OF CRANIAL NERVES FROM BRAIN TO END ORGAN



The purpose of this figure is to show how some cranial nerves pass directly to their end organ (1,2,5c,8,9,10,11,12) whilst others pass through well defined cavities such as the cavernous sinus (3,4,5a,5b,6) or the pterygopalatine fossa (5b). For purposes of remembering the likely exit from the skull of cranial nerves, they can be grouped into those that pass to the nose (1), to the orbit (2,3,4,5a,6), to the front of the face (5b) and through the base of the skull (5c,7,9,10,11,12)

## CILIARY GANGLION: DETAILED PATHWAYS TO AND FROM IT

CENTRAL

Edinger-Wesphal (mid brain)

EMERGING WITH CRANIAL NERVE

III (oculomotor)

NERVE CARRYING PREGANGLIONIC FIBRES

III. Nerve to inferior oblique

PATHWAY & FORAMEN

Cavernous sinus and superior orbital

fissure

SITE OF GANGLION

Between optic nerve and lateral

rectus in apex of orbit

NAME OF GANGLION

Ciliary

NERVE CARRYING POSTGANGLIONIC FIBRES

Va: nasociliary and short ciliary

ORGAN(S) SUPPIED Ciliary muscle for accommodation. Circular iris muscle for pupil

constriction

SOURCE OF SYMPATHETIC THROUGH GANGLION Ophthalmic artery (internal carotid)

## SUBMANDIBULAR GANGLION: DETAILED PATHWAYS TO AND FROM IT

CENTRAL

Superior salivary (pons)

EMERGING WITH CRANIAL NERVE

VII (facial)

NERVE CARRYING PREGANGLIONIC

NG Nervus intermedius then VII then chorda
C tympani then lingual

FIBRES

PATHWAY & Internal acoustic meatus then middle ear FORAMEN then petrotympanic fissure then

infratemporal fossa

SITE OF GANGLION

Below lingual nerve on hyoglossus

NAME OF GANGLION

Submandibular

NERVE CARRYING POSTGANGLIONIC FIBRES Lingual (Vc). Some fibres may reach the

submandibular gland directly

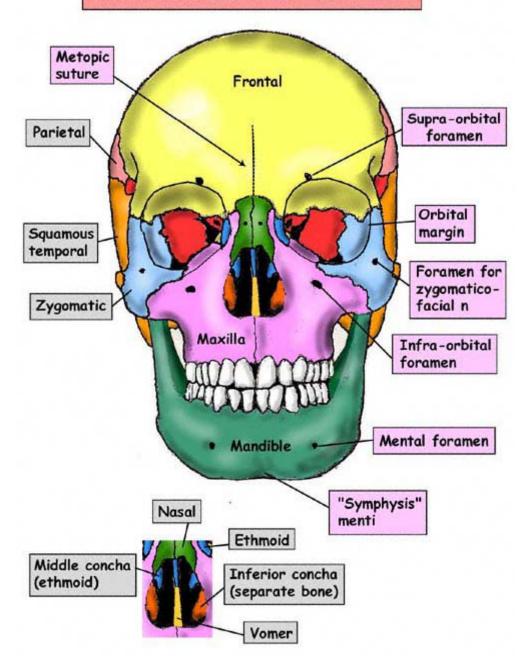
ORGAN(S) SUPPIED

Submandibular, sublingual, anterior lingual & mucosal glands on side of

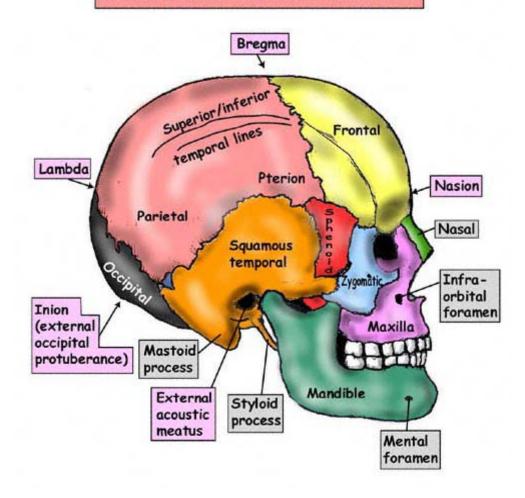
tongue

SOURCE OF SYMPATHETIC THROUGH GANGLION Facial artery (external carotid)

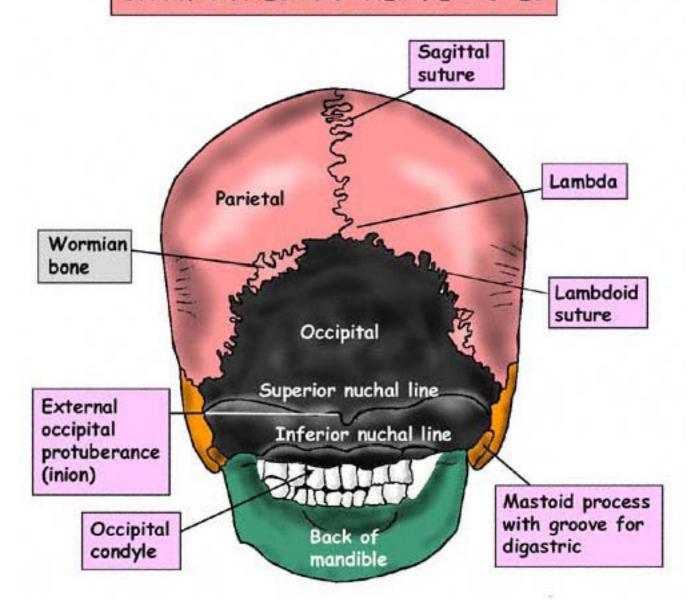
## ANTERIOR VIEW OF SKULL TO SHOW BONES & OTHER FEATURES



## LATERAL VIEW OF SKULL TO SHOW BONES & OTHER FEATURES

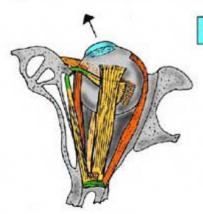


# POSTERIOR VIEW OF SKULL TO SHOW BONES & OTHER FEATURES



### EYE - TORSION

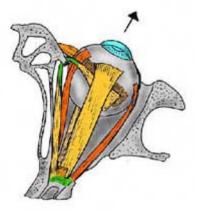
Because of the oblique angle of the orbit and the way that the muscles attach distal to the equator of the eye there is a tendency for some of the muscles to twist the eye in addition to its main action. This torsion, which can be internal (intorsion) or external (extorsion), is important as it counteracts the tilting movements of the head. The degree of twisting for any one muscle is determined by whether the eyeball is abducted or adducted



#### RIGHT EYE LOOKING FROM ABOVE

#### EYE IN ADDUCTION

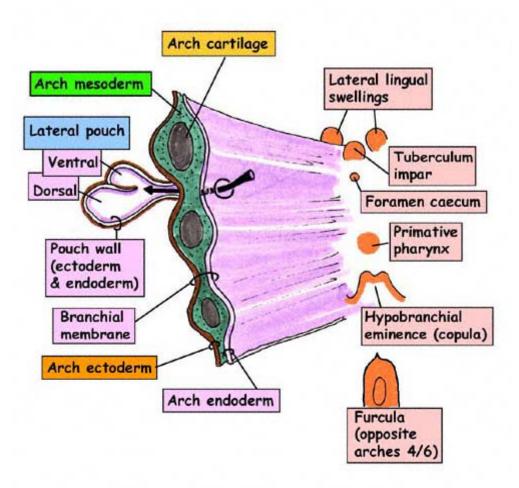
Superior rectus elevates & intorts
Inferior rectus depresses & extorts
Superior oblique turns eye down &
out only
Inferior oblique turns eye up & out
only



#### EYE IN ABDUCTION

Superior rectus elevates only
Inferior rectus depresses only
Superior oblique turns eye down &
out & intorts
Inferior oblique turns eye up & out
& extorts

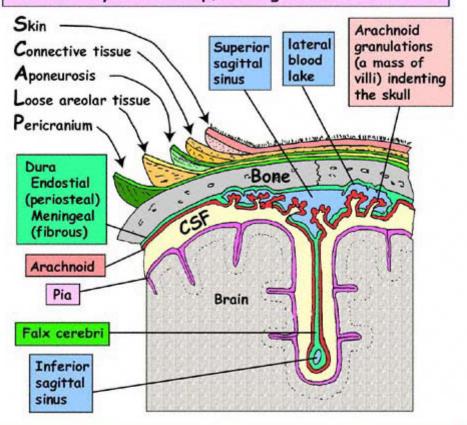
## PHARYNGEAL (BRANCHIAL) DERIVATIVES



See pharyngeal derivatives section in Instant Anatomy for more details

### CORONAL SECTION OF SKULL, SCALP & MENINGES IN MIDLINE

### To show layers of scalp, meninges and falx cerebri



#### CEREBROSPINAL FLUID

- 130ml 30ml in ventricles, 75ml in spinal system, 25ml in cranium
- Turn over 500ml per day from choroid plexus to 4th ventricle to subarachnoid space to arachnoid villi
- Pressure 130mm of water
- Function Brain floats in it, some metabolic change, effectively reduces weight of brain from 1500g to 50g

### FACIAL NERVE LESIONS

#### SUPRANUCLEAR LESION

Upper face has bilateral innervation (bilateral cortical representation)



Frontal lobe to corticonuclear fibres



Upper face



Lower face

Part of hemiplegia
Upper motor neurone lesion
Lower face worse for
voluntary movement but may
be OK for emotion

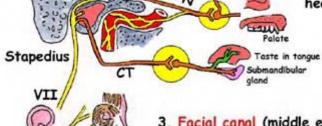
#### NUCLEAR/INFRANUCLEAR LESION

**Ipsilateral** 

Lacrimal

VII from cerebellopontine angle Lesion of nucleus/pontine fibres
 Complete unilateral palsy. Loss of
 VII, VI, V, taste, opposite limbs
 long tracts

Temporal bone (fracture)
 Complete unilateral palsy, loss of taste, decreased hearing or hyperacusis



- Facial canal (middle ear infection) Bell's palsy
- Other (MS, surgery, acoustic neuroma, herpes, diabetes, sarcoid)

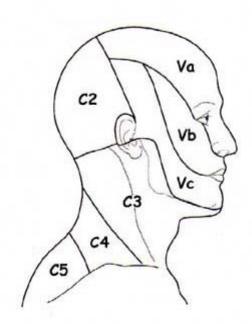


Lower motor neurone lesion

## DERMATOMES & NAMED SKIN NERVES

See under head and neck nerves, somatic, cervical plexus and also under the individual branches of the trigeminal nerve in the cranial nerve section of nerves.

See also in nerve section of Instant Anatomy

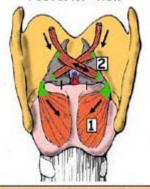


## VERTEBRAL LEVELS OF STRUCTURES

- Spinal root of accessory nerve crosses transverse process of atlas
  - Open mouth and dens
- Superior cervical ganglion
- 63 Body of hyoid bone
- C4 Upper border of thyroid cartilage
  - Bifurcation of common carotid arteries
- C6 Cricoid cartilage
  - Larynx becomes trachea
  - Pharynx becomes oesophagus
  - Middle cervical ganglion
  - Vertebral artery enters foramen transversum of C6
  - Carotid tubercle of Chassaignac
  - Inferior thyroid artery crosses to thyroid gland and passes behind sympathetic chain
- First clearly palpable spinous process (Vertebra prominens - C7)
  - Stellate/inferior cervical ganglion

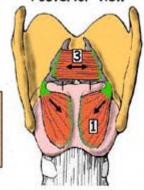
## LARYNX - INTRINSIC MUSCLES





Posterior cricoarytenoid (1) (abducts/opens cords)

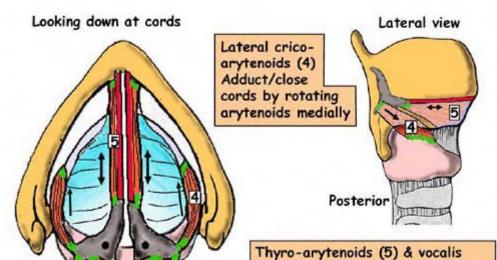
Posterior view



Oblique arytenoids (2) close cords by drawing together arytenoids. They extend into aryepiglottic fold as aryepiglotticus to close the aditus

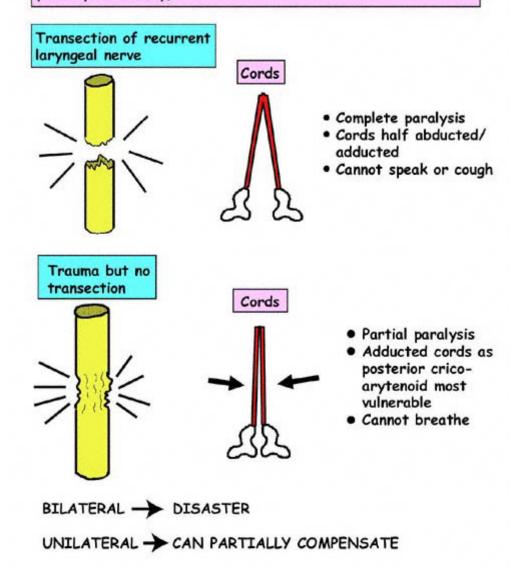
Transverse arytenoid (3) closes cords by drawing together arytenoids

loosen cords by drawing together the thyroid cartilage & arytenoids



## SEMON'S LAW FOR DAMAGE OF NERVES TO LARYNX

Semon's Law indicates the different effect between damage and transection of the recurrent laryngeal nerve as applicable to surgery in the region of this nerve (eg thyroidectomy or parathyroidectomy)



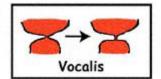
#### LARYNX - FUNCTION AND DEVELOPMENT

#### DURING SWALLOWING

- Closure of aditus by aryepiglotticus acting like a pursesting on the aryepiglottic folds
- Closure of rima glottidis/cords (lateral crico-arytenoids & transverse arytenoids)
- Epiglottis flips backwards/downwards with solid food
- Larynx/pharynx hauled up under the tongue (suprahyoid muscles)

#### **DURING PHONATION**

- · Cords held together for up to 3mm
- Vocalis helps to change the amount of cord that approximates
- · Series of jets of air
- Resonance produced by structures above larynx (pharynx/sinuses)
- Whispering is very wasteful of air as it is a constant stream

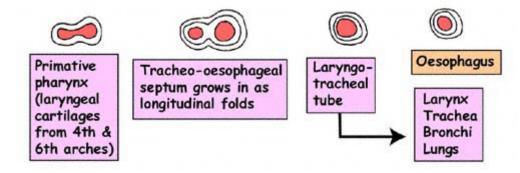


#### DURING COUGHING AND STRAINING

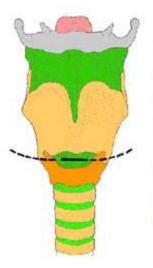
· Explosion of compressed air via closed cords

#### DEVELOPMENT

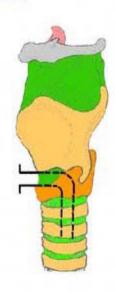
From primative pharynx, a laryngotracheal groove appears in midline, in floor, distal to pharyngeal pouches



## LARYNX - SURGICAL ACCESS



Emergency laryngotomy (cricothyroidotomy) Quick, relatively easy stab through cricothyroid membrane. Insert any small round airway such as biro casing. Anaesthetic not essential. Saves lives



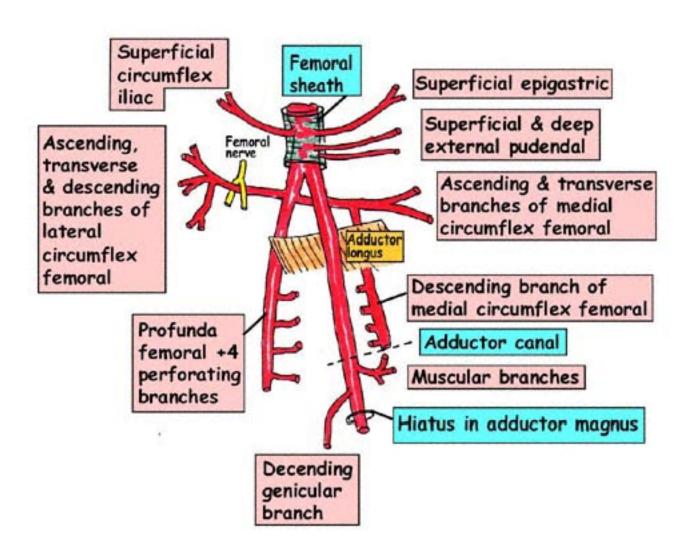


## Formal tracheostomy.

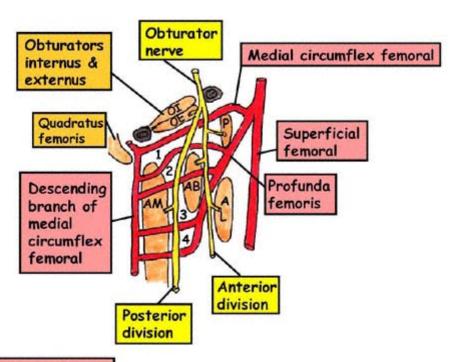
Not usually an emergency. Needs full anaesthetic. Ideal for temporary or permanent intubation. Hole cut in 2nd & 3rd tracheal rings, usually after dividing thyroid isthmus. Inferior thyroid veins can be a nuisance



## RIGHT FEMORAL ARTERY



### PROFUNDA FEMORIS ARTERY



### RELATIONSHIPS

Pectineus (P): Separates profunda from medial circumflex femoral artery

Adductor longus (AL): Separates profunda from femoral artery

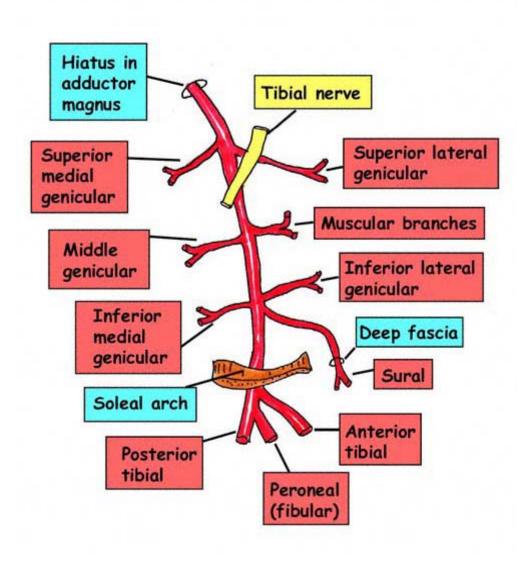
Adductor brevis (AB): Separates anterior & posterior

divisions of obturator nerve

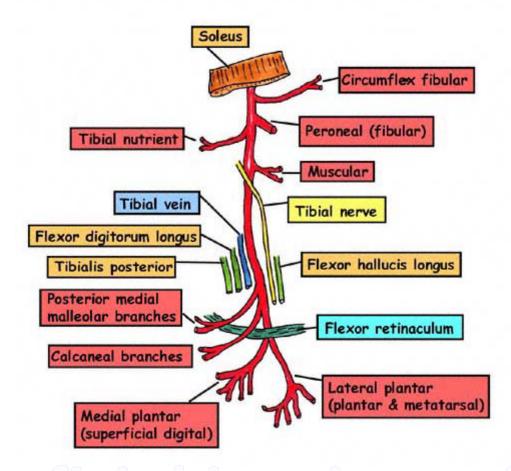
Adductor magnus (AM): separates descending branch of medial circumflex femoral

artery from profunda

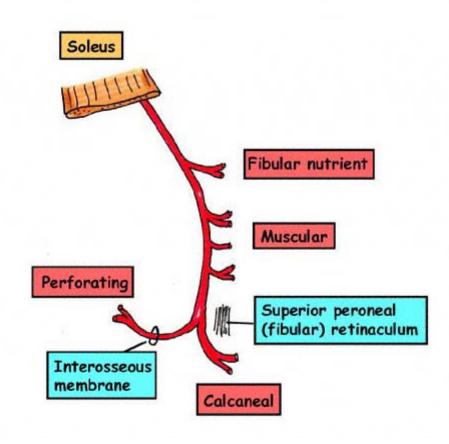
# RIGHT POPLITEAL ARTERY VIEWED FROM BEHIND



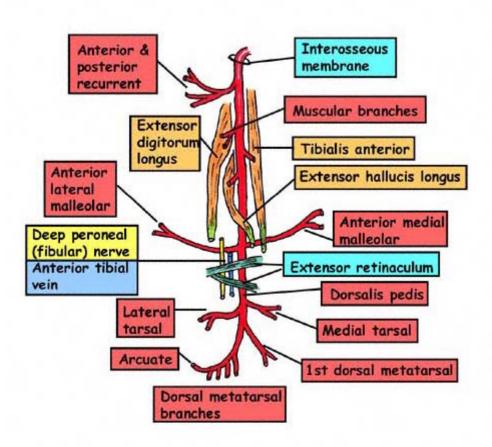
## RIGHT POSTERIOR TIBIAL ARTERY VIEWED FROM BEHIND



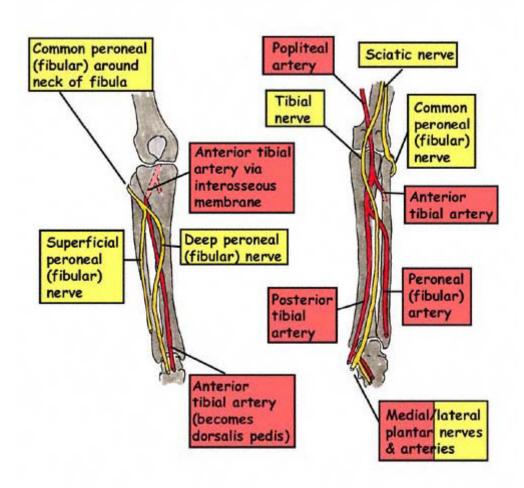
# RIGHT PERONEAL (FIBULAR) ARTERY VIEWED FROM BEHIND



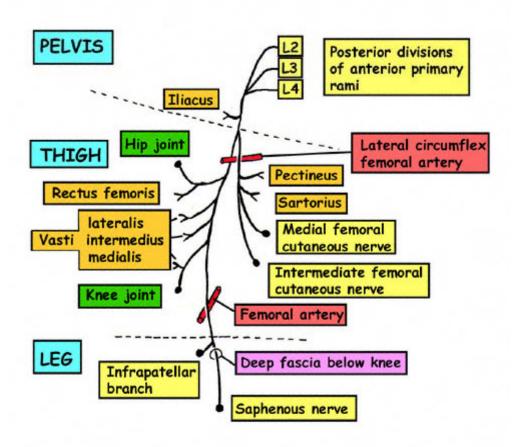
## RIGHT ANTERIOR TIBIAL ARTERY VIEWED FROM IN FRONT



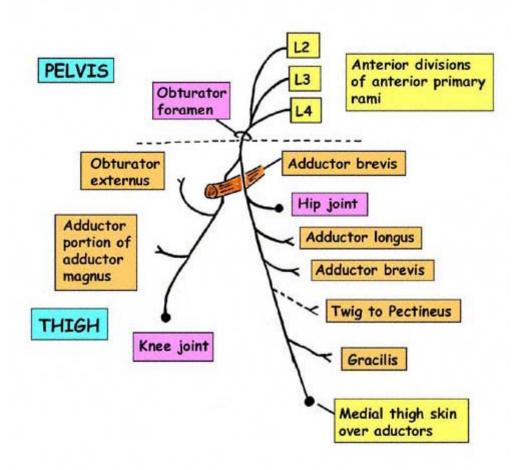
#### GENERAL PATTERN OF ARTERIES AND NERVES IN RIGHT LOWER LEG



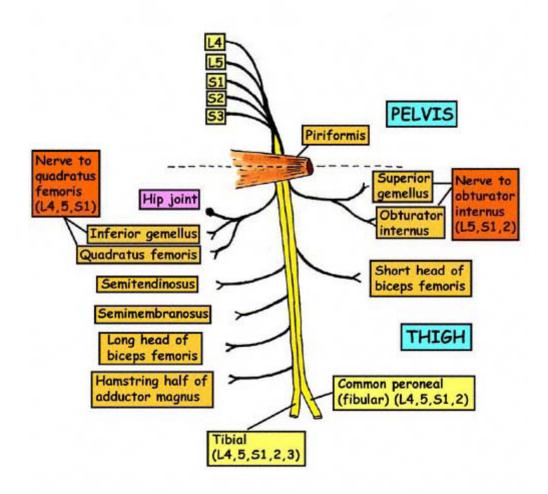
## FEMORAL NERVE



## OBTURATOR NERVE



### RIGHT SCIATIC NERVE VIEWED FROM BEHIND



# TIBIAL NERVE

See Instant Anatomy, section on peripheral nerves, for details of this nerve

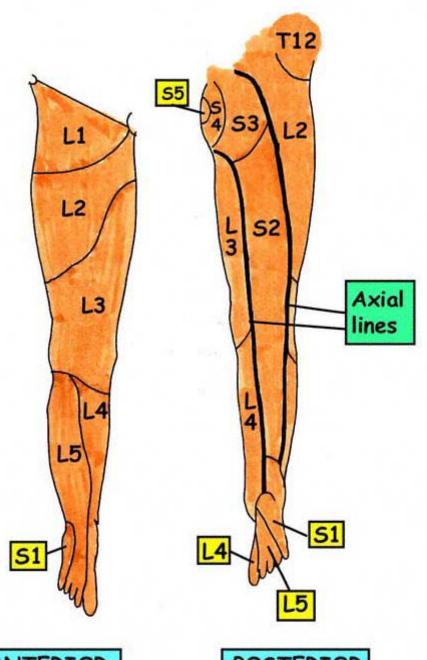
## COMMON PERONEAL (FIBULAR) NERVE

See Instant Anatomy, section on peripheral nerves, for details of this nerve

## MEDIAL AND LATERAL PLANTAR NERVES

See Instant Anatomy, section on peripheral nerves, for details of this nerve

#### CUTANEOUS NERVES OF LOWER LIMB Femoral branch of genitofemoral Iliohypogastric(L1) (L1) Posterior Subcostal(T12) 2,3,4 Ilio-inguinal primary Subcostal rami Perforating (T12)cutaneous (52,3)Lateral femoral Posterior 3 cutaneous femoral (L2,3)Cutaneous cutaneous branch of (51,2,3) obturator Intermediate (L2,3)Lateral femoral femoral cutaneous Medial femoral (L2,3)cutaneous cutaneous(L2,3,4) (L2,3) Lateral sural Lateral sural Infrapatellar branch (L4,5) (L4,5)of saphenous(L3,4) Superficial peroneal Saphenous (fibular) Superficial (L3,4)(L4,5,51)peroneal (fibular) Sural(S1) Medial (L4, 5, 51)calcaneal (51) Sural(S1) Lateral Medial plantar(S1,2) ANTERIOR plantar (L4,5)Deep peroneal POSTERIOR (fibular)(L5) Lumbar plexus Tibial Other Sacral plexus Femoral Obturator Common peroneal



## SEGMENTAL NERVE SUPPLY TO MUSCLES

SEGMENT	MUSCLE	NERVE
L1,2	Psoas	Segmental
L2,3	Adductor brevis	Obturator
L2,3	Adductor longus	Obturator
L2,3	Gracilis	Obturator
L2,3	Sartorius	Femoral
L2-4	Iliacus	Femoral
L3,4	Obturator externus	Obturator
L3,4	Pectineus	Femoral (+/- obturator)
L3,4	Quadriceps femoris	Femoral
L3-51	Adductor magnus	Obturator & sciatic
L4,5	Tibialis anterior	Deep peroneal (fibular)
L4-51	Gluteus medius	Superior gluteal
L4-51	gluteus minimis	Superior gluteal
L4-S1	Inferior gemellus	N to quadratus femoris
L4-51	Lumbricals	Medial & lateral plantar
L4-S1	Plantaris	Tibial
L4-51	Popliteus	Tibial
L4-51	Quadratus femoris	N to quadratus femoris
L4-51	Tensor fasciae latae	Superior gluteal
L4-52	Semimembranosus	Sciatic
L4-52	Semitendinosus	Sciatic
L5,51	Extensor digitorum longus	Deep peroneal (fibular)
L5,51	Extensor hallucis longus	Deep peroneal (fibular)
L5,S1	Peroneus brevis	Superficial peroneal (fibular)
L5,51	Peroneus longus	Superficial peroneal (fibular)
L5,51	Peroneus tertius	Deep peroneal (fibular)
L5,51	Tibialis posterior	Tibial
L5-52	Gluteus maximus	Inferior gluteal
L5-52	Obturator internus	N to obturator internus
L5-52	Soleus	Tibial
L5-52	Superior gemellus	N to obturator internus
L5-52	Biceps femoris	Sciatic (tibial & common peroneal)
51,2	Abductor digiti minimi	Lateral plantar
51,2	Abductor hallucis	Medial plantar
51,2	Adductor hallucis	Lateral plantar
51,2	Extensor digitorum brevis	Deep peroneal (fibular)
51,2	Extensor hallucis brevis	Deep peroneal (fibular)
51,2	Flexor digiti minimi	Lateral plantar
51,2	Flexor digitorum brevis	Medial plantar
51,2	Flexor digitorum longus	Tibial
51,2	Flexor hallucis brevis	Medial plantar
51,2	Flexor hallucis longus	Tibial
51,2	Gastrocnemius	Tibial
51,2	Interossei	Lateral plantar
51,2	Piriformis	N to pi riformis
51,2	Quadratus plantae	Lateral plantar

## SEGMENTAL NERVE SUPPLY TO MOVEMENTS AND REFLEXES IN LOWER LIMB

HIP:	Flexion	L2,3
	Extension	L4,5
	Adduction/internal rotation	L1,2,3
	Abduction/external rotation	L5,51
KNEE:	Flexion	L5,51
	Extension	L3,4
ANKLE	Dorsiflexion (extension)	L4,5
	Plantarflexion (flexion)	51,2

#### NERVE LESIONS IN THE LOWER LIMB

NERVES TO PSOAS AND ILIACUS:

No pelvic swing on walking

FEMORAL:

Loss of hip flexion & knee extension. Loss of sensation anterior thigh & medial leg

OBTURATOR:

Loss of adduction of thigh. Loss of sensation inner thigh

SUPERIOR GLUTEAL:

Loss of abduction at hip. Pelvic dip on walking

INFERIOR GLUTEAL:

Loss of extension at hip. Buttock wasting

SCIATIC:

Loss of all motor except adduction & flexion of thigh & extension of knee. Loss of sensation lower leg & foot

TIBIAL (HIGH): Loss of flexion of toes & inversion of foot. Loss of sensation of sole of foot, inferior aspect of toes & nail beds

COMMON PERONEAL (TIBIAL) (HIGH): Loss of extension of toes & foot (footdrop). Loss of sensation of lateral lower leg & upper foot

ROOT COMPRESSION:

Prolapsed discs catches nerve that emerges at the next intervertebral foramen and not one at the same level as the disc. For example, disc lesion of the L4/5 space catches L5 nerve

## OF LOWER LIMB

#### SITE

Between tough deep fascia, intermuscular septa, bones and interoseous membrane

#### CAUSE

Trauma/infection leads to swelling, increased pressure, decreased perfusion, then ischaemia and tissue death

#### SYMPTOMS & SIGNS

Pain, decreased muscle & nerve function, pain on passive movement. Pulse may be lost (30mmHg or more is enough to cause damage)

#### ANTERIOR

Pain, decreased dorsiflexion, extension of toes, sensation in first dorsal skin cleft

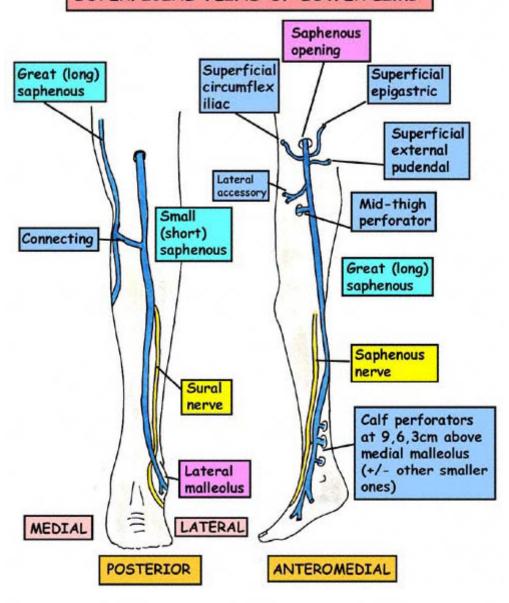
#### LATERAL

Pain, decreased plantar flexion, inversion, sensation of dorsal foot and toes

#### POSTERIOR

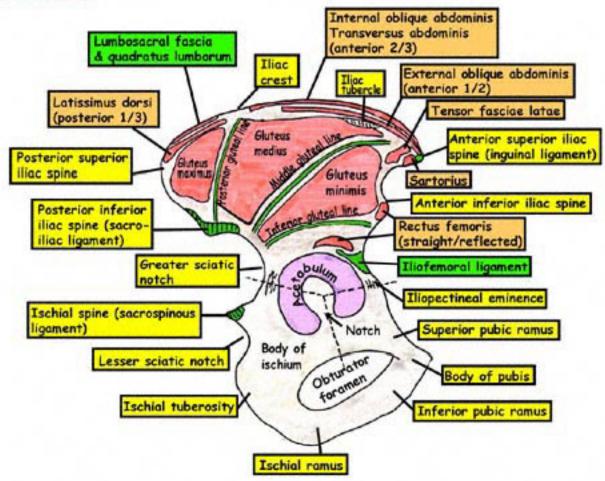
Divided by deep transverse intermuscular septum into superficial and deep syndromes. Superficial gives decreased plantar flexion and sural nerve sensation. Deep gives decreased plantar & toe flexion, tibial nerve sensation

### SUPERFICIAL VEINS OF LOWER LIMB

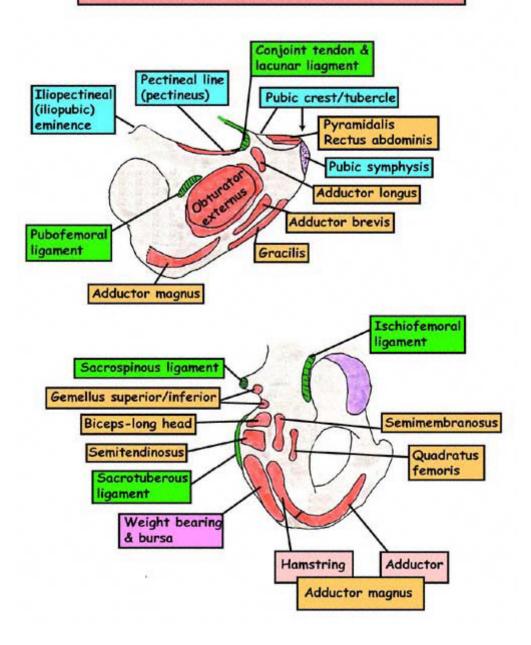


## ATTACHMENTS TO HIP BONE

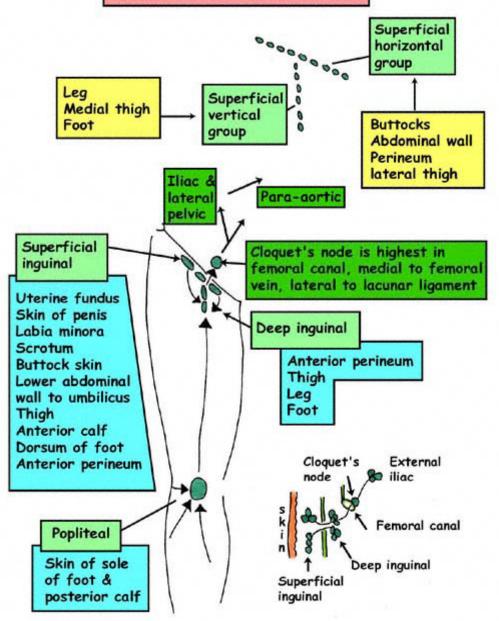




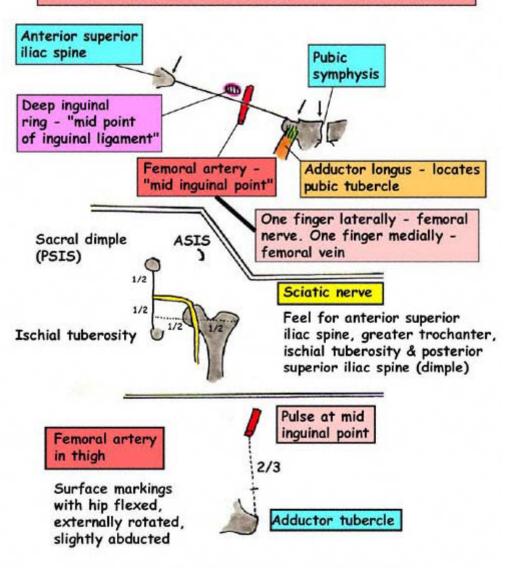
### ATTACHMENTS TO ISCHIUM & PUBIS



### LOWER LIMB LYMPHATICS



### LOWER LIMB SURFACE & APPLIED ANATOMY 1



The artery lies for 2/3 along the line indicated above

## LOWER LIMB SURFACE & APPLIED ANATOMY 2



## SHENTON'S LINE

Shenton's Line is a useful observation when looking at an X-ray of a pelvis/hip. In the normal appearances this line is smooth and unbroken

Note: When measuring to see if there is shortening of the lower limb it can be measured from the umbilicus to the medial malleolus. This may give an APPARENT shortening when the two sides are compared. However, only if the legs are measured from the anterior superior iliac spine to the medial malleolus will TRUE shortening be detected.

## FEMORAL TRIANGLE

Pectineus

Add

longus/

BOUNDARIES

Superior

Inguinal ligament

Iliacus

Lateral

Medial border of sartorius

Roof

Fascia lata

Medial

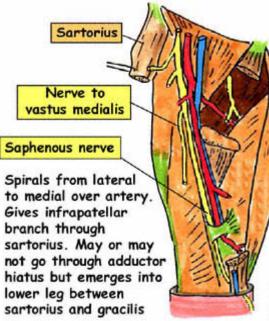
Medial border of adductor longus

Floor

Marked muscles with adductor brevis just showing. It has the anterior division of the obturator nerve on its surface Contains

Femoral nerve Femoral artery Femoral vein Deep inguinal nodes

## ADDUCTOR CANAL (HUNTER'S/SUBSARTORIAL)



#### Relations

Femoral artery is always between vein & saphenous nerve.

Femoral vein spirals from medial to artery in femoral triangle to posterior to artery in canal. Femoral artery gives descending genicular artery as it leaves the adductor hiatus

#### Adductor hiatus

Transmits:

- Femoral artery & vein
- Saphenous nerve (usually)
- Small genicular branch of posterior division of obturator nerve

#### **Boundaries**

Lateral

Vastus medialis

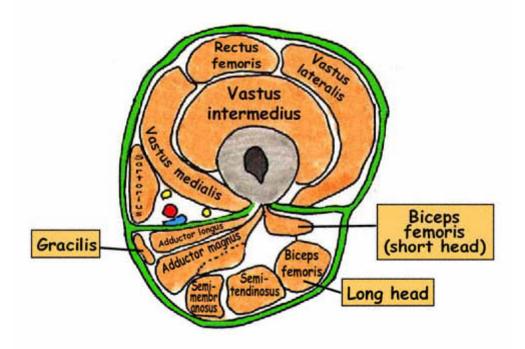
Medial/floor

- Adductor longus
- Adductor magnus

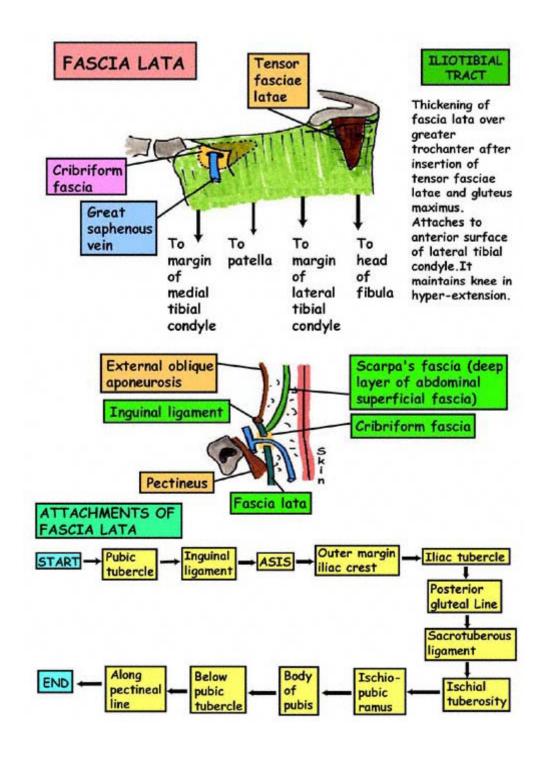
#### Roof

- Fascia
- Sartorius
- Subsartorial plexus (contributed to by:
- Anterior branch of obturator
- Medial cutaneous n of thigh
- Saphenous nerve
   Supplies: Skin of medial thigh)

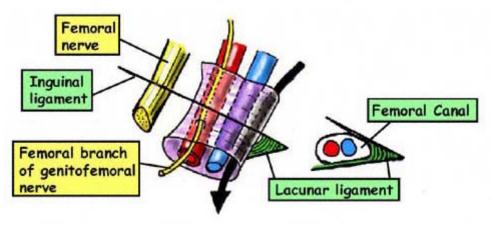
## CROSS (AXIAL) SECTION OF MID LEFT THIGH LOOKING UP



Note: There is no posterior intermuscular septum. It would divide adductor magnus if present.



#### FEMORAL SHEATH & CANAL



The big black arrow is passing downwards from the femoral ring, superiorly, via the femoral canal and into the femoral triangle.

The femoral sheath surrounds the canal, femoral vein and femoral artery but NOT the femoral nerve. The femoral branch of the genitofemoral nerve is surrounded by sheath but the nerve pierces its anterior wall to reach the skin of the femoral triangle.

#### ANTERIOR LAYER OF SHEATH

Transversalis fascia

#### POSTERIOR LAYER OF SHEATH

Psoas fascia (both these layers of fascia fuse with adventitia of femoral artery 1" below inguinal ligament)

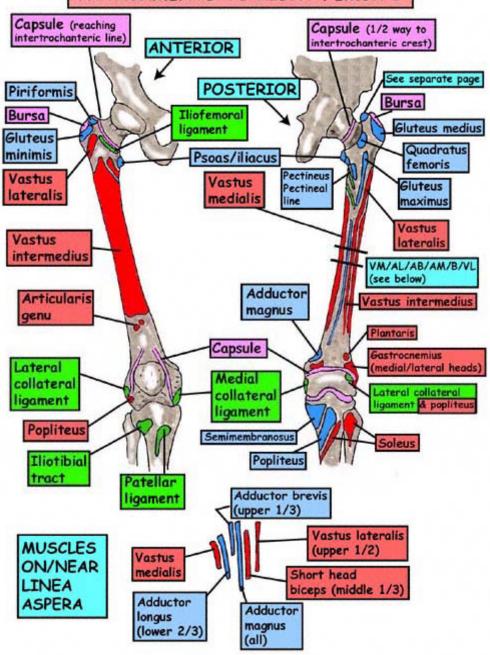
#### CONTENTS OF SHEATH

Femoral vein femoral artery femoral canal Lymphatics

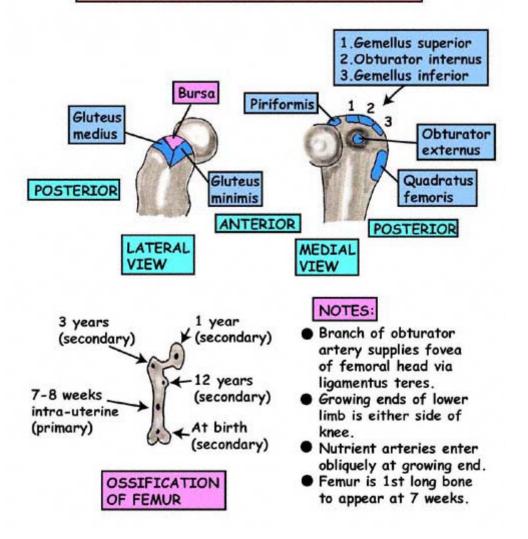
## ADDITIONAL FUNCTION OF SHEATH

Allows expansion of femoral vein

#### ATTACHMENTS TO RIGHT FEMUR 1



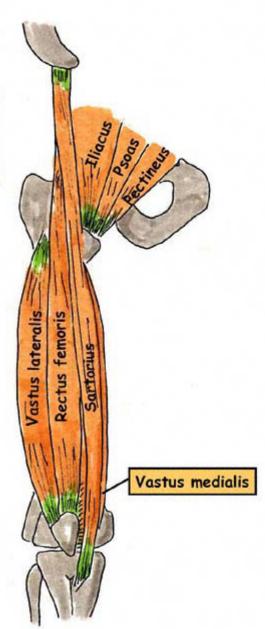
## ATTACHMENTS TO RIGHT FEMUR 2 GREATER TROCHANTER



## ANTERIOR THIGH & HIP FLEXORS

See muscle section of Instant Anatomy for details of these muscles

Note on Psoas/iliacus:
Despite some opinions
it is probable from
recent experiments that
these muscles act purely
as flexors of the hip and
not rotators. However,
in the presence of a
fractured neck of femur
the line of axis changes
and they produce external
rotation



#### MEDIAL THIGH

Branch of obturator artery via ligamentum teres to fovea of head of femur

See muscle section of Instant Anatomy for details of muscles



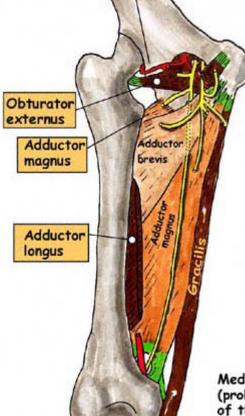
From anterior divisions of anterior primary rami of L2,3,4

Anterior branch; Lies between adductors longus & brevis, contributes to subsartorial plexus for medial thigh skin, supplies adductors longus, brevis & gracilis

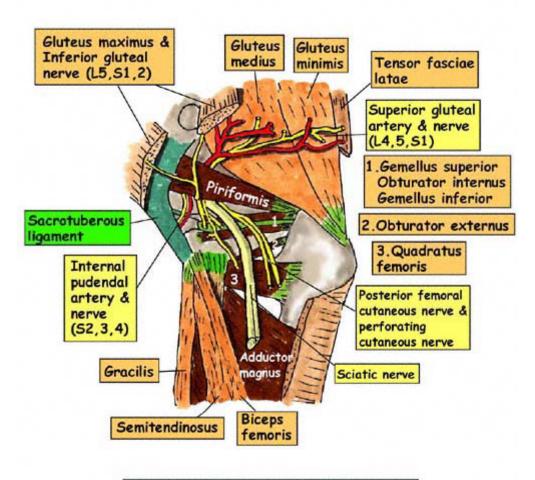
Posterior branch; Lies between adductors brevis & magnus, supplies adductor magnus, obturator externus & knee joint via a small branch that passes through the adductor hiatus

Medial collateral ligament of knee (probably a remnant of the tendon of the hamstring portion of adductor magnus that was originally attached to the tibia)

ADDUCTOR HIATUS Transmits femoral artery, femoral vein, the small genicular branch of the posterior branch of the obturator nerve and usually the saphenous nerve



### GLUTEAL REGION 1



See muscle section of Instant Anatomy for details of muscles

### **GLUTEAL REGION 2**

#### SUPERIOR GLUTEAL NERVE L4,5,51

Gluteus Medius Gluteus minimis Tensor fasciae latae

#### INFERIOR GLUTEAL NERVE L5,S1,2

Gluteus maximus

#### NERVE TO OBTURATOR INTERNUS L5,51,2

Obturator internus Superior gemellus

#### NERVE TO QUADRATUS FEMORIS L4,5,51

Quadratus femoris Inferior gemellus

## NOTE

An easy way to remember these root values is that the highest and lowest nerves have the same value (L4,5,S1) and the two middle nerves have the sames roots (L5,S1,2)

## NOTES ON SACRAL PLEXUS AND SCIATIC NERVE

#### 6 P'S FROM THE ROOTS OF THE SACRAL PLEXUS

There are 6 nerves that emerge from the sacral roots that all begin with the letter "P". This provides an easy way of remembering them.

- 1. Nerve to Piriformis (51,2)
- 2. Perforating cutaneous nerve (52,3)
- 3. Posterior femoral cutaneous nerve (\$1,2,3)
- Pudendal nerve (52,3,4)
- 5. Perineal branch of 54
- Pelvic splanchnics (parasympathetics) (52,3,4)

See notes on greater and lesser sciatic foramina for which of these pass out through each foramen, if at all.

#### SCIATIC NERVE

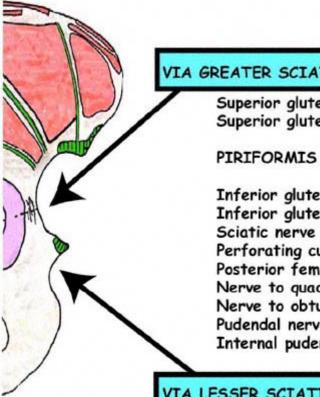
#### Anterior division

Tibial to flexors (L4,5,51,2,3) Nerve to obturator internus (L5,51,2) Nerve to quadratus femoris (L4,5,51)

#### Posterior division

Common peroneal to extensors Superior gluteal (L4,5,51) Inferior gluteal (L5,S1,2)

### STRUCTURES PASSING THROUGH THE GREATER & LESSER SCIATIC FORMINA



### VIA GREATER SCIATIC FORAMEN

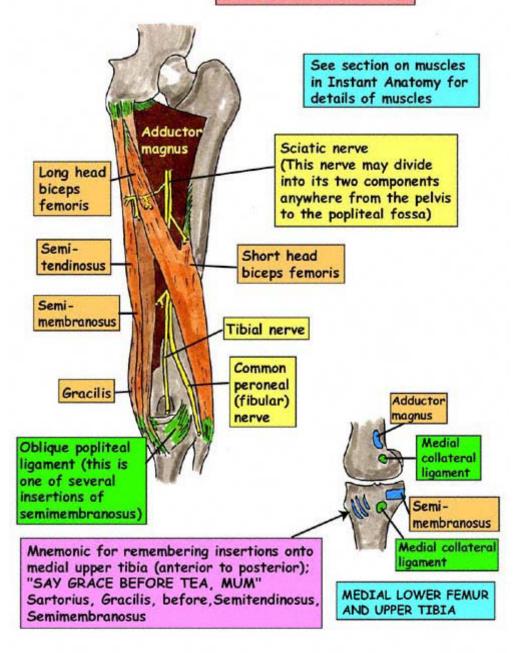
Superior gluteal vessels Superior gluteal nerve

Inferior gluteal vessels Inferior gluteal nerve Sciatic nerve Perforating cutaneous nerve Posterior femoral cutaneous nerve Nerve to quadratus femoris Nerve to obturator internus Pudendal nerve Internal pudendal vessels

### VIA LESSER SCIATIC FORAMEN

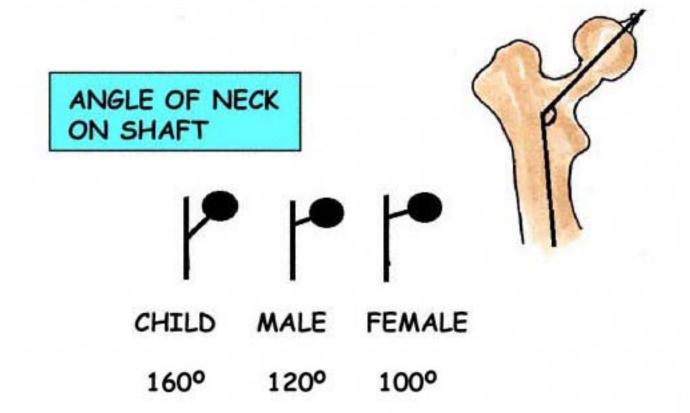
Tendon of obturator internus Nerve to obturator internus Internal pudendal vessels Pudendal nerve

#### POSTERIOR RIGHT THIGH



## HIP JOINT 1

- Ball and socket
- Synovial
- Ligamentum teres in fovea



## HIP JOINT 2

## SYNOVIUM

From: Femoral articular margin

Covers: Intracapular femoral neck, labrum, ligamentum

teres, Havesian fat pad & may communicate with

PSOAS BURSA

Labrum acetabulare

Ligamentum teres attached to transverse ligament & sides of acetabular notch

Acetabular notch leads into acetabular fossa and fat pad

#### CAPSULE

Strong ++

Anterior: Covers whole neck to intertrochanteric line

Posterior: Covers neck half way to intertrochanteric crest Reflects: Back as retinaculum which carries the blood supply



#### 2 ANASTOMOSES

#### Trochanteric (at greater trochanter):

- Descending superior gluteal
- Inferior gluteal
- · Ascending branches of medial & lateral circumflex femoral

#### Cruciate (at lesser trochanter):

- Transverse branches of medial & lateral circumflex femoral
- · Descending branch of inferior gluteal
- · Ascending branch of 1st perforating artery

#### Mnemonic:

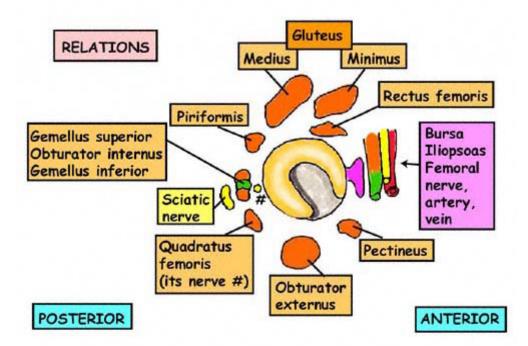
Upper anastomosis does not receive branch from lowest artery, lower anastomosis does not receive branch from highest artery.

#### BURSAE

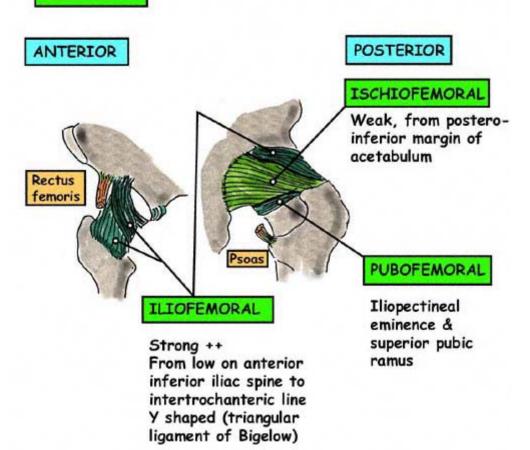
- · Psoas may communicate into hip joint
- Trochanteric
- Ischial

### NERVES

- Femoral (because of rectus femoris)
- Sciatic (because of quadratus femoris)
- Obturator posterior division



# LIGAMENTS



#### HIP MOVEMENTS

#### Abduction

Gluteus medius, gluteus minimus, tensor fasciae latae (+/- piriformis)

#### Adduction

Adductors brevis, longus, magnus (pectineus, gracilis, iliopsoas)

### Flexion

Psoas, iliacius, rectus femoris, sartorius, (pectineus, tensor fasciae latae). Note soft tissue limitation

#### Extension

Gluteus maximus, semitendinosus, semimembranosus, adductor magnus, long head biceps femoris. Note capsule & ligaments limitation

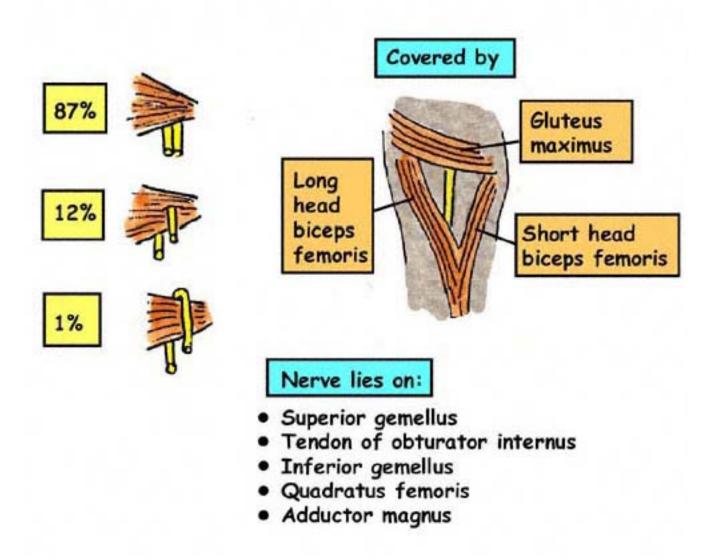
#### External rotation

Gluteus maximus, (piriformis, obturators internus & externus, gemelli, quadratus femoris

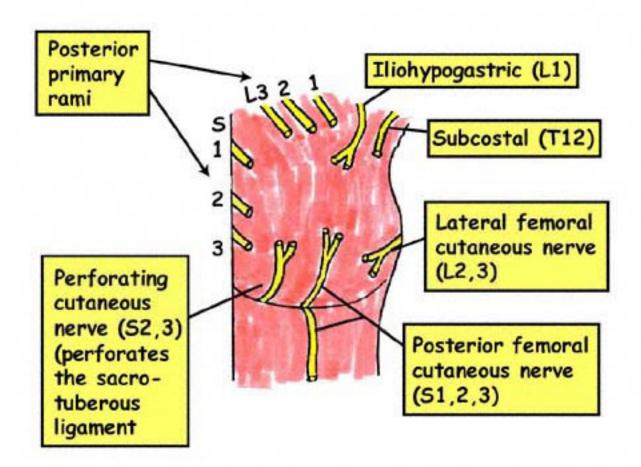
#### Internal rotation

Anterior fibres of gluteus medius & minimis

# VARIATIONS IN SCIATIC NERVE



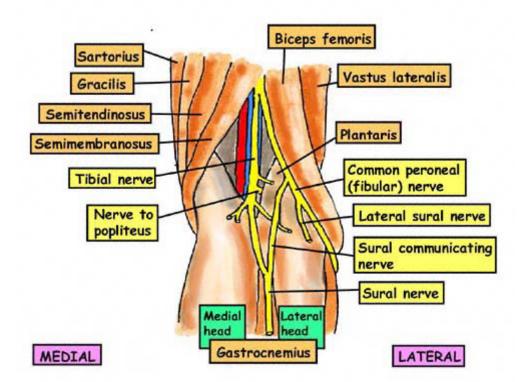
# CUTANEOUS NERVE SUPPLY OF BUTTOCKS



NOTE: Pain may be referred between pelvis (autonomics 52,3) and the posterior femoral cutaneous nerve (52,3)

### RIGHT POPLITEAL FOSSA SUPERFICIAL DISSECTION

- · Diamond shaped
- Borders:
  - Upper medial Semimembranosus (& semitendinosus)
  - Upper lateral Biceps femoris
  - Lower medial Gastronemius (medial head)
  - Lower lateral Plantaris & gastrocnemius (lateral head)
  - Floor Popliteus, capsule, femur
  - Roof Short saphenous & communicating veins
    - Lateral sural cutaneous nerve
    - Sural communicating nerve
    - End of posterior femoral cutaneous nerve
    - Fascia lata



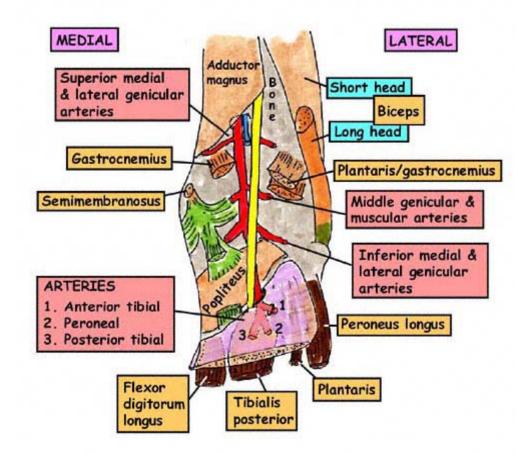
# RIGHT POPLITEAL FOSSA DEEP DISSECTION

#### CONTENTS

- · Popliteal artery & vein
- Tibial nerve
- Common peroneal (fibular) nerve Starts medial to tibial nerve
- Fat
- Lymph nodes

#### NOTE ON POPLITEAL ARTERY

- 8" long
- Ends lateral to tibial nerve
- · Vein always between two



#### RIGHT PATELLA

- Largest sesamoid bone in body
- · Mobile from side to side
- Quadriceps pull obliquely along the line of the femur & this tends to lateral dislocation.
- There are 3 factors that prevent lateral displacement of patella

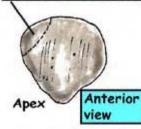


- Larger lateral condyle of femur
  - Tension in medial retinacular fibres

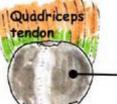


3 Direction & insertion of lowest fibres of vastus medialis

Upper lateral part is site of bipartite patella



Anterior/posterior is obvious

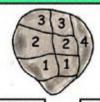


Lateral/posterior surface is: Larger, longer, more steeply sloped

Patella tendon attaches to the tibial tubercle

Posterior view

#### ARTICULATION WITH FEMUR



- 1. In extension
- 2. In slight flexion
- 3. In flexion

4. In full flexion

Lateral

Medial

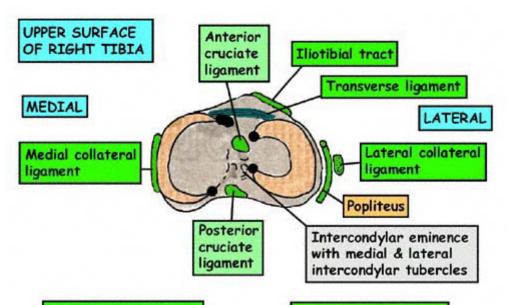
#### OSSIFICATION

Several centres between 3 & 6 years that fuse at puberty (they appear as child starts running). Sometimes a separate centre superior/lateral at 6 years - fuses at puberty

Attachments to lower right femur Posterior view Back, high, lateral Anterior Mnemonic: AL cruciate (anterior - lateral) ligament Adductor magnus Medial head of **Plantaris** gastrocnemius Lateral head of gastrocnemius Medial Lateral collateral ligament collateral **Popliteus** ligament Lateral condyle Medial condyle Posterior (broad/flat) (narrow/rounded) cruciate ligament Intercondylar Forward, low, notch medial Mnemonic: PM (posterior - medial)

#### MENISCI

Liable to tears when flexed knee is twisted Function: transfers forces, keep bones together, helps locking



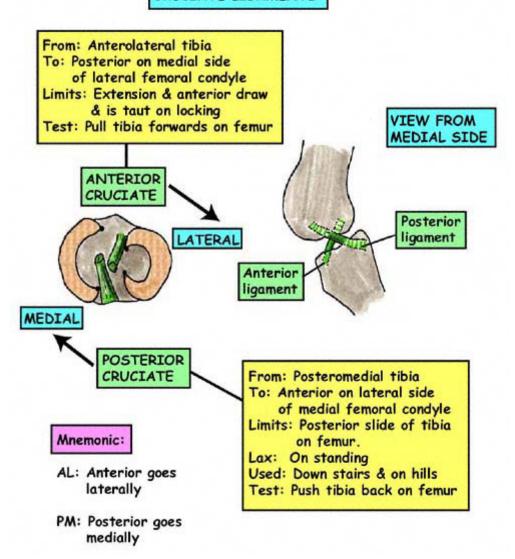
#### MEDIAL MENISCUS

- Wider C
- · Medial lip slopes up
- Attaches as shown but also to medial collateral ligament
- More liable to damage than lateral meniscus

#### LATERAL MENISCUS

- Smaller, tighter C
- Lateral lip slopes down
- Not attached to lateral collateral ligament
- Attached as shown
- Lightly attached to popliteus & is retracted by it on flexion

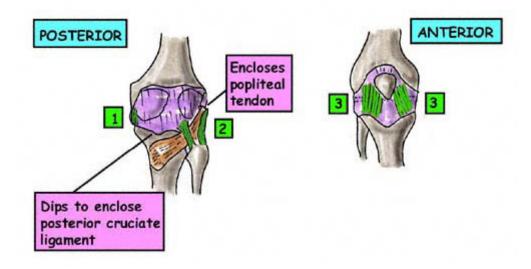
#### CRUCIATE LIGAMENTS



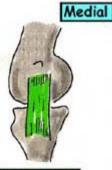
#### RIGHT CAPSULE

Capsule is attached to the bony margins of the tibia and femur It has several thickenings shown below called internal ligaments

- Thickened medially to make Short Internal (medial) Ligament which attaches to medial collateral ligament outside & to the medial meniscus inside as the coronary ligaments
- Arcuate Popliteal Ligament. This is Y shaped and the lateral part of it is often known as the Short External (lateral) ligament. Popliteus tendon passes medially to it
- 3. Medial and lateral Patellar Retinacular Fibres. These reinforce the capsule anteriorly. The medial ones are important as they help to prevent the patella dislocating laterally

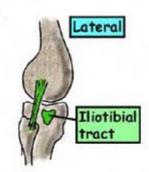


# LIGAMENTS OF RIGHT KNEE



MEDIAL COLLATERAL LIGAMENT

- · Broad, long & thick · Thick, cordlike
- Strong
- Attached to capsule & medial meniscus • Limits full
- · Limits full extension & thus helps with locking



LATERAL COLLATERAL LIGAMENT

- Not attached to joint structures
- extension & thus helps with locking



OBLIQUE POPLITEAL LIGAMENT

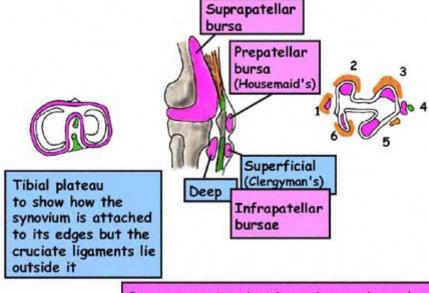
- Upward extension of semimembranosus tendon
- · Limits extension & thus helps with knee locking

### NOTE

- Knee is largest joint in body
- It is a modified hinge joint
- The line of the body weight is anterior to the knee

#### BURSAE AND SYNOVIUM

Synovium lines the inside of the capsule and is attached to the bony edges. It extends into the suprapatellar bursa. The cruciate ligaments and popliteus tendon lie out side it (see figure below)



#### Bursae associated with tendons and muscles

- 1. Under sartorius, gracilis, semitendinosus
- Under medial head of gasrocnemius (often into joint)
- Under lateral head of gastrocnemius (sometimes into joint)
- 4. Under lateral collateral ligament
- 5. Under popliteus (into joint)
- 6. Under semimembranosus

#### BLOOD & NERVE SUPPLY, MOVEMENTS

### **BLOOD SUPPLY**

#### Genicular arteries

Popliteal gives: Superior (medial and lateral)

Middle

Inferior (medial and lateral)

Femoral gives: Descending branch from profunda

### NERVES

- Posterior division of obturator
- Femoral
- Sciatic (both parts)

#### MOVEMENTS

Flexion: Semimembranosus, semitendinosus, biceps, gracilis, sartorius (gastrocnemius, plantaris, popliteus)

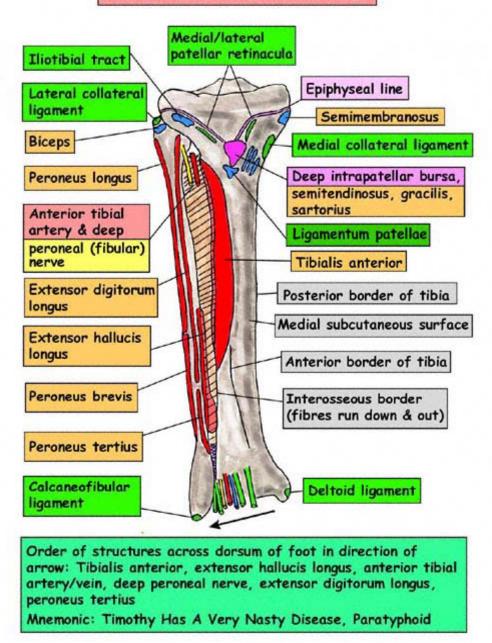
Extension: Quadriceps femoris, iliotibial tract (gluteus maximus, tensor fasciae latae)

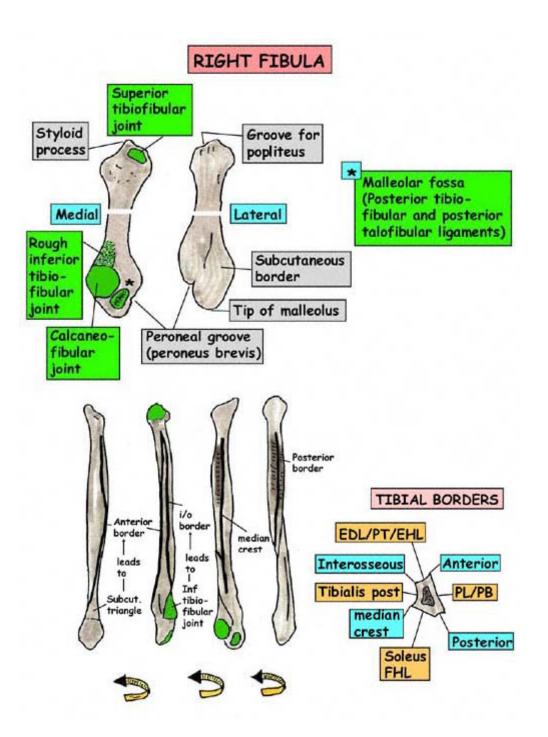
Internal rotation Semimembranosus, semitendinosus, (with knee flexed): gracilis, sartorius

External rotation Biceps (with knee flexed):

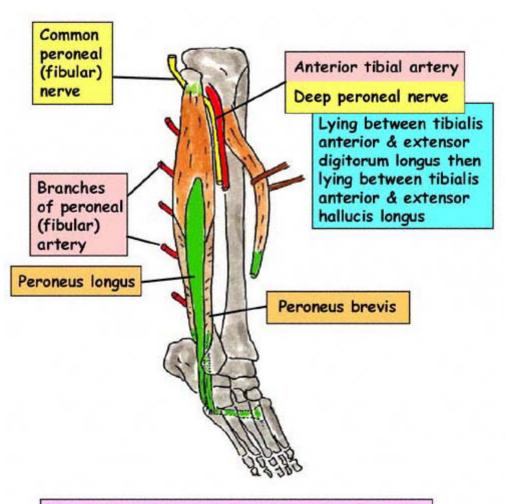
#### **KNEE JOINT 8** LOCKING OF KNEE LOCKING Medial femoral No further Full Taut anterior condyle moves symmetrical back - lateral extension cruciate extension condyle moves forwards Medial/lateral Tensor fasciae latae Femur internally collateral & rotates on tibia & gluteus maximus tighten iliotibial tract oblique popliteal on axis of anterior ligaments tighten cruciate ligament Knee hyperextends and locks UNLOCKING Popliteus externally Hamstrings can Locked ligaments rotates femur on then flex knee loosen tibia

### ANTERIOR LOWER RIGHT LEG



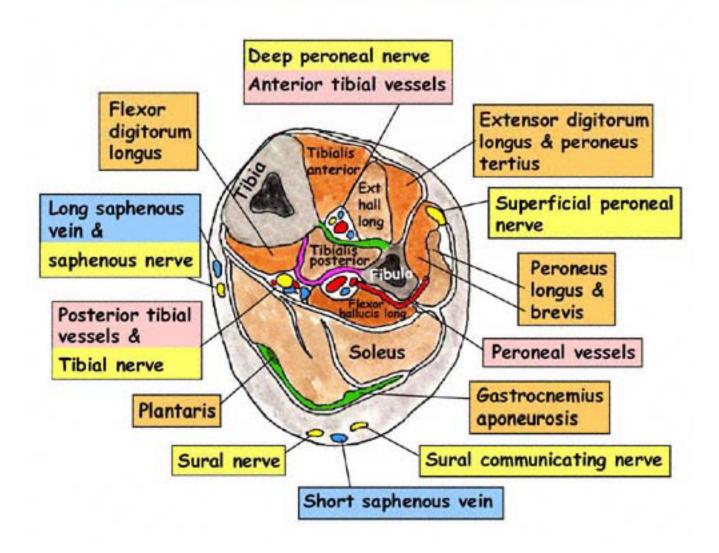


# PERONEAL (FIBULAR) COMPARTMENT

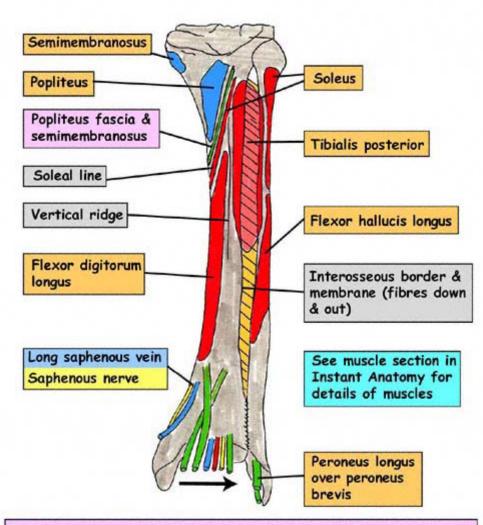


For details of the extensor and peroneal muscles see section on muscles in Instant Anatomy

# AXIAL (CROSS) SECTION LOWER LEG

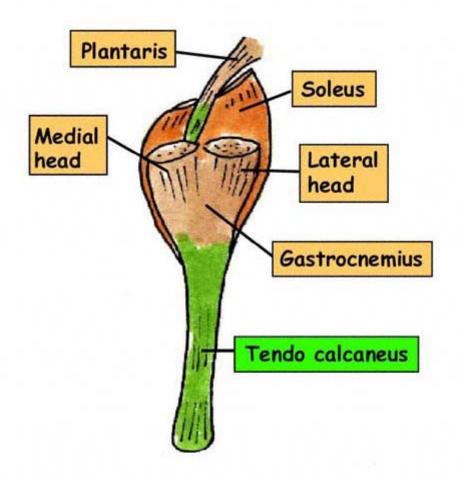


#### POSTERIOR LOWER RIGHT LEG

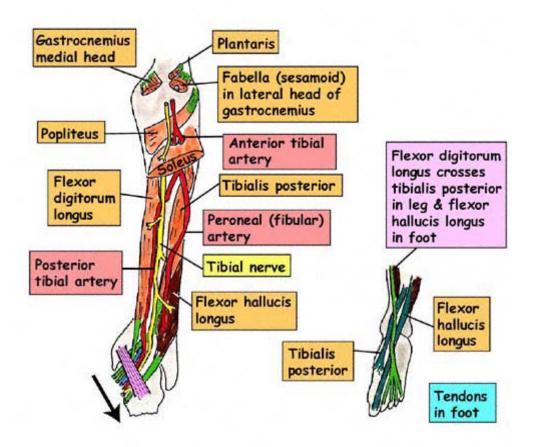


Order of structures behind medial malleolus as indicated by arrow: Tibialis posterior, flexor digitorum longus, posterior tibial vein & artery, tibial nerve, flexor hallucis longus Mnemonic: Timothy Doth Vex All Nervous Housemaids

# POSTERIOR RIGHT LOWER LEG

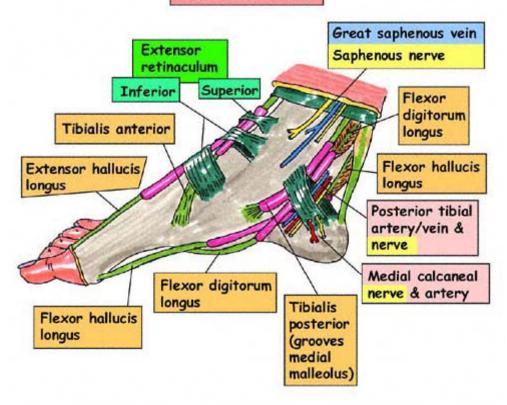


#### POSTERIOR LOWER RIGHT LEG & TENDONS AT MEDIAL ANKLE



Order of structures behind medial malleolus as indicated by arrow: Tibialis posterior, flexor digitorum longus, posterior tibial vein & artery, tibial nerve, flexor hallucis longus Mnemonic: Timothy Doth Vex All Nervous Housemaids

# MEDIAL ANKLE



Order of structures behind medial malleolus from anterior to posterior:

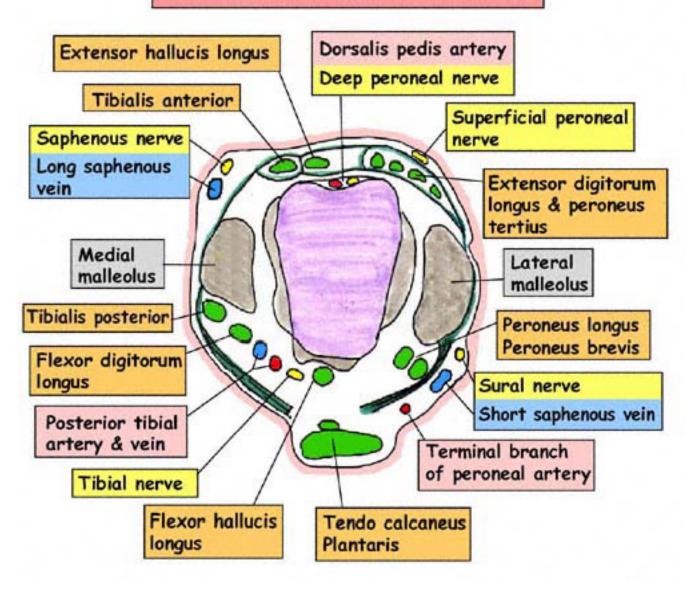
Tibialis posterior, flexor digitorum longus, posterior tibial vein & artery, tibial nerve, flexor hallucis longus

Mnemonic: Timothy Doth Vex All Nervous Housemaids

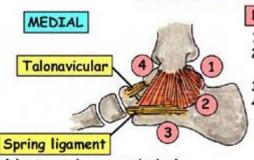
#### Flexor retinaculum

Tip of medial malleolus to medial calcaneal process and plantar aponeurosis

# AXIAL (CROSS) SECTION THROUGH ANKLE RIGHT ANKLE



### ANKLE LIGAMENTS



#### Deltoid/medial collateral

- 1. Tibiotalar (superficial/deep)
- Tibiosustentacular (middle) (tibiocalcanean)
- 3. Tibio-spring ligament (middle)
- 4. Tibionavicular (anterior)

(plantar calcaneonavicular)

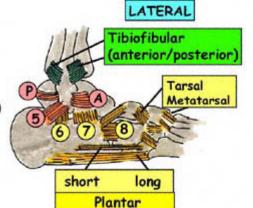
- · Thick, strong, non-elastic
- From sustentaculum tali to navicular
- Upper surface articulates with head of talus

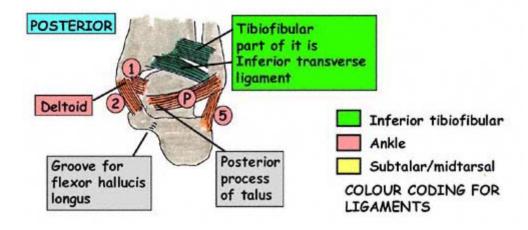
#### Lateral collateral ligament

Talofibular (anterior A, posterior P)
Calcaneofibular (5)

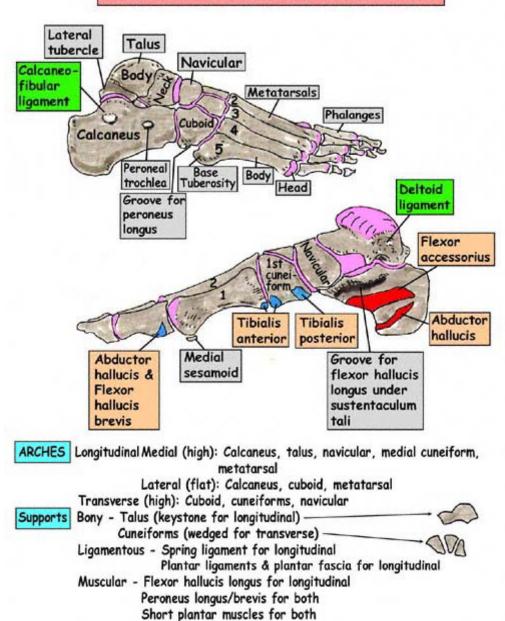
#### Others

Lateral talocalcaneal (6) Cervical (7) Bifurcate (8)





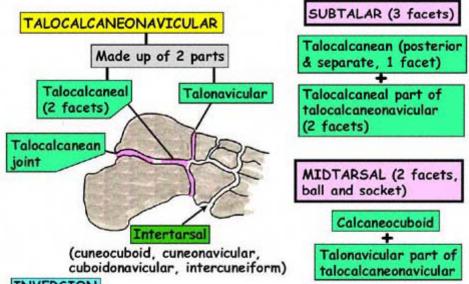
### BONES AND ARCHES OF RIGHT FOOT



# ANKLE, SUBTALAR AND TALOCALCANEONAVICULAR JOINTS

#### ANKLE (talocrural)

- Effectively a hinge joint but-
- Trochlear surface is slightly wider anteriorly so that there is a slight wiggle in full flexion
- Forces are transmitted to talus from tibia
- Plantar flexion 30-50°
- Dorsiflexion 20-30°
- Inversion injury may 1. tear ligaments, 2. pull off lower fibula,
   3. pull of lower tibia & fibula



#### INVERSION

Always with some adduction of toes

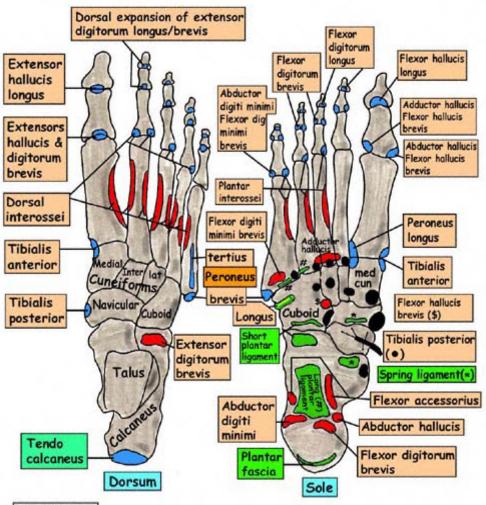
Muscles: Tibialis anterior/posterior (+/- flexor hallucis longus)

#### EVERSION

Always with some abduction of toes

Muscles: Peronei longus/brevis (+ flexion), tertius (+ extension)
As all these tendons insert distal to the midtarsal joint, this joint
moves first and a little, soon reaches its maximum and the torque is
then transmitted to the midtarsal joint which gives most of each
movement

### MUSCLE ATTACHMENTS TO RIGHT FOOT

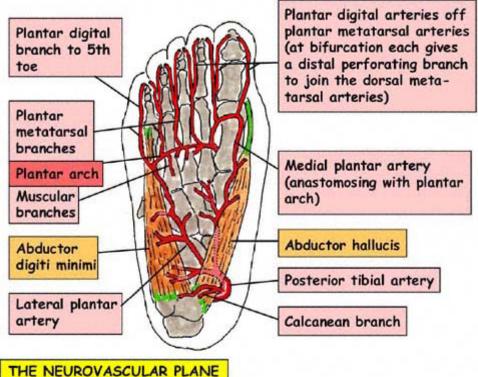


#### Tarsal sinus

- Between talocalcaneonavicular & talocalcanean joints
- Contains ligaments between bones
- Closed off by cervical ligament, extensor digitorum brevis, extensor retinaculum

Talus: No muscles attached, almost entirely intra-articular, neck blood supplies body (avascular necrosis with fracture likely)

#### ARTERIES IN SOLE OF RIGHT FOOT



Lies between 1st and 2nd layers Has arteries lying marginal & nerves central

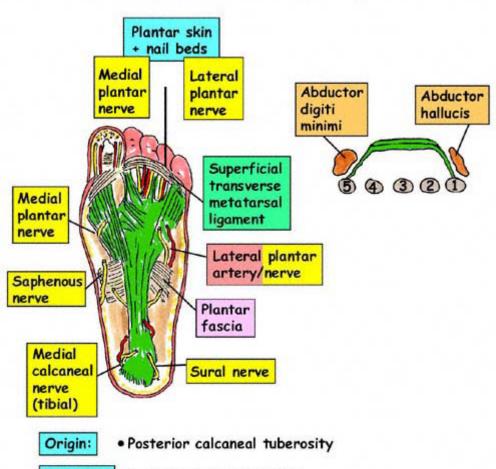
#### PLANTAR ARCH (lateral plantar artery)

There are anastomotic vessels from this arch that pass:

- 1. Between the 1st & 2nd metatarsals to dorsalis pedis artery
- 2. Between 2/3. 3/4, 4/5 metatarsals to dorsal metatarsal arteries

### PLANTAR APONEUROSIS

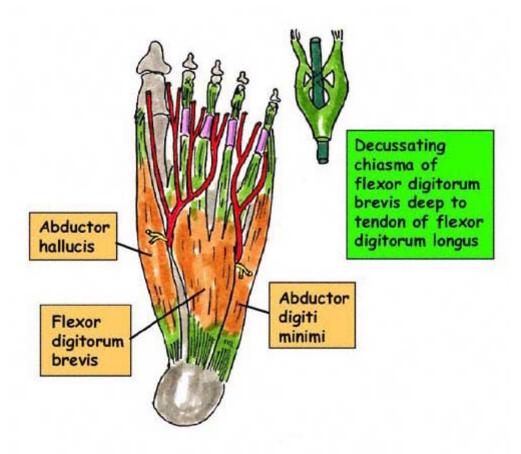
Condensation of deep fascia



- Insertion: 5 slips into toe pads/skin
  - Edges of fibrous flexor sheaths
  - · Superficial transverse metatarsal ligaments
  - Medial & lateral septa into 1st & 5th metatarsals

# FIRST LAYER OF SOLE OF LEFT FOOT

# 3 MUSCLES



#### SECOND LAYER OF SOLE OF LEFT FOOT

# 2 MUSCLES 2 TENDONS

#### Lumbricals

- Lateral 3 are bipennate & are between tendons of flexor digitorum longus (lateral plantar nerve).
- Medial one from medial side of 1st tendon & is unipennate (medial plantar nerve)

#### Flexor accessorius

- · 2 heads.
- Pulls flexor digitorum longus tendons so that they pull straight.
- Assists the long tendons with flexion of lateral 4 toes when ankle is flexed (lateral plantar nerve)

# Tendon of flexor digitorum longus

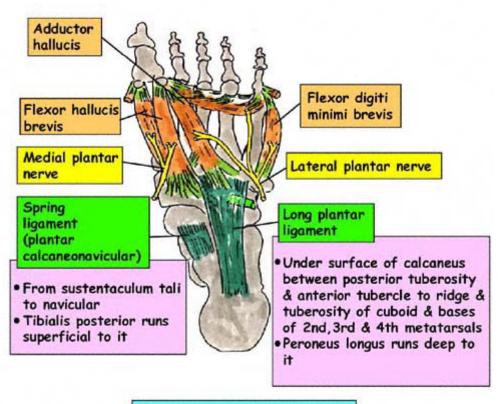
- Crosses superficial to flexor hallucis longus
- · Receives flexor accessorius
- Gives off lumbricals
- Receives 2 slips from flexor hallucis longus to 2 medial tendons
- To base of distal phalanges via fibrous flexor sheaths

#### Tendon of flexor hallucis longus

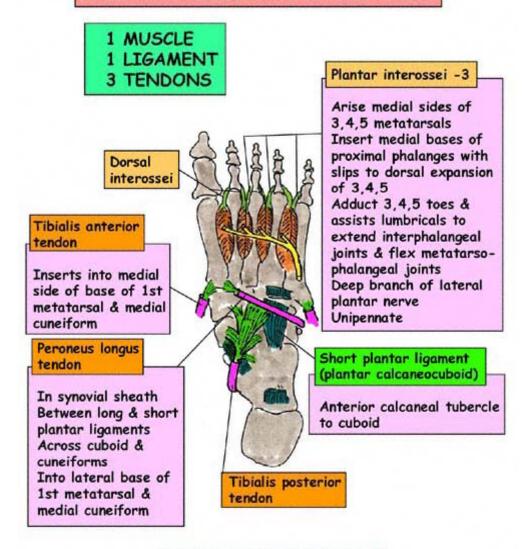
- Grooves sustentaculum tali
- · Crossed by flexor dig longus
- Gives slips to medial 2 tendons of flexor digitorum longus
- Into base of distal phalanx
- Synovial sheath throughout (opened distally here)

# THIRD LAYER OF SOLE OF LEFT FOOT

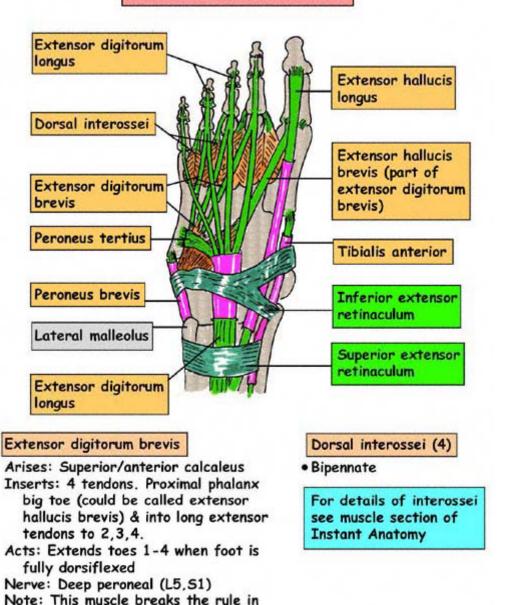
# 3 MUSCLES 2 LIGAMENTS



#### FOURTH LAYER OF SOLE OF LEFT FOOT



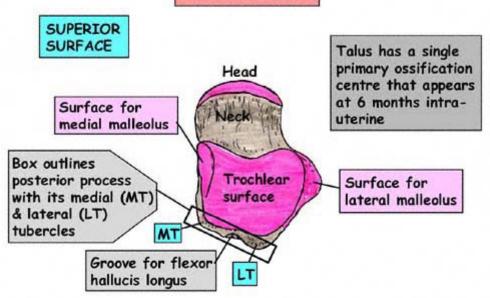
# DORSUM OF LEFT FOOT



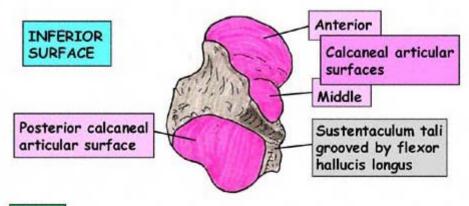
that, as a short "digitorum" muscle it does not supply the 5th digit

(cf. Flexor Digitorum superficialis in hand)

# RIGHT TALUS

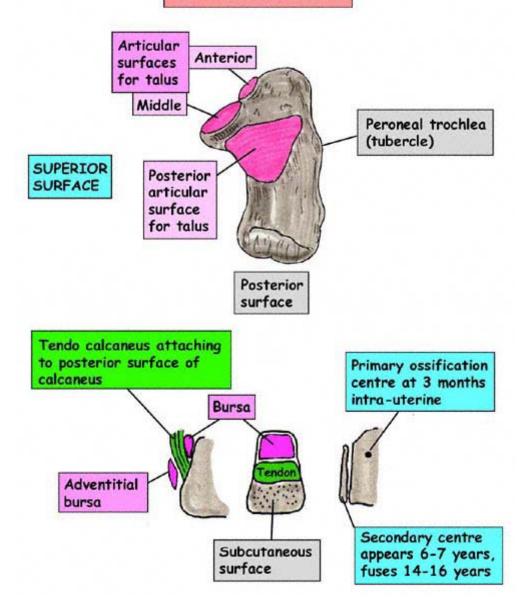


Mnemonic "TPP" reminds that the TALUS has a POSTERIOR PROCESS with 2 tubercles. The lateral tubercle has a separate ossification centre (age 7-13) that may fail to fuse in 7% of feet giving an "OS TRIGONUM"

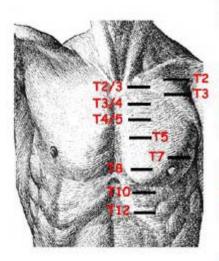


NOTE: Talus has no muscle attachments, it is almost entirely intra-articular & its blood supply to its body is via its neck with the risk of avascular necrosis with a fracture

# RIGHT CALCANEUS



# POSITION OF THORACIC STRUCTURES ACCORDING TO VERTEBRAL LEVELS



T2 Superior border of scapula.

T2/3 Suprasternal notch.

Medial end of spine of scapula. Spine of T3 is posterior end of oblique fissure of lung.

T3/4 Top of arch of aorta.

T4 End of arch of aorta. Azygos vein enters SVC.

T4/5 Manubriosternal junction. (angle of Louis). Start of arch of aorta.

Thoracic duct crosses midline.

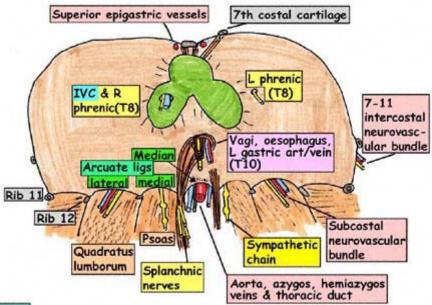
17 Inferior angle of scapula.

T8 Caval opening in diaphragm.
(IVC & right phrenic nerve)
Left phrenic pierces diaphragm.
Hemi-azygos veins cross to left.

T10 Oesophageal opening in diaphragm. (oesophagus, branches of left gastric vessels, vagus nerves)

T12 Aortic opening in diaphragm.
(Aorta, azygos vein, hemi-azygos vein, thoracic duct)
Coeliac axis.
Splanchnic nerves pierce crura.
Sympathetic trunk passes behind medial arcuate ligament.
Subcostal bundle passes behind lateral arcuate ligament.

# UNDER SURFACE OF DIAPHRAGM



## Origin:

Vertebral - Right crus (L1,2,3), left crus (L1,2), 5 arcuate ligaments Sternal - Xiphoid Costal - Rib & costal cartilages 7-12

#### Insertion:

Central tendon (trefoil-1 ant, 2 post, fused with pericardium)

## Action:

Inspiration - 70% at rest (5cm of movement)
Less % on exertion (10cm movement)

Straining - Outlet of chest is fixed to raise intra-abdominal pressure

## Nerve supply:

Phrenic nerves - C3,4,5. 1/3 sensory, 2/3 motor. Diaphragm has no other motor supply

Outer - lower 5 intercostals & subcostal arteries

Inner - Inferior phrenic (aorta), musculophrenic/pericardiacophrenic (internal thoracic)

## DIAPHRAGM - OPENINGS & RELATIONS

#### **OPENINGS**

Caval (T8)

- Inferior vena cava & right phrenic nerve
- Left phrenic nerve

Anterior hiatus (T9)

· Superior epigastric artery & vein

Oesophageal (T10)

- Oesophagus
- · Left & right vagus nerves
- · Oesophageal branches of left gastric artery/vein
- Lymphatics

Aortic (T12) (Strictly behind diaphragm)

- Aorta
- · Azygos vein & hemiazygos vein
- Thoracic duct

Crura (T12)

· Greater, lesser & least splanchnic nerves

Behind medial arcuate ligament

Sympathetic chain

Behind lateral arcuate ligament

Subcostal (T12) neurovascular bundle

#### RELATIONS

- Right dome reaches 4th costal space (nipple) in expiration
- · Left dome reaches 5th rib in expiration
- · Superior pericardium, basal lung segments
- Inferior Right liver, suprarenal, kidney
   Left stomach, suprarenal, kidney & spleen
- Posterior Aorta, azygos veins, oesophagus, vagi, pleural folds

#### DEVELOPMENT OF THE DIAPHRAGM

#### SEPTUM TRANSVERSUM

Separates pericardial development (ventrally) from developing gut (dorsally). It moves to lie caudal to pericardial cavity. It Descends from neck to form the central tendon of the diaphragm

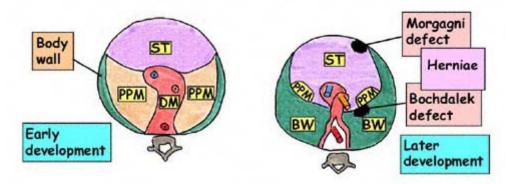
BODY WALL (Transverse layer) and PLEUROPERITONEAL MEMBRANES

Both grow in to fuse with septum transversum and give the diaphragm

#### DORSAL MESENTERY OF OESOPHAGUS

Completes the diaphragm posteriorly

Note: Despite this complex development few defects occur in the diaphragm. Perhaps the severer ones are incompatible with life. The important sites for hernia are shown here

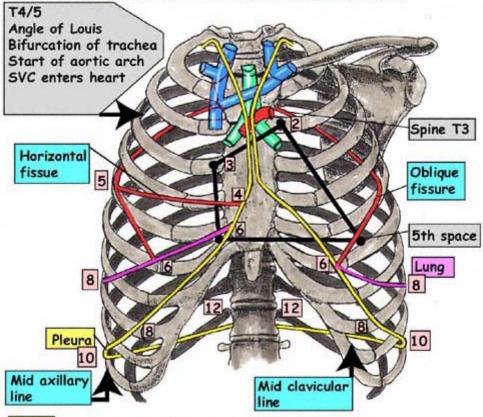


ST = Septum transversum becomes central tendon

PPM = Pleuroperitoneal membranes become small area of muscle

DM = Dorsal mesentery becomes crura BW = Body wall becomes bulk of muscle

## THORAX - SURFACE MARKINGS



Pleura Starts above middle of medial third of clavicle

Meet at rib 2. Diverge at rib 4 (left more than right)

Right is still parasternal at rib 6. Both rib 8 in mid clavicular line, rib 10 in mid axillary line and rib 12 posteriorly

(Mnemonic - 2-4-6-8-10-12)

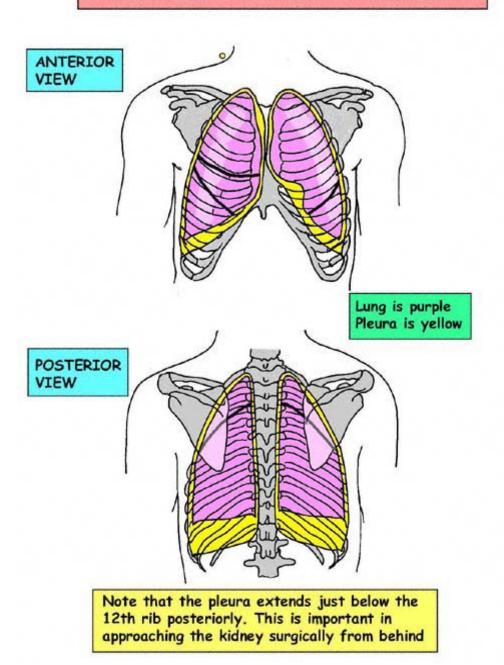
Lung 2 spaces less than pleura below 6th rib

Heart 2nd left rib to 3rd right rib to 6th right rib (all parasternal) to 5th intercostal space midclavicular line (9cm from midline) (Mnemonic 2-3-6-51/2)

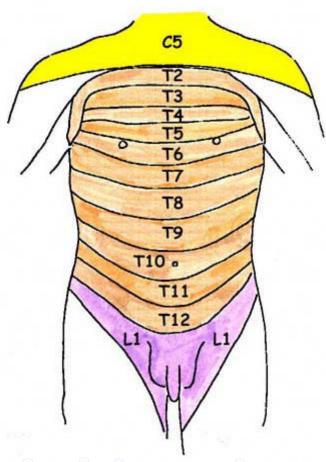
Oblique fissure Spine of T3 posteriorly to 6th rib anteriorly (medial border of abducted scapula

Horizontal fissue 4th rib/costal cartilage anteriorly to 5th rib in mid axillary line (Mnemonic for both fissures 3-6-4-5)

# PLEURAL AND LUNG SURFACE MARKINGS



# DERMATOMES OF THORAX AND ABDOMEN



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# CHEST WALL MUSCLES

#### External intercostals

From sharp edge of rib above - downwards/forwards to rounded edge of rib below, from superior costotransverse ligament posteriorly to costochondral junction anteriorly. Then anterior intercostal membrane beyond this

#### Internal intercostals

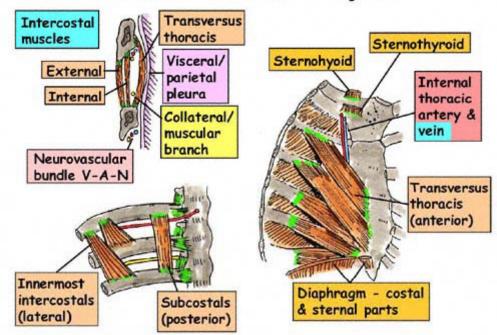
From costal groove above - downwards/backwards to upper border of rib below, from sternal edge to angle of rib. The posterior intercostal membrane beyond this

#### Transversus thoracis

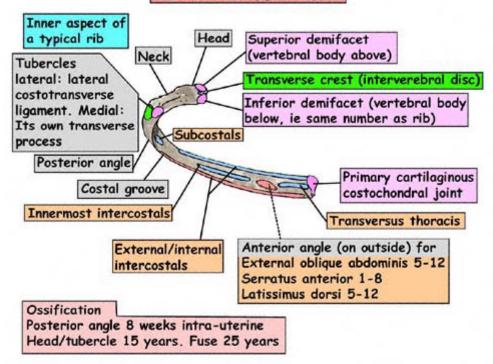
At back: Subcostals. In lower chest. Wider below

At side: Innermost intercostals. Extend for more than one space

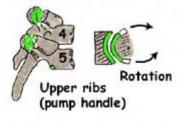
At front: Transversus thoracis (previously Sternocostalis) from lower sternum to costal cartilages 2-6

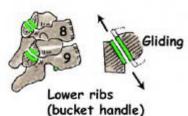


## RIB ARTICULATION









Ist rib Short, broad, most curved, single facet on head
2nd rib Poorly marked costal groove, rough area for serratus anterior & scalenus posterior
3-10 ribs Typical. 7th longest
11/12 ribs Floating, single facet, no tubercle, tapered end. 12th no groove
1-7 ribs articulate with sternum

#### Muscles attached to outer ribs

8-10 ribs with each other

Serratus anterior 1-8
External oblique abdominis 5-12
Pectoralis minor 3,4,5
Latissimus dorsi 9-12

Muscles attached to costal cartilages Pectoralis major 1-7 (often 2-6)

### COSTOTRANSVERSE LIGAMENTS

As the name implies, the costotransverse ligament connects the rib to the transverse process but it is a complex ligament in that it has three parts to it with somewhat confusing terminology.

#### THE costotransverse ligament

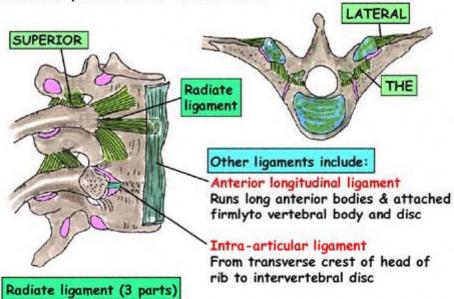
This fills the gap between the rib and its own transverse process

#### LATERAL costotransverse ligament

This lies posteriorly and extends from the transverse process to its own rib, just beyond the tubercle

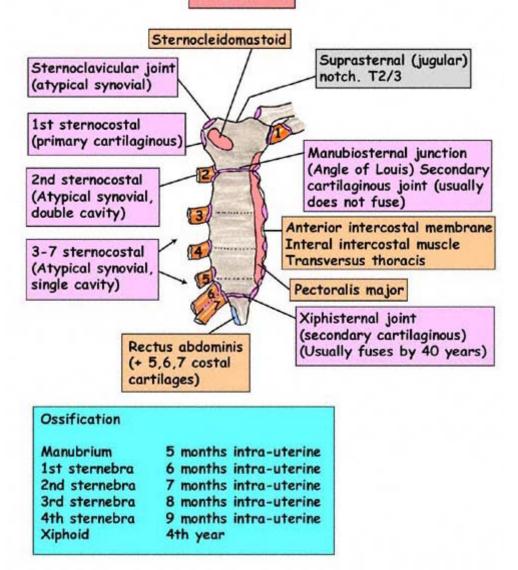
#### SUPERIOR costotransverse ligament

This is a two layered ligament with the fibres at right angles to each other (corresponding and continuous with the intercostal muscles) that passes from the upper border of the neck of the rib to the transverse process of the vertebra above

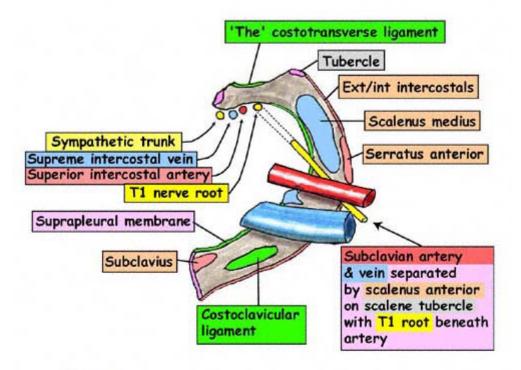


- · To body above (upper)
- · To own body (lower)
- Hypochordal bow (middle) which lies deep to anterior logitudinal ligament and blends with intervertebral disc & fibres from other side

## STERNUM



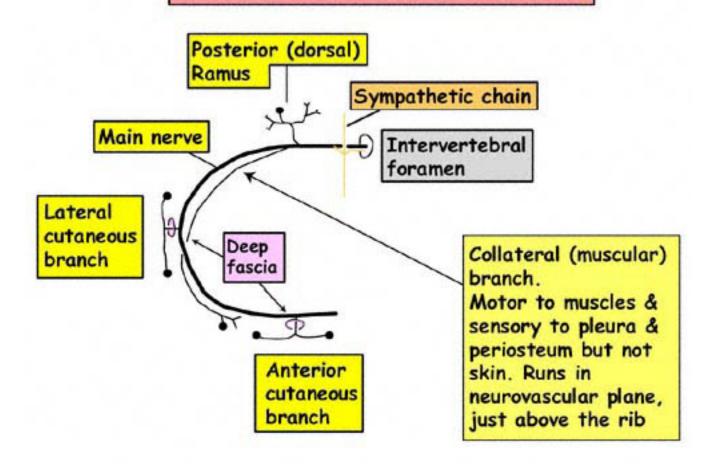
# THE FIRST RIB



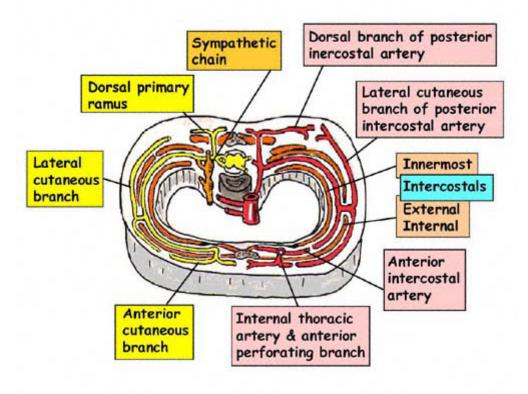
## Note:

- The under surface of the 1st rib is smoother
- When the rib is laid on a flat surface, the head touches the flat surface when the rib is the correct way up

# TYPICAL INTERCOSTAL NERVE



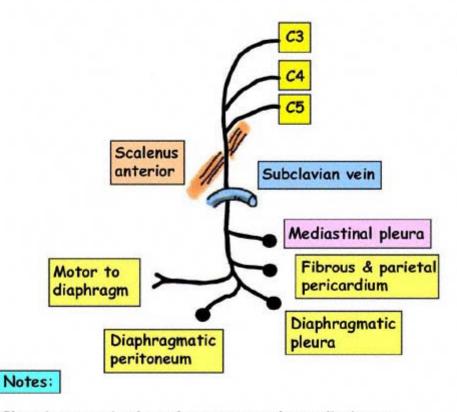
# INTERCOSTAL NERVES AND ARTERIES



### Remember:

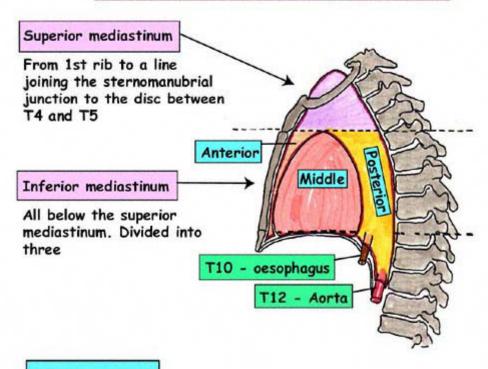
- Nerve is always outside the artery
- 1st thoracic nerve has no lateral cutaneous branch
- Nerves T7 &-T11 also supply the abdomen

# THE PHRENIC NERVE



- · Phrenic nerve is the only motor supply to diaphragm
- A third of its fibres are sensory (as above)
- · In the neck it lies on scalenus anterior
- It passes into the thorax with the large veins in front and the large arteries behind it
- Pain detected by the phrenic nerve from the diaphragmatic peritoneum from an inflammed gall bladder is referred to C4 nerve supply to the right shoulder tip via the supraclavicular nerves. There is no autonomic component to this type of referred pain

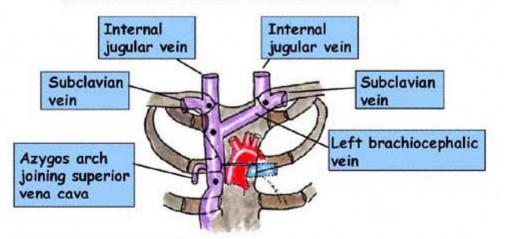
# DIVISIONS OF THE MEDIASTINUM



### MEDIASTINUM

- This is the area of the thorax that lies between the lungs. Note that although the lungs reach up above the front of the 1st rib, the mediastinum does not. It stops at the level of the 1st rib. The great vessels lie in the superior mediastinum, the thymus and fat in the anterior part of the inferior, the heart in the middle and the oesophagus & aorta in the posterior parts of the inferior mediastinum.
- Note that, although it is stated here that the apex of the lung reaches above the FRONT of the 1st rib, it does not reach above the NECK of the 1st rib

# SUPERIOR MEDIASTINAL VEINS



# Brachiocephalic veins

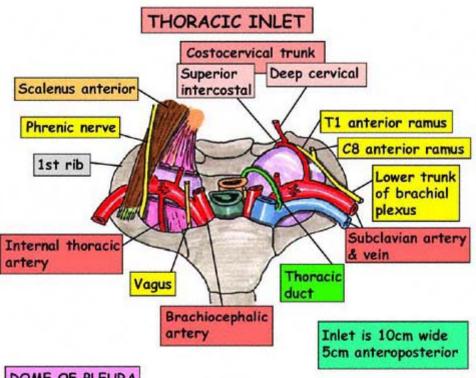
Form as the junction of the internl jugular and subclavian veins on each side behind the sternoclavicular joints

#### Superior vena cava

Forms as the junction of the two brachiocephalic veins at the first right sternocostal junction (ie lower border of right 1st costal cartilage). It runs inferiorly to end at the right 2nd intercostal space parasternally

## Tributaries of left brachiocephalic vein

- Thoracic duct (into junction as it forms)
- · Thymic vein
- · Left vertebral vein
- · Left & usually right inferior thyroid veins
- · Left internal thoracic vein
- · Left supreme intercostal vein
- · Left superor intercostal vein



## DOME OF PLEURA

Covered by suprapleural membrane (Sibson's fascia) Held up by scalenus minimis (pleuralis) from transverse process of C7

Extends 4cm above middle of medial third of clavicle and first rib, BUT NOT above neck of first rib Relations:

Posterior: Sympathetic trunk, supreme intercostal vein,

superior intercostal artery, T1 nerve root,

1st rib, thoracic duct on left

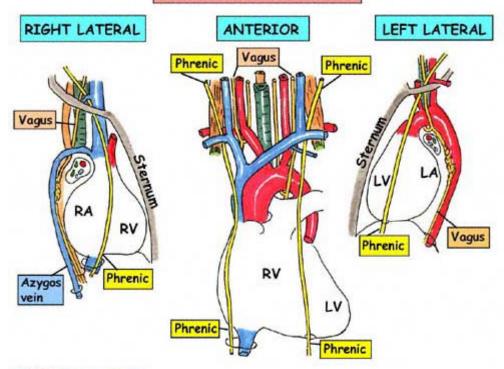
Anterior: On right - brachiocephalic artery and vein

On left - Subclavian artery and vein

Superior: Costocervical trunk, thoracic duct on left

Mnemonic: Vagus nerves and phrenic nerves enter the chest between the arteries behind and the veins in front

# UPPER MEDIASTINUM



#### Right vagus nerve

Enters: posterior to right brachiocephalic vein & anterior to brachiocephalic artery. Descends: lateral to trachea behind hilum. Gives: pulmonary & oesophageal plexuses. Becomes posterior vagus Left vagus nerve

Enters: posterior to left brachiocephalic vein. Descends: lateral to aortic arch. Gives: Recurrent laryngeal nerve, cardiac & pulmonary plexuses. Descends: behind hilum. Gives: oesophageal plexus.

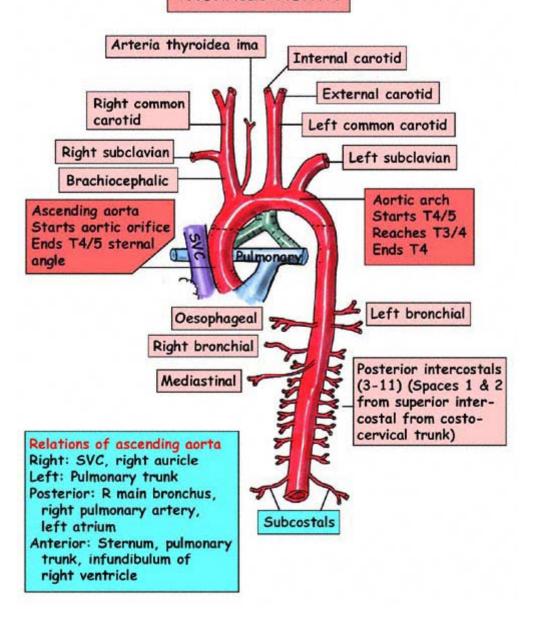
Becomes: anterior vagus Right phrenic nerve (C3,4,5)

Enters: lateral to right brachiocephalic vein. Descends: lateral to superior vena cava, right atrium, inferior vena cava. Leaves: by IVC opening. Gives: branches to diaphragm

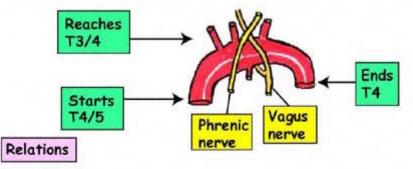
Left phrenic nerve (C3,4,5)

Enters: posterior to left brachiocephalic vein. Descends: lateral to aortic arch, left auricle & left ventricle on pericardium. Leaves: via left leaf of diaphragm.

# THORACIC AORTA



# AORTIC ARCH



Left:

- Pleura
- Vagus
- · Left phrenic nerve

Right:

- Trachea
- Oesophagus
- Thoracic duct
- · Left recurrent laryngeal nerve
- Superior vena cava
- Right phrenic nerve

Anterior:

- Thymus
- Superficial cardiac plexus
   (Inferior cardiac branch of left vagus & Left cardiac sympathetic branch from superior cervical ganglion)

Inferior:

- · Ligamentum arteriosum
- · Left recurrent laryngeal nerve
- Bifurcation of pulmonary trunk
- Deep cardiac plexus

(Superior cardiac branch of left vagus
Superior & inferior cardiac branches from right vagus
Left & right recurrent laryngeal nerves
Left cardiac sympathetic branch from middle & inferior
cervical ganglion
Right cardiac sympathetic branch from aall 3 cervical
ganglia)

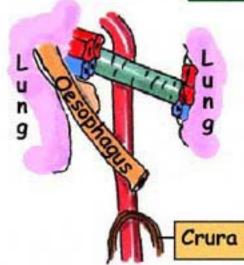
# DESCENDING AORTA

ANTERIOR VIEW

# To its right

- Right lung
- Left atrium
- Right crus





# To its left

- · Left lung
- Left crus

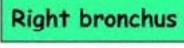
Anterior to it

- Crura
- Oesophagus
- · Root of left lung
- Left main bronchus

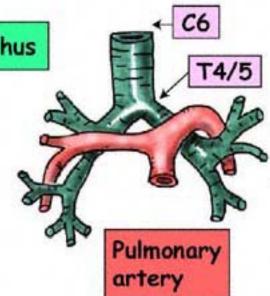
It supplies

- Posterior intercostals 3-11
- Subcostal (12)
- Oesophageal
- Bronchial
- Phrenic
- Mediastinal
- Spinal

# MAIN BRONCHI



- Wider
- Shorter
- Steeper
- 2cm

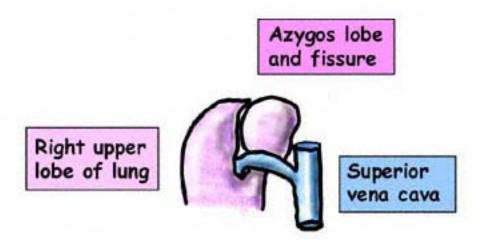


# Left bronchus

- Narrower
- Longer
- More horizontal
- 5cm

Inhaled foreign body is much more likely to enter the right bronchus because of the above facts

# AZYGOS LOBE OF RIGHT LUNG

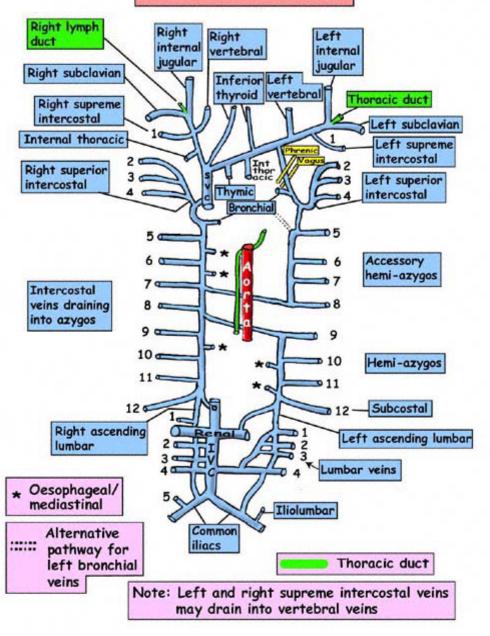


Occasionally the azygos vein reaches the superior vena cava by passing through the substance of the right lobe trapping a segment of upper right lobe and creating an azygos fissure

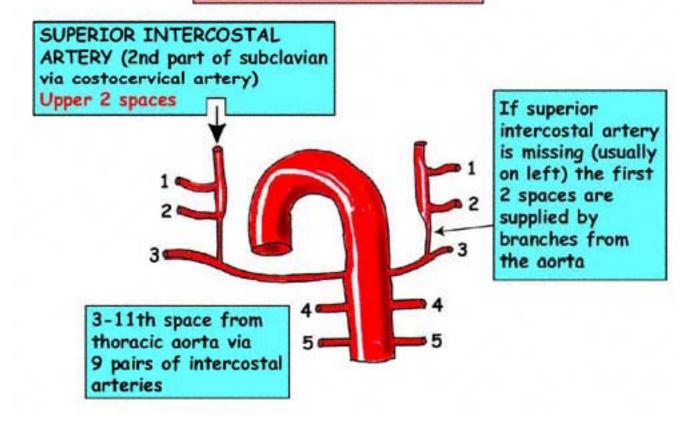
# Other notes:

- The lingula of the left lobe arises from the upper bronchus
- Incomplete segmentation is common
- Left lung is longer and lower but lighter

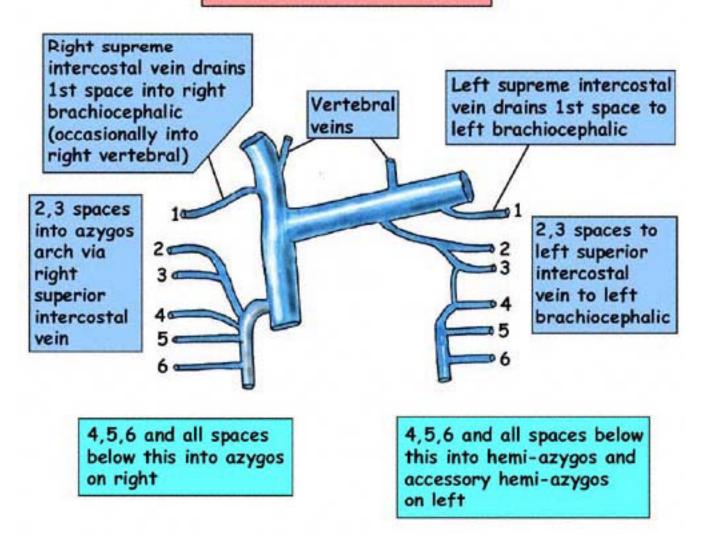
# SUPERIOR VENA CAVA AND AZYGOS SYSTEMS



# ARTERIAL SUPPLY OF INTERCOSTAL SPACES



# VENOUS DRAINAGE OF INTERCOSTAL SPACES



# **OESOPHAGUS**

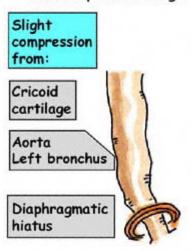
27cm long (45cm from teeth to cardia of stomach)

Nerves: Sensation and motora via vagus nerves

Lining: • Stratified squamous (non-keratinising) becoming columnar at stomach

- Thick muscularis mucosae ++
- Mucous glands in mucosa and submucosa

Endoscopic narrowings: From mouth at 17cm, 28cm, 45cm



#### Relations

Posterior: vertebrae, thoracic duct crosses to left at T5, hemiazygos/ accessory hemiazygos cross to right at T8/9, descending aorta, first 2 intercostal arteries from aorta

Anterior: trachea to T4/5, recurrent laryngeal nerves, left bronchus, left atrium, diaphragm

Left: thoracic duct, aorta, left subclavian artery, lung

Right: lung, azygos vein (hence good side to approach the oesophagus

1/3rds	MUSCLE	ARTERY	VEIN	LYMPH	LENGTH
Upper	Striated	Inferior thyroid	Inferior thyroid	Deep cervical	9cm
Middle	Striated/ smooth	Aortic branches	Azygos branches	Mediastinal	9cm
Lower	Smooth	Left gastric	Left gastric	Gastric	9cm

## **THYMUS**

In anterior mediastinum Bilobed, lobulated Larger in children

Plays a major role in development of immune system

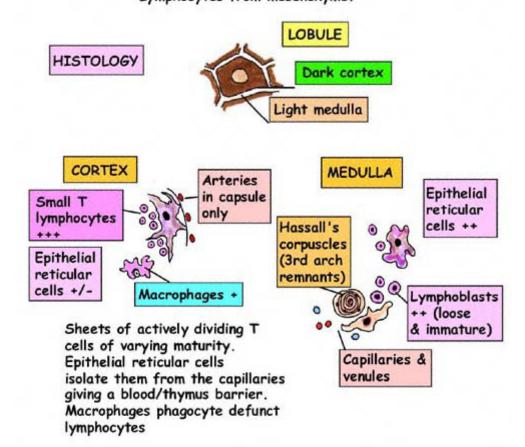
Blood supply: Internal thoracic artery

Venous drainage: Thymic to left brachiocephalic & some

to internal thoracic veins

Embryology: Endoderm(epithelium) of ventral 3rd pharyngeal

pouch (+/- ventral recess 4th pouch). Lymphocytes from mesenchyme.

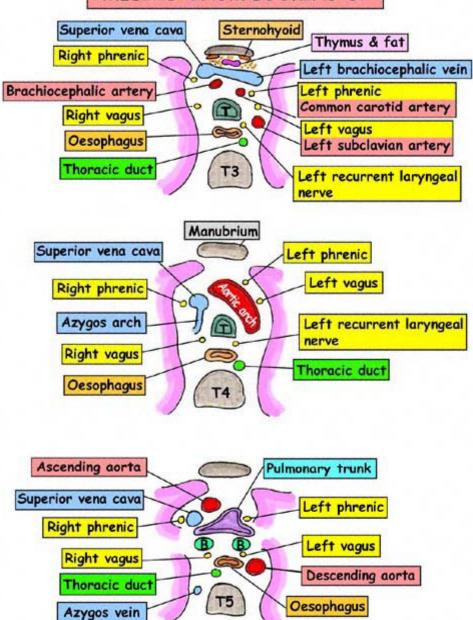


#### THORACIC DUCT Left vertebral Right lymphatic trunk artery Left jugular Right jugular lymph trunk Inferior lymph trunk cervical eft subclavian ganglion lymph trunk Right subclavian lymph trunk Right broncho-Upper left intercostal mediastinal & mediastinal lymph lymph trunk trunks Hemi-azygos & Descending accessory hemithoracic aorta azygos cross behind thoracic duct to reach azygos vein Left & right descending thoracic lymph trunks Right crus of diaphragm Cisterna chyli at T12, L1 confluence of lymph trunks Right & left lumbar & intestinal lymph trunks

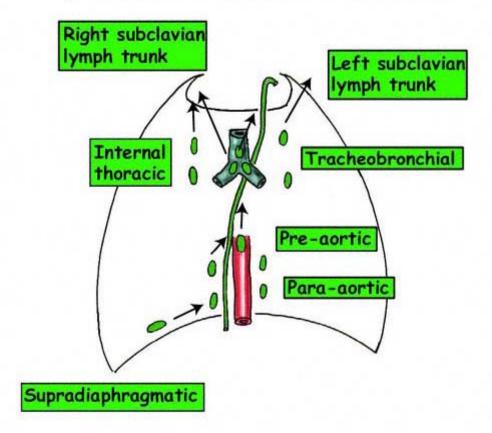
#### THORACIC DUCT

- 45cm long (see also spinal cord, femur, vas, transverse colon, teeth/cardia)
- Several terminal branches
- · Many valves in the system
- Drains all lymph below diaphragm, left head/neck & left thorax
- Commences at T12, ascends behind right crus, to right of aorta & oesophagus, then behind oesophagus, crosses midline at T5
- Lies superficial (anterior) to posterior intercostal arteries & the crossing azygos systems, over the dome of the pleura, over (anterior) to left vertebral & left subclavian arteries
- Into confluence of left subclavian and left internal jugular veins

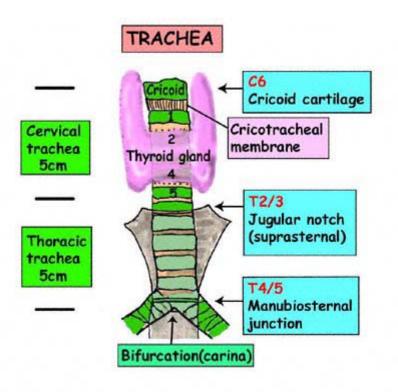
# CROSS (AXIAL) SECTIONS OF MEDIASTINUM LOOKING UP



# LYMPHATICS IN THE THORAX

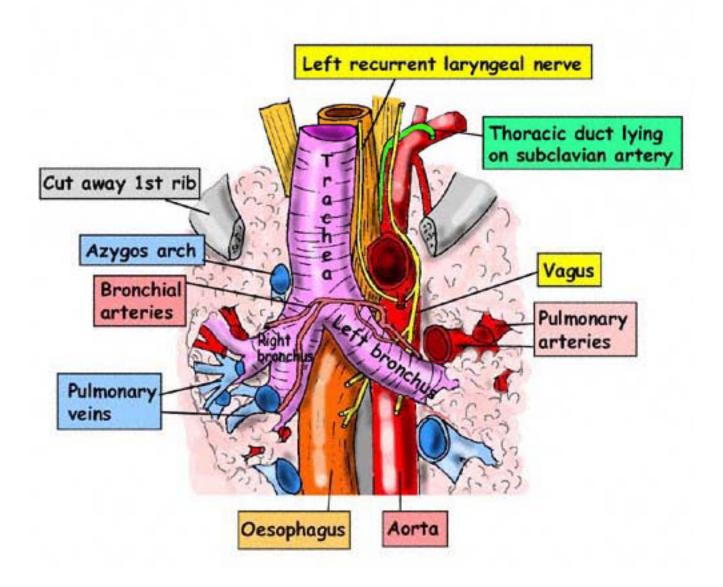


See section on lymphatics in Instant Anatomy for full details of lymphatic drainage in thorax

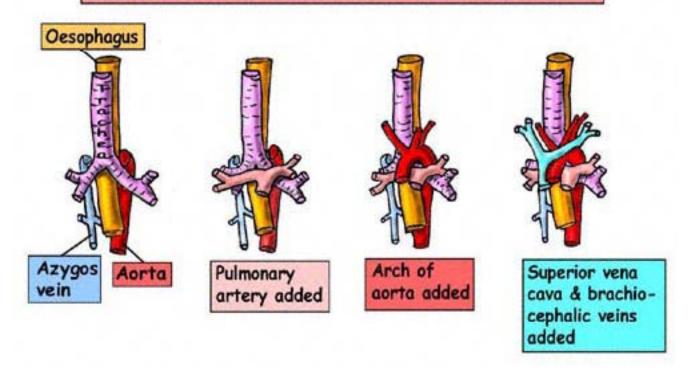


- Elastic structure
- 10cm long but extends to 15cm on inspiration
- · C shaped cartilages trachealis muscle closes C
- Mucosa ciliated pseudostratified columnar
- · Blood: Inferior thyroid artery & veins & bronchial arteries.
- · Lymph: Posterior/inferior deep cervical
- Nerves: Vagus & recurrent laryngeal for pain and secretomotor
   Sympathetic to blood vessels and smooth muscle (T1-4)
- Relations: (see cross section at C7)
  - Posterior oesophagus, recurrent laryngeal nerves
  - · Sides carotid sheath, lateral lobes of thyroid to 6th ring
  - Anterior Inferior thyroid veins, anterior jugular arch, thyroidea ima artery, levator glandulae thyroidea, thymus if large, manubrium, sternohyoid, sternothyroid, left brachiocephalic vein

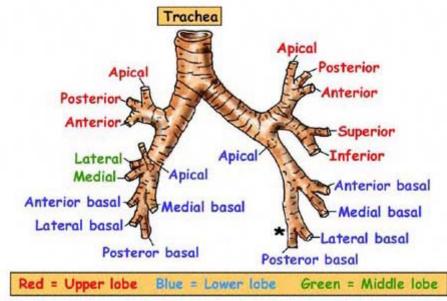
# SUPERIOR MEDIASTINAL RELATIONS



# KEY RELATIONS IN SUPERIOR MEDIASTINUM IN PROGRESSIVE LAYERS



#### BRONCHOPULMONARY SEGMENTS



\* Late branching due to cardiac pressure

Mnemonic: Starting on right at upper lobe, working down right lobe then down left lobe the segments are as follows:

APALM APALM APAIS APAL

#### BRONCHI

Blood supply: Bronchial arteries from aorta (2 on left, 1 on right) Venous drainage: On right -azygos, left - hemiazygos. Also a little via bronchial veins and pulmonary veins

Nerve Supply: Pulmonary plexus at hilum - vagus and sympathetics

#### SYMPATHETIC

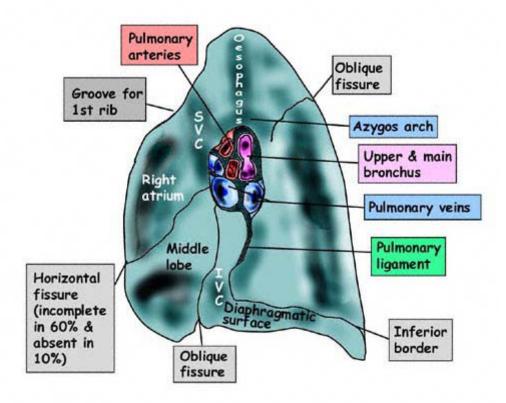
Vasoconstriction Bronchodilatation (beta 2) Suppress glandular secretion (alpha)

#### PARASYMPATHETIC

Vasodilatation
Bronchoconstriction
Increase glandular secretions
Sensation

#### LATERAL & POSTERIOR SURFACES OF LUNGS RIGHT LEFT ANTERO-LATERAL Apex Apex Horizontal **ASPECTS** fissue Upper Upper lobe Anterior lobe border Lower Lower lobe lobe Middle Lingula lobe LEFT RIGHT POSTERIOR Upper Upper **ASPECTS** lobe Oblique Fissue Horizontal Oblique fissue fissue Middle Lower lobe lobe lobe Posterior border

## MEDIAL SURFACE OF RIGHT LUNG

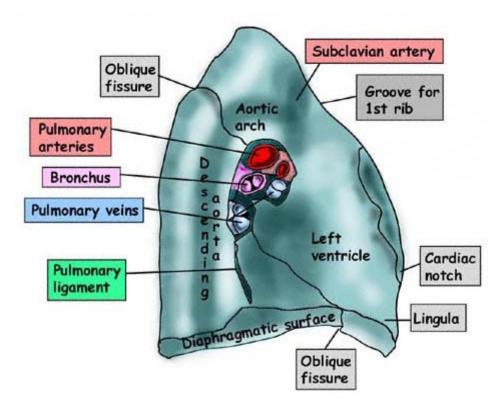


Note that the indentations on the lung are post-mortem effects. They indicate the relationships in life

#### Hilum

- Bronchi
- · Pulmonary arteries & veins
- · Bronchial arteries and veins
- Lymphatics
- Nerves

## MEDIAL SURFACE OF LEFT LUNG

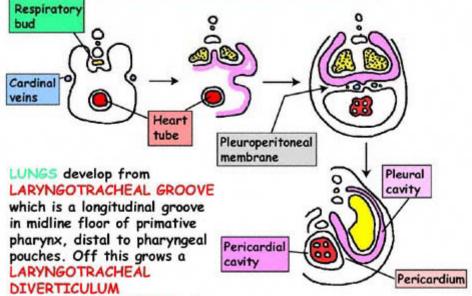


Note that the indentations on the lung are post-mortem effects. They indicate the relationships in life

## Hilum

- Bronchi
- · Pulmonary arteries & veins
- · Bronchial arteries and veins
- Lymphatics
- Nerves

## DEVELOPMENT OF LUNGS, PHARYNX AND OESOPHAGUS



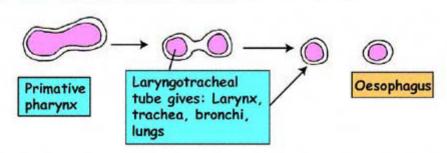
from which LUNG BUDS arise

Its ENDODERM gives:

Bronchioles, pulmonary lining, epithelium of larynx, trachea, tracheal glands, epithelium of bronchi
The surrounding MESENCHYME gives everything else

Development of PHARYNX and OESOPHAGUS

These two separate by longitudinal folds growing in to give the TRACHEO-OESOPHAGEAL SEPTUM in primative pharynx



# THORACIC SYMPATHETICS

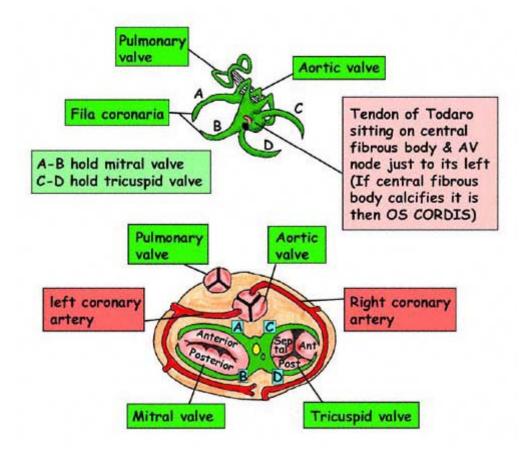
See autonomic nervous system section in Instant Anatomy for full details of this system. However, a useful way of remembering which fibres synapse in the sympathetic chain ganglia is as follows:

ALL SYMPATHETIC FIBRES ENTERING THE CHAIN FROM THE SPINAL CORD AS GREY RAMI COMMUNICANTES SYNAPSE IN THE GANGLION FROM WHICH THEY LEAVE FOR DISTRIBUTION EXCEPT THOSE TO "GUT" OR ADRENAL GLAND.

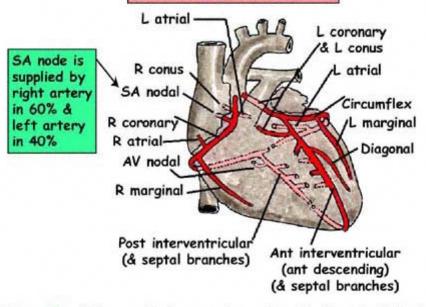
In practice this means that the splanchnic nerves (greater, lesser, least, lumbar & sacral) do not synapse until they reach their peripheral ganglia, whilst all others synapse in the chain ganglia.

## HEART - FIBROUS SKELETON

- Remnant of Atrioventricular cushions
- Divides atria from ventricles
- Supports valves
- Electrically separates atria from ventricles
- Is origin of membranous interventricular septum



#### CORONARY ARTERIES



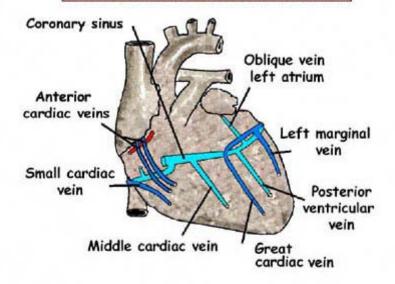
The ostia of these arteries are above the attachment of the base of the relevant cusp. The right from the anterior sinus & the left from the left posterior sinus.

The right artery passes anteriorly between the right atrial appendage & the pulmonary trunk into the right anterior atrioventricular (AV) groove & then the right posterior AV groove where it anastomoses with the circumflex branch of the left coronary artery. In 90% of people it gives the posterior interventricular artery which anastomoses with the termination of the anterior interventricular artery (left coronary) in this groove. The AV node is supplied by the right coronary artery in 90% of people

The left coronary artery passes anteriorly between the left atrial appendage & the pulmonary trunk into the left anterior AV groove. It divides into anterior interventricular & circumflex arteries.

The latter artery continues first in the anterior & then in the posterior AV grooves. It anastomoses with the terminal branches of the right coronary artery. In 10% of people it gives the posterior interventricular artery (left dominence) & also supplies the AV node. The anterior interventricular (anterior descending) passes down & around the apex of the heart to anastomose with the terminal branches of the posterior interventricular artery.

## VENOUS DRAINAGE OF HEART



The veins of the heart are more variable than the arteries. Drainage of the left & right ventricles commences with the great cardiac vein in the anterior interventricular groove. It runs left in the anterior atrioventricular (AV) groove where it collects the left marginal vein and then, in the posterior AV groove, it is joined by the oblique vein of the left atrium, the posterior ventricular vein and finally the middle cardiac vein which lies in the posterior AV groove & drains the left & right ventricles posteriorly. The confluence of these veins is the 3cm long coronary sinus, lying in the posterior AV groove. Just before the coronary sinus enters the right atrium to the left of the entry of the inferior vena cava, it is usually joined by the small cardiac vein which drains the right atrium & right ventricle. Sometimes the small cardiac vein drains directly into the right atrium. Two anterior cardiac veins drain the anterior aspect of the right ventricle & right atrium before crossing the right coronary artery to enter the right atrium. Some 20-30% of all drainage is in the venae cordis minimae (Thebesian veins) which drain directly into the chambers of the heart, mostly on the right side.

## HEART - PERICARDIUM

#### PERICARDIUM

- · Outer layer Fibrous
- Blends with adventitia of aorta, pulmonary trunk, superior vena cava (not inferior vena cava), central tendon of diaphragm
- Inner layer Serous

Visceral

Parietal

- Blood: pericardiacophrenic & internal thoracic
- Nerve: Phrenic to fibrous and parietal serous layers
   Sympathetic for pain & muscles and vessels of heart
   Nil to visceral layer

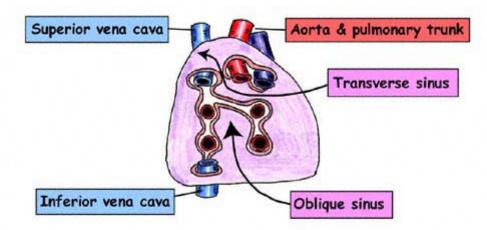
#### SINUSES OF PERICARDIUM

#### Transverse

Lies between the pulmonary artery and aorta in front and pulmonary veins and superior vena cava behind

#### Oblique

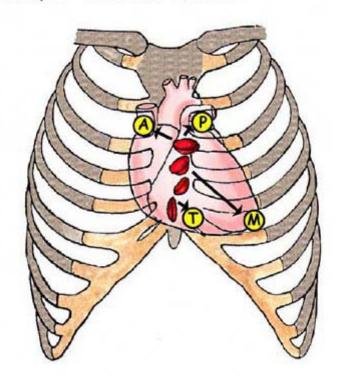
This is a pouch of pericardium between the pulmonary veins at the base of the heart where the visceral pericardium is reflected off the vessels to become the parietal pericardium



## HEART - AUSCULTATION

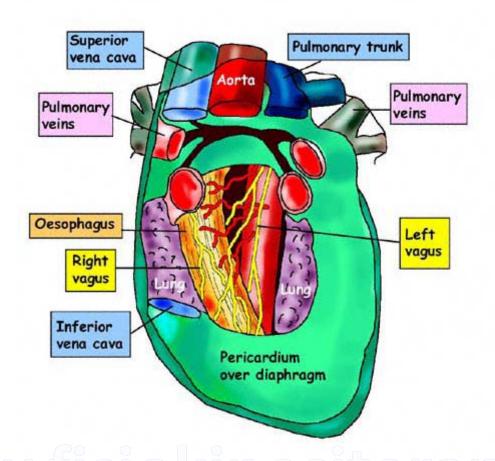
As the valves open and close they produce sounds that are transmitted in the direction of the flow of blood. Thus, by picturing the heart and the positioning of the four valves it is easy to work out the likely points for maximal audiability of the sounds. The position of the valves, relative to the surface is shown on this diagram and the points at which ausculatation is best achieved.

- P Pulmonary 2nd left space, parasternally
- A Aortic 2nd right space, parasternally
- M Mitral 5th left space, mid clavicular line (apex)
- T Tricuspid Over lower sternum

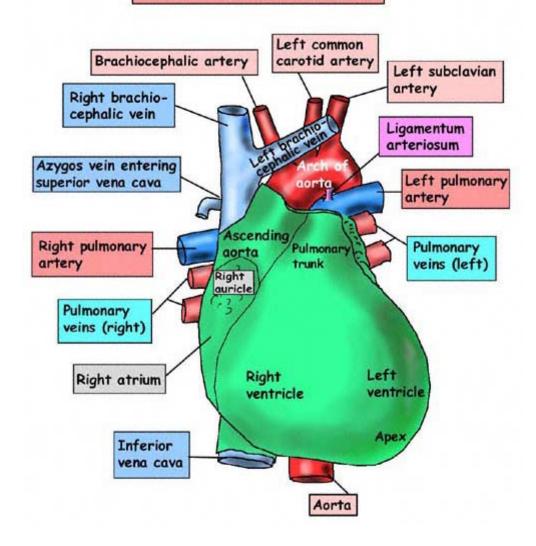


# POSTERIOR RELATIONS OF PERICARDIUM

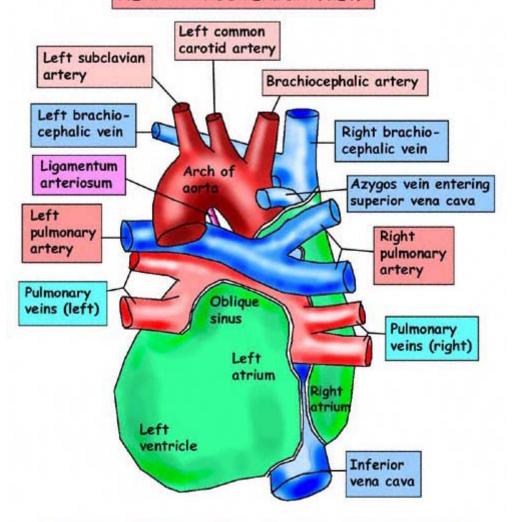
If the pericardial lining which makes up the oblique sinus of the pericardium is removed the structures posterior to it are exposed



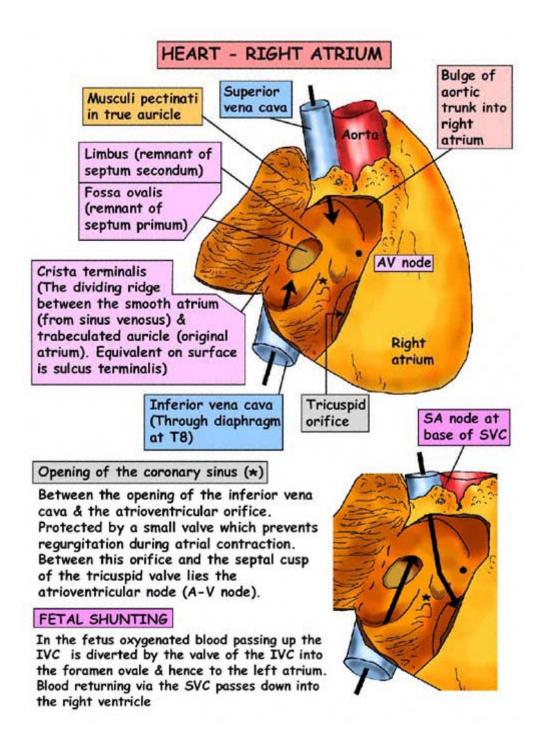
# HEART - ANTERIOR VIEW



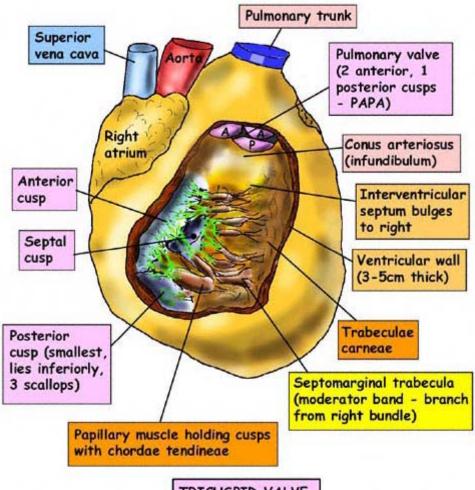
## HEART - POSTERIOR VIEW



As the visceral pericardium reaches up posteriorly on the left atrium it reflects off the pulmonary veins to become the parietal pericardium. This is the oblique sinus



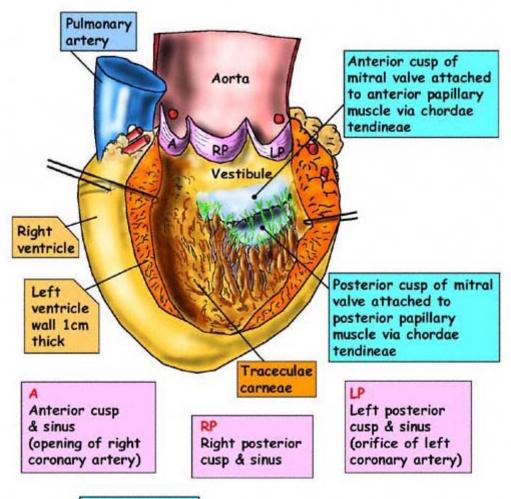
## HEART - RIGHT VENTRICLE



#### TRICUSPID VALVE

- · Anterior, septal & posterior
- · Attached to fibrous AV ring
- · Admits tips of 3 fingers

## HEART - LEFT VENTRICLE



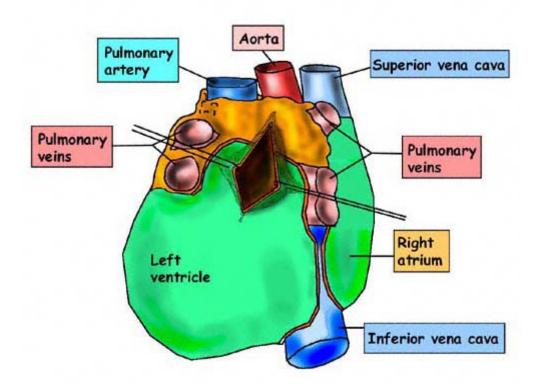
## MITRAL VALVE

- · Anterior cusp is larger, septal & thicker
- · Posterior is smaller & has three scallops
- · Admits the tips of 2 fingers
- · Attached to fibrous AV ring

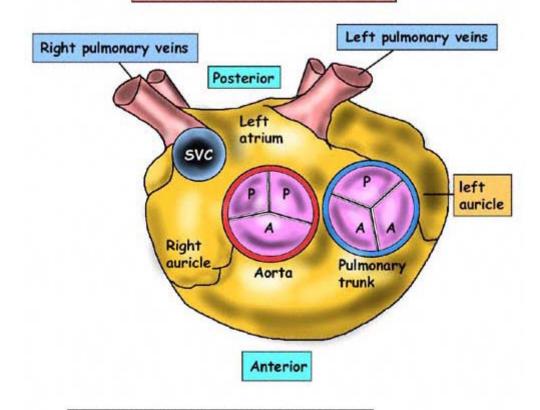
## HEART - LEFT ATRIUM

Base of heart( posterior surface). The left atrium is opened to show its smooth walled interior, apart from the musculi pectinati of the auricle.

4 large, valveless pulmonary veins drain into it. On the interatrial wall there is a oval, thin area which is the left side of the fossa ovalis of the right atrium



## HEART - LOOKING DOWN ON SUPERIOR SURFACE



Mnemonic for aortic and pulmonary valves

A ortic P osterior A nterior P osterior APAP

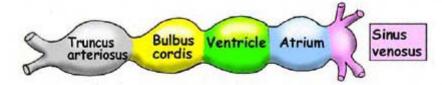
Pulmonary Anterior Posterior Anterior PAPA

## HEART - DEVELOPMENT

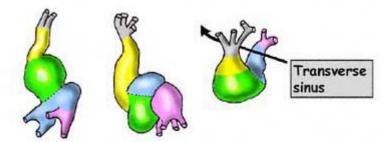
2 primative blood vessels fuse to give a single pulsatile heart tube which runs down the back of the fetus with a mesentery



The fused tube divides into 5 chambers with arterial and venous ends. The bulbus cordis fuses with ventricles to give smooth portions of ventricular outlets



There is limited room for the developing heart and it thus kinks between the atrium and ventricle. Internally, the 4 chambers develop by means of the interatrial and interventricular septa. The heart continues to kink and fold as shown here

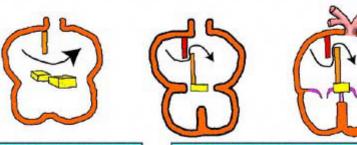


Truncus arteriosus divides to give aorta and pulmonary trunks by the spiral aorticopulmonary septum Sinus venosus gives coronary sinus, SA node, oblique vein of left atrium, & then incorporates into atrium to give the smooth portions AV node and Bundle of His develop from the original atrium

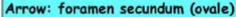
## HEART - DEVELOPMENT OF CHAMBERS AND SEPTA

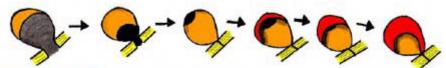
Endocardial cushions (yellow) are anterior and posterior; they meet in the centre to make a right and left atrioventricular orifices which become tricuspid and mitral.

Interventricular septum (muscular part) grows up from floor of original ventricle but leaves a gap superiorly which is filled later as the fibrous part of septum from the endocardial cushions



Arrow: foramen primum





Septum primum grows down to the endocardial cushions but before it reaches it, a gap appears above it. The initial gap below it is the foramen primum. The second gap above it is foramen secundum. A second septum, septum secundum, grows down on the RIGHT, which just covers the top of septum primum. The gap between these two is the foramen ovale (secundum)

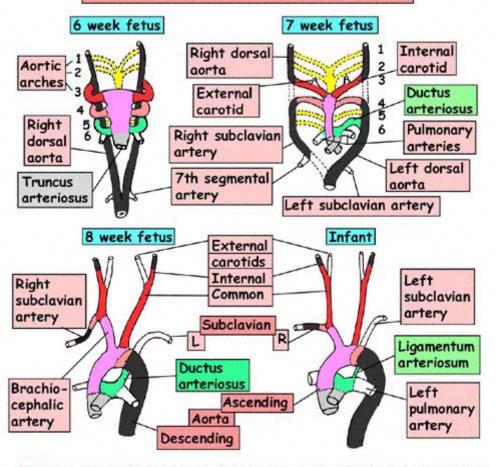




After birth p

Before birth the pressure (P) in the right atrium is higher than in the left atrium as there is no circulation through the lungs. After birth the pressure rises in the left atrium and the septum primum fuses back against the septum secundum

## HEART - DEVELOPMENT OF MAJOR VESSELS AND ARCH ARTERIES



Notes: Aortic sac is distal part of truncus ateriosus. Distal subclavian arteries are from 7th intersegmental arteries. Distal pulmonary arteries are from buds from 6th arch into lungs.

Fate of arch arteries:

1st - parts of maxillary and external carotids

2nd - dorsal parts of arch arteries become stapedial & hyoid arteries.

3rd - common carotids and 1st parts of internal carotids

4th - Left: part of aortic arch. Right: proximal part of right subclavian

5th - Nil

6th - Left: proximal left pulmonary artery & ductus arteriosus Right: proximal right pulmonary artery

# HEART DEVELOPMENT FATE OF VENOUS VALVES

## LEFT AND RIGHT VENOUS VALVES

Where the sinus venosus opens into the right atrium, to right of septum secondum, are the left and right venous valves. Upper ends fuse to give SEPTUM SPURIUM. Rest of left valve fuses with interatrial septum. Septum spurium and upper right valve become the CRISTA TERMINALIS. Lower right valve becomes the VALVE OF THE INFERIOR VENA CAVA and the VALVE OF THE CORONARY SINUS

## CONGENITAL ANOMALIES OF HEART

#### INTERATRIAL SEPTAL DEFECTS (ASD)

- Secundum easy surgical graft
- Primum Difficult surgery. Often associated with VSD

#### INTERVENTRICULAR SEPTAL DEFECTS (VSD)

Usually the upper fibrous part

#### TETRALOGY OF FALLOT

- Pulmonary stenosis
- Right ventricular hypertrophy
- · Fibrous interventricular septal defect
- · Over-riding aorta (astride the two ventricles)

#### PATENT DUCTUS ARTERIOSUS

#### CO-ARCTATION OF AORTA

Hypoplasia of 4th arch with post-stenotic dilatation and notching of ribs. Decreased pulse in left arm and below diaphragm

# PERSISTENT RIGHT DORSAL AORTA RETRO-OESOPHAGEAL RIGHT SUBCLAVIAN ARTERY

Gives dysphagia lusoria

#### DOUBLE AORTIC ARCH

Vascular ring enclosing trachea & oesophagus Right common Left subclavian carotid

Right subclavian

Right subclavian

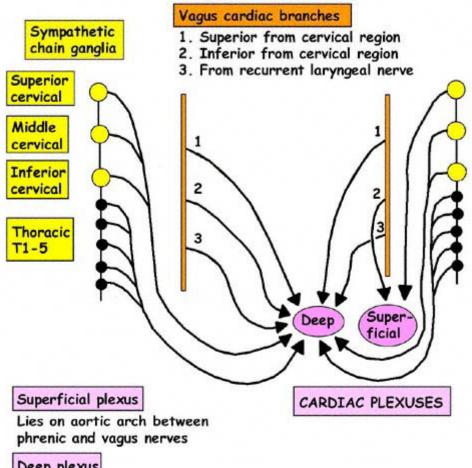
#### CYANOTIC CONDITIONS

- Persistent truncus with VSD
- Transposition of aorta with patent ductus and VSD
- Fallot's tetralogy Pumonary atresia with patent ductus
- Tricuspid atresia with ASD

# ACYANOTIC CONDITIONS

- Primary/secondary ASD
- Membranous/muscular
- VSD
- Patent ductus

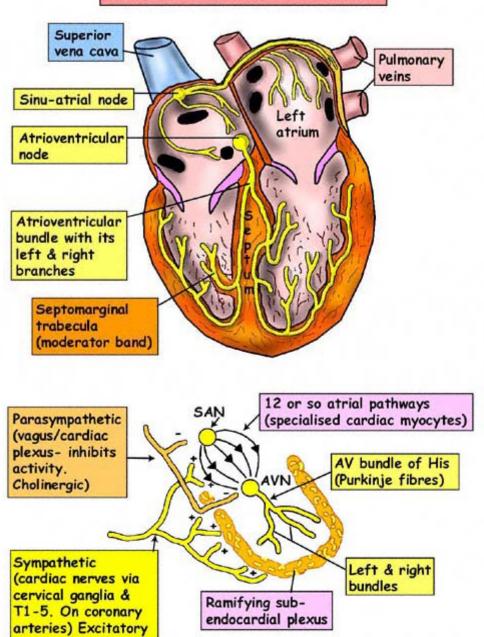
## AUTONOMIC NERVE SUPPLY TO HEART



#### Deep plexus

Lies to right of ligamentum arteriosum, inferior & medial to aortic arch

## HEART - ELECTRICAL SYSTEM



# MUSCLES OF THE BACK 1

Rib

Vertebral

body

Arranged in three layers with three muscles on each layer All supplied by posterior primary rami Divided up as follows:

#### SUPERFICIAL LAYER

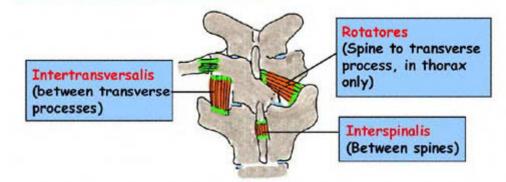
ILIOCOSTALIS (ILC) LONGISSIMUS (LG) SPINALIS (SP)

#### INTERMEDIATE LAYER

LEVATOR COSTARUM (LC) SEMISPINALIS (SS) MULTIFIDUS (M)

#### DEEP LAYER

INTERSPINALIS (IS)
INTERTRANSVERSALIS (IT)
ROTATORES (R)



## MUSCLES OF THE BACK 2

# Spinalis (small, indefinite between spines) Iliocostalis (mostly lateral, all levels, angles of last 6 ribs to: lumbosacral spines transverse processes above & below

#### Longissimus

(Medial, thoracis, cervicis & capitis. From thoracolumbar fascia & lumbar transverse processes to several transverse processes above & mastoid process

posterior tubercles

in cervical region

## SUPERFICIAL LAYER

ILIOCOSTALIS (ILC) LONGISSIMUS (LG) SPINALIS (SP)

ERECTOR SPINAE

#### Semispinalis

Capitis (Transverse processes C5-7, T1-6 to occiput)

Cervicis

Thoracis

(On multifidus, lower thorax to skull, Transverse processes to spinal processes 6 above)

#### Levator costarum

(12 slips from transverse processes C7-T11 to posterior angle of rib below

#### Multifidus

(lamina to spinous process 2-3 above, from sacrum to C2)



#### INTERMEDIATE LAYER

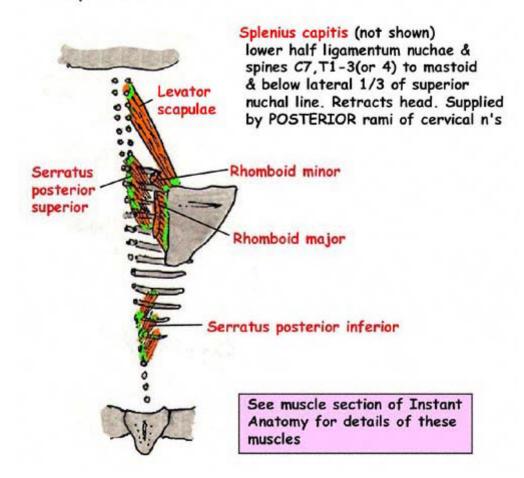
LEVATOR COSTARUM (LC) SEMISPINALIS (SS) MULTIFIDUS (M)

TRANSVERSOSPINALES

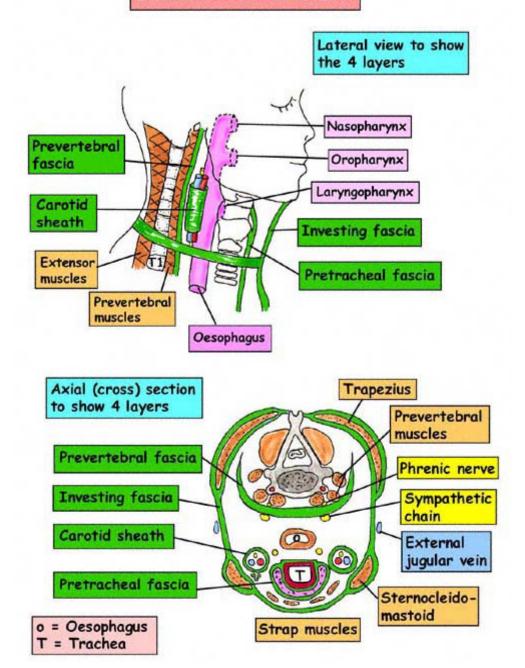
## MUSCLES OF THE BACK 3

#### COVERING MUSCLES

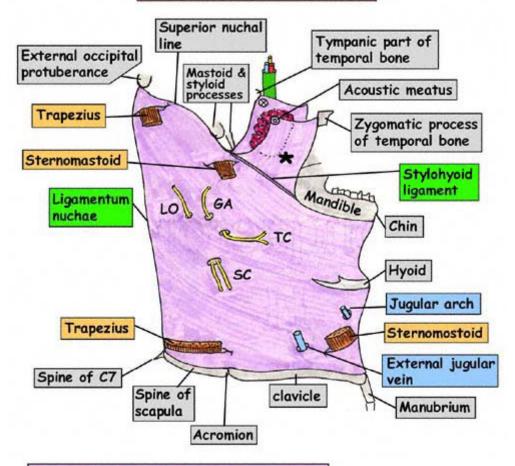
All supplied by ANTERIOR primary rami of spinal nerves except SPLENIUS



# DEEP FASCIA OF NECK

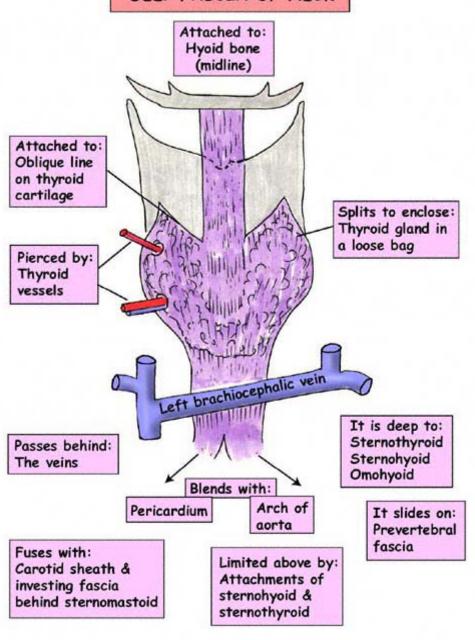


## INVESTING LAYER OF DEEP FASCIA OF NECK

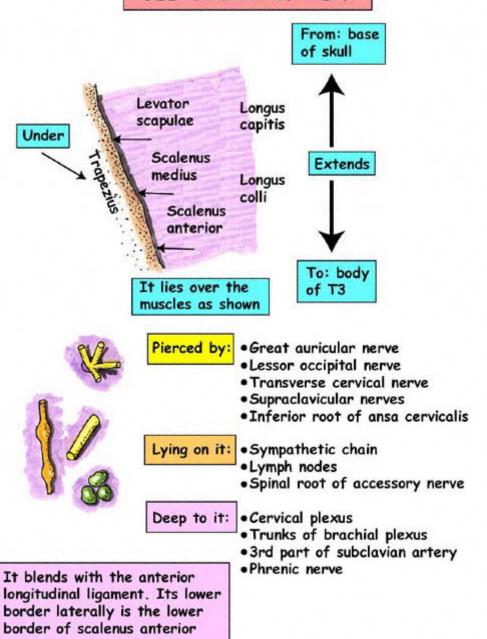


- ★ Anterior layer of parotid fascia is the superficial layer of the investing fascia that has split from the stylohyoid ligament
- Posterior layer of parotid fascia is the deep layer of the investing fascia that has split from the stylohyoid ligament. It fuses with the parotid gland

## PRETRACHEAL PART OF DEEP FASCIA OF NECK



## PREVERTEBRAL PART OF DEEP FASCIA OF NECK



## TISSUE SPACES IN THE NECK

## PREVERTEBRAL SPACE

Closed space behind prevertebral fascia which allows infection to track down into axilla via the axillary sheath which is, itself, part of the prevertebral fascia that is dragged off by the subclavian artery as it emerges from behind scalenus anterior

## RETROPHARYNGEAL SPACE

Immediately anterior to prevertebral fascia. Below, it extends behind oesophagus to diaphragm via superior and then posterior mediastinum. Infection may spread from here, laterally, behind the carotid sheath into the posterior triangle

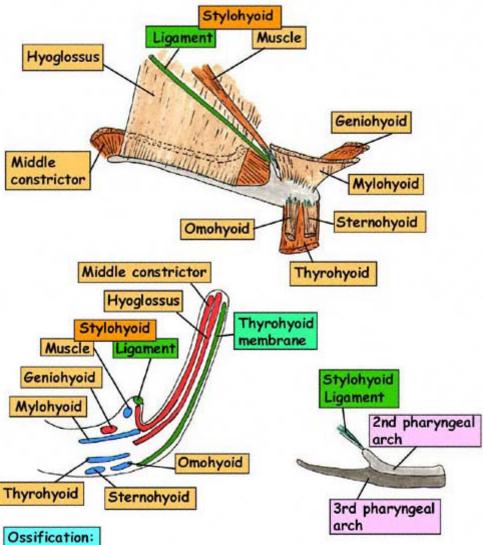
## PARAPHARYNGEAL SPACE

Lateral continuation of retropharyngeal space

## SUBMANDIBULAR SPACE

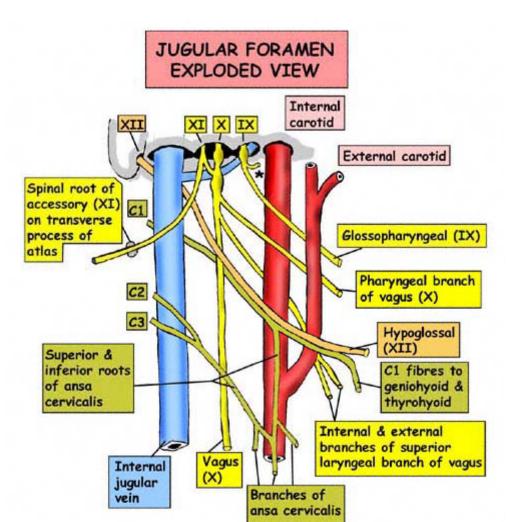
Extends above investing layer of deep cervical fascia, between hyoid and mandible to mucous membrane of floor of mouth. Contains mylohyoid muscle, sublingual gland above this muscle and submandibular gland hooking around its posterior border. Infection here gives cellulitis known as LUDWIG'S ANGINA

#### HYOID BONE AND ATTACHMENTS



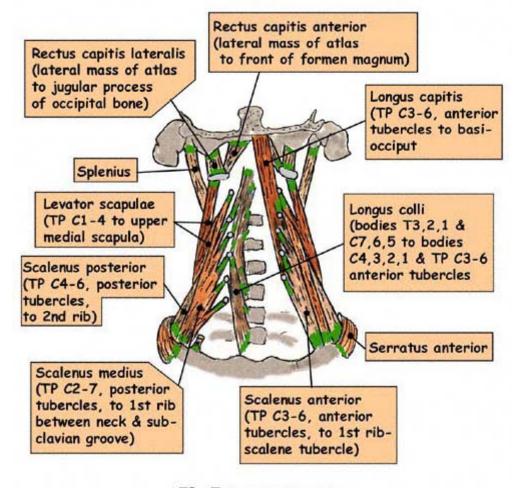
In cartilage

Primary centre in greater cornu (8-9 months gestation) Secondary centres X2 in body (9 months gestation) Secondary centres in each lesser cornu at puberty



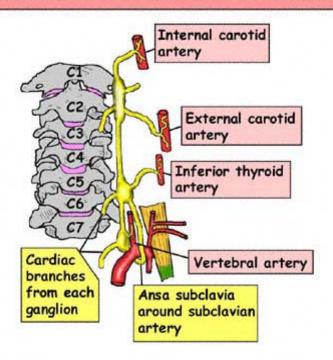
- The vagus lies most medial in the foramen
- Glossopharyngeal nerve & inferior petrosal sinus exit from the anterior compartment of the foramen
- Vagus & accessory nerves exit from the middle compartment
- The sigmoid sinus exits from the posterior compartment, is soon joined by the inferior petrosal sinus to become the internal jugular vein
  - \* = Tympanic branch of IX (Jacobson's nerve)

#### PREVERTEBRAL MUSCLES



TP= Transverse process

#### SYMPATHETIC CHAIN & GANGLIA IN NECK



SUPERIOR CERVICAL GANGLION

- Anterior to lateral mass C1 & C2
- 3cm long
- 4 somatic branches (C1-4)
- · Branches to internal arteries

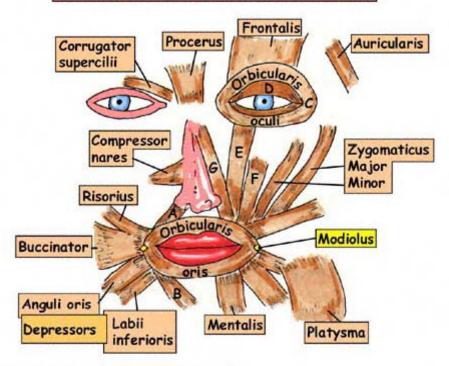
MIDDLE CERVICAL GANGLION

- · At C6, medial to carotid tubercle
- Anterior to verebral artery
- 2 somatic branches (C5,6)
- & external carotid Branches to inferior thyroid & subclavian arteries

INFERIOR CERVICAL GANGLION

- · At C7, behind vertebral artery 1cm x 0.5cm on neck of 1st rib
- 2 somatic branches (C7,8)
- Branches to verebral artery

#### MUSCLES OF FACIAL EXPRESSION

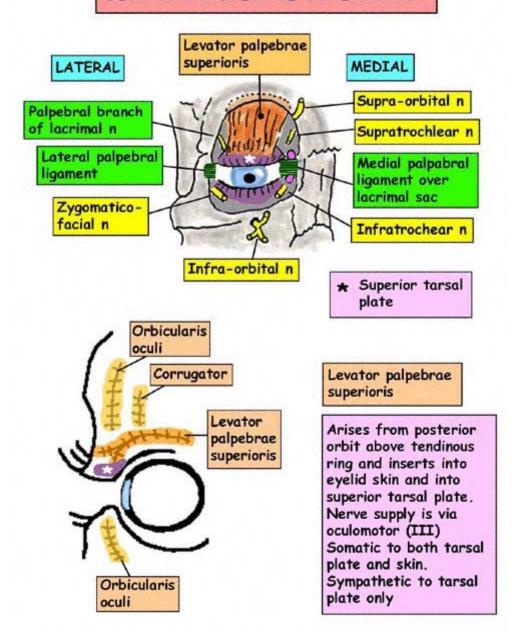


- A = Incisive slip of orbicularis oris
- B = Mental slip of orbicularis oris
- C = Orbital part of orbicularis oculi (complete sphincter, screws up eye, decreases volume of conjunctiveal sac & tears spill over)
- D = Palpebral part of orbicularis oculi
  (Medial palpebral ligament to lateral palpebral raphe. Keeps
  volume of conjuctival sac constant, no tear spill, closes eye)
- E = Levator labii superioris
- F = Levator anguli oris
- G = Levator labii superioris alaeque nasi

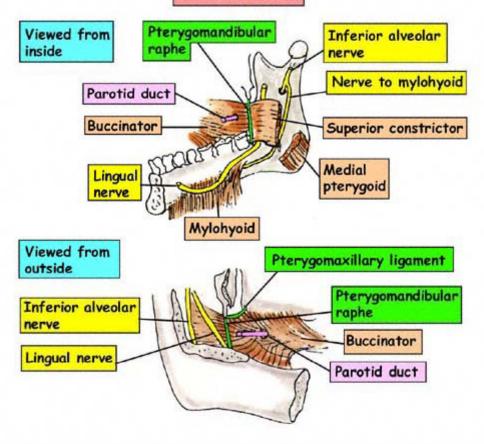
(Dilator nares & depressor septi are not shown)

Note: The face has no deep fascia, variables amount of fat, good blood supply & drainage. Muscles are 2nd arch mesoderm, equivalent to the paniculus carnosus of animals, often attached to the dermis & are arranged into sphincters, dilators and expressors

#### LEVATOR PALPEBRAE SUPERIORIS



## BUCCINATOR



Origin: Both jaws opposite 1st molar teeth & pterygomandibular

raphe & pterygomaxillary ligament

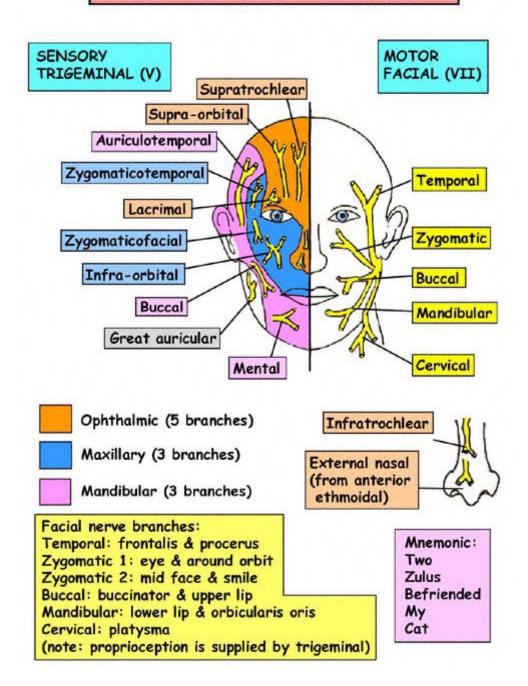
Insertion: Modiolus

Action: Helps chewing, returns food to mouth from cheek pouches

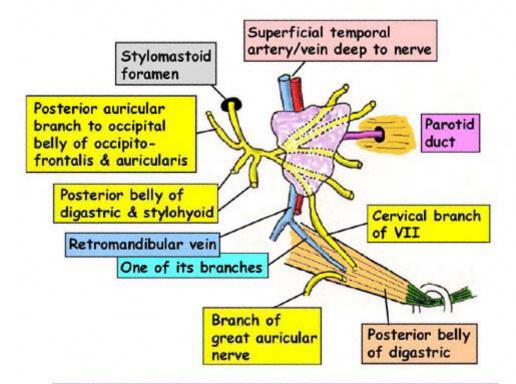
Nerve supply: Facial (VII - buccal branches). Proprioceptive

afferent fibres via buccal branch of Vc

#### FACE: MOTOR AND SENSORY SUPPLY



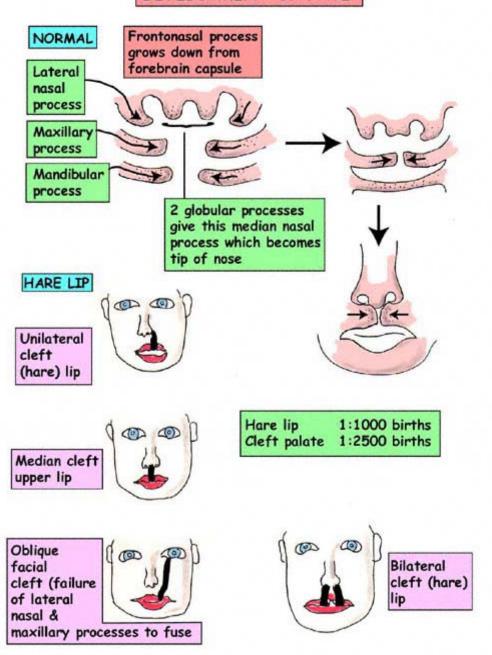
### RIGHT FACIAL NERVE IN & BEFORE THE PAROTID



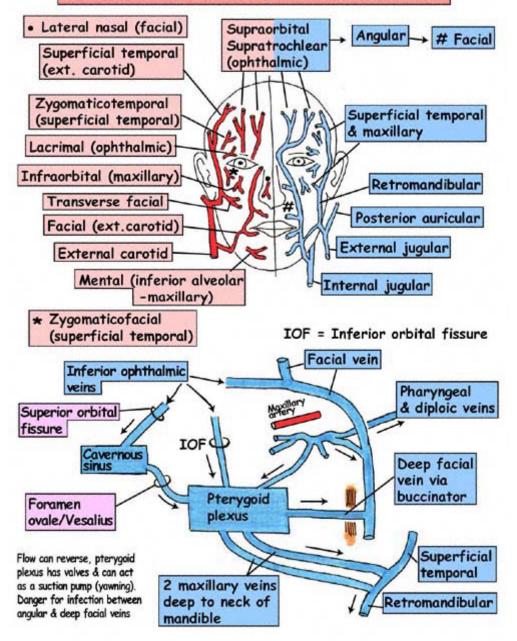
Note: Only three structures lie anterior to the posterior belly of digastric:-

- · Cervical branch of VII
- · Branch of the retromandibular vein
- Branch of great auricular nerve (cervical plexus)

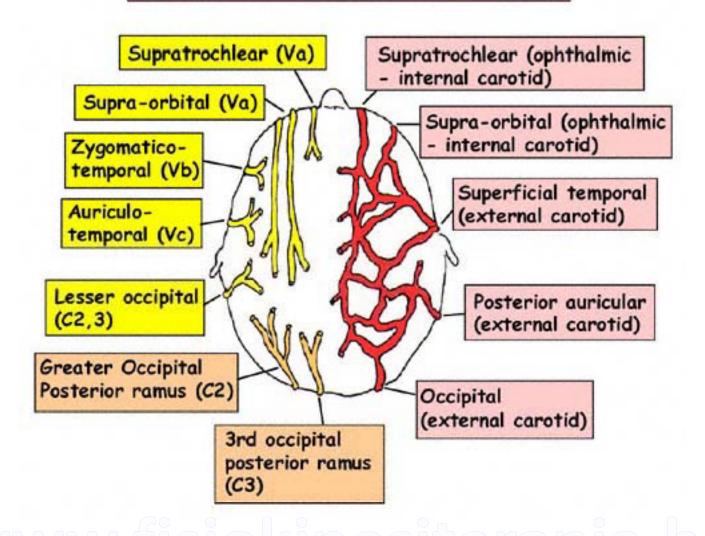
## DEVELOPMENT OF FACE



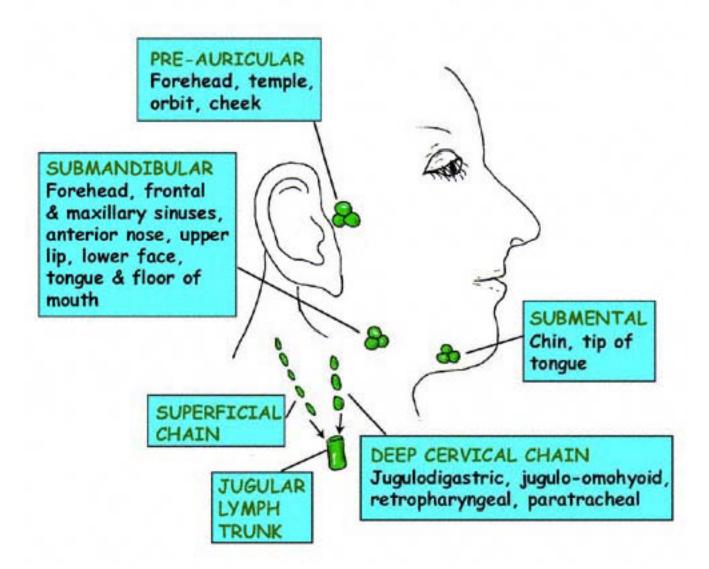
#### FACE ARTERIAL SUPPLY & VENOUS DRAINAGE



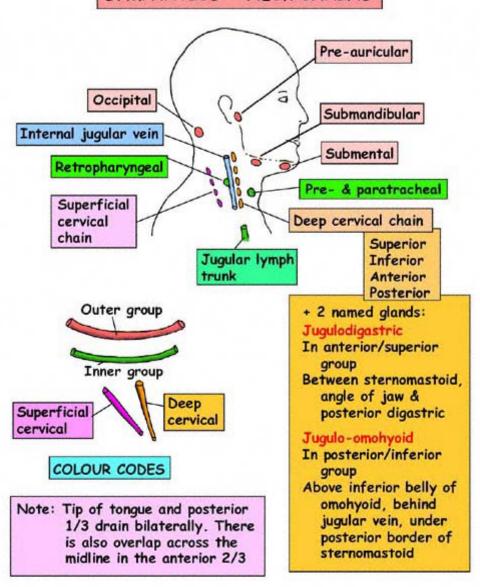
# SCALP - ARTERIES AND NERVES



## LYMPHATICS- GENERAL PATTERN



#### LYMPHATICS - NECK CHAINS

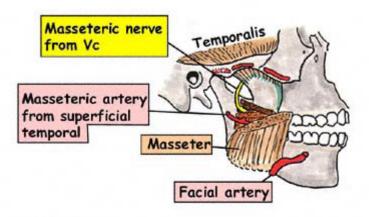


#### PAROTID REGION & MASSETER

· Definition: In front and below ear

• Features: Masseter

Parotid gland



#### MASSETER

Origin: 3 heads from zygomatic arch

1. Superficial - anterior 2/3

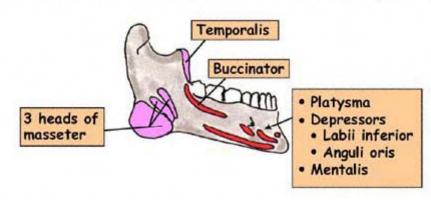
2. Intermediate - middle 1/3

3. Deep - Deep surface of posterior arch

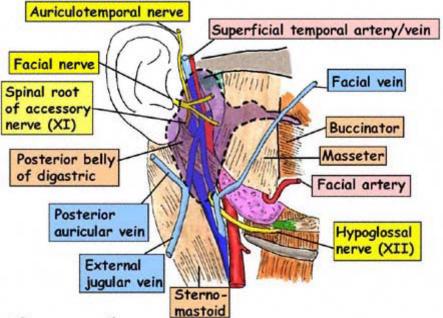
Insertion: Ramus/angle of mandible

Action: Closes jaw

Nerve: Masseteric branch of mandibular division of trigeminal (Vc)



#### PAROTID GLAND 1



- Serous secretions
- Produces amylase, water, Ig factors (lubicates & oral hygiene)
- · Lies between mastoid, styloid process, ramus of mandible
- Has an upper & lower pole, lateral, anterior & deep surfaces
- Surrounded by parotid fascia (investing layer of deep fascia)

#### RELATIONS:

#### Posterior

Sternocleidomastoid Mastoid process

#### Above

Externl acoustic meatus Temporomandibular joint

#### Anterior

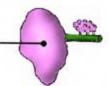
Angle of mandible Medial pterygoid plate Masseter Stylomandibular ligament

In gland: Facial nerve, retromandibular vein, external carotid artery, lymph nodes, fibres of auriculotemporal nerve

Deep to gland: Mastoid process, sternomastoid, posterior belly of digastric, styloid process, stylohyoid ligament & muscle, styloglossus, stylopharyngeus, tempormandibular joint

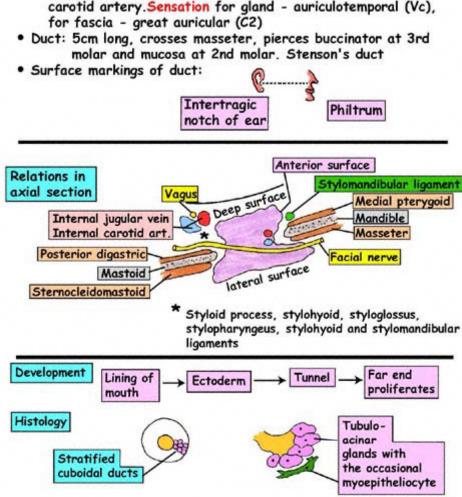
#### Lateral:

subcutaneous surface



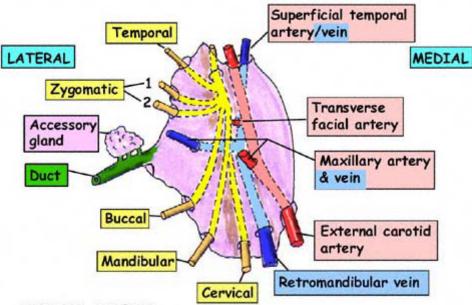
#### PAROTID GLAND 2

- · Blood supply: Branches of external carotid
- Venous drainage: To retromandibular
- · Lymph drainage: Pre-auricular to deep cervical
- Nerve supply: Secretomotor via inferior salivary nucleus to glossopharyngeal nerve to its tympanic branch to lesser petrosal nerve to otic ganglion to auriculotemporal nerve. Sympathetics via superior cervical ganglion and external carotid artery. Sensation for gland - auriculotemporal (Vc), for fascia - great auricular (C2)



#### PAROTID GLAND 3

# LOOKING POSTERIORLY INTO ANTERIOR SURFACE OF RIGHT GLAND

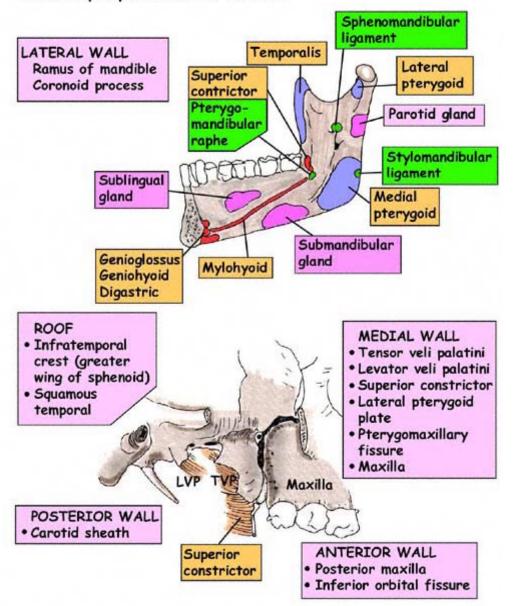


#### CLINICAL ASPECTS

- · Mickulitz & Sjorgren's syndromes
- Adenomas
  - Both sexes equal occurence
  - Pleomorphic
  - Poorly circumscribed
  - · Can become malignant
  - · Usually superficial to VII
- Adenolymphoma Warthin's tumour (more in males than females)
- Primary malignant adenocystic, acinar cell
- · Secondary malignant from face
- Stones in duct
- Frey's syndrome gustatory sweating. Regrowth of parasympathetic fibres into damaged sympathetic of auriculotemporal nerve

#### INFRATEMPORAL FOSSA - BOUNDARIES

- · Base of skull
- Between pharynx & ramus of mandible

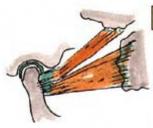


#### MUSCLES OF MASTICATION

- Temporalis
- Masseter
- Medial pterygoid
- Lateral pterygoid

All supplied by:

- Mandibular division of Trigeminal (Vc)
- All derived from 1st pharyngeal arch



#### LATERAL PTERYGOID

Arises: 2 heads

Upper: infratemporal surface

sphenoid

Lower: lateral surface of

lateral pterygoid plate

Inserts: pterygoid fossa below head

of mandible, disc, and capsule of temporomandibular

joint

Action: protrudes jaw and opens mouth



#### MEDIAL PTERYGOID

Arises: 2 heads

Deep: medial side of lateral pterygoid

plate and fossa between plates

Superficial: smaller. Tuberosity of maxilla and pyramidal

process of palatine bone

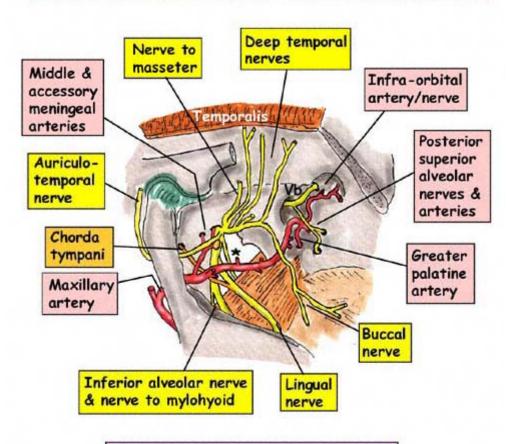
Inserts: Medial ramus of mandible

Action: pulls mandible upwards, forwards and

medially (closes mouth and chews)

See Muscle section of Instant Anatomy for details of temporalis and masseter

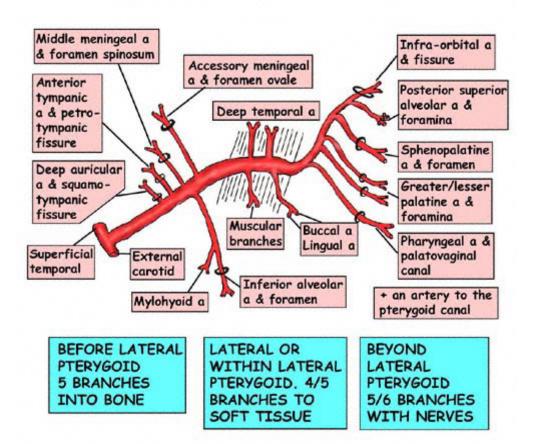
## INFRATEMPORAL FOSSA - DEEP DISSECTION



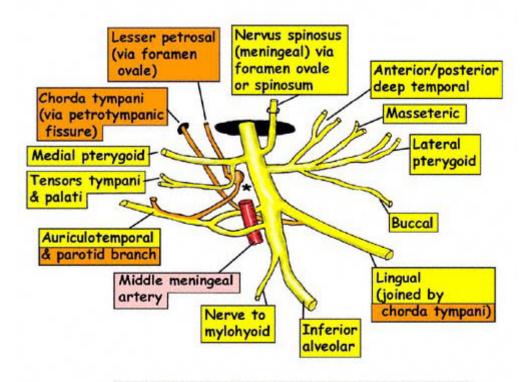
\* Nerve to lateral pterygoid and just to its left is the otic ganglion

### MAXILLARY ARTERY

In infratemporal fossa, either within or lateral to the superficial head of lateral pterygoid muscle. This muscle is shown below

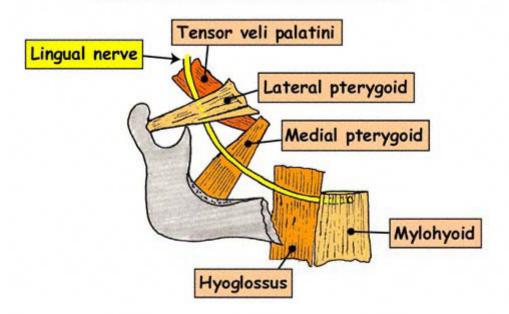


#### MANDIBULAR DIVISION OF TRIGEMINAL NERVE, EMERGING FROM FORAMEN OVALE DEEP IN INFRATEMPORAL FOSSA



★ Otic ganglion. Parasympathetics from lesser petrosal nerve synapse within it and postganglionic fibres are taken to the parotid gland by the auriculotemporal nerve

# LINGUAL NERVE: RELATION TO MUSCLES

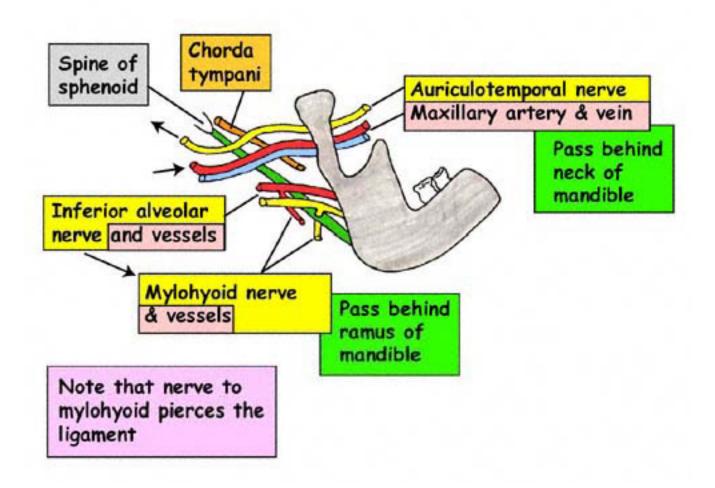


### The lingual nerve passes between:

- 1. Tensor veli palatini and lateral pterygoid
- 2. Medial pterygoid and mandible
- 3. Mandible and mucosa of mouth
- 4. Mylohyoid and hyoglossus

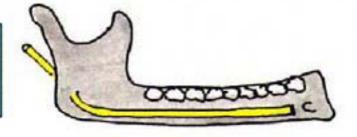
# SPHENOMANDIBULAR LIGAMENT RELATIONS

Structures that pass between ligament and mandible

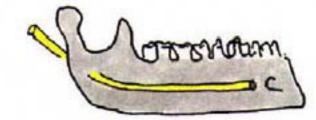


# INFERIOR ALVEOLAR NERVE: RELATIONS WITH MANDIBLE

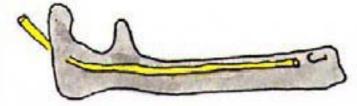
BABY (Tooth buds)



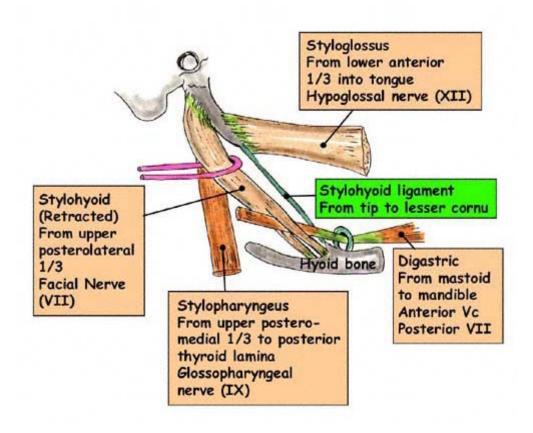
ADULT (Teeth)



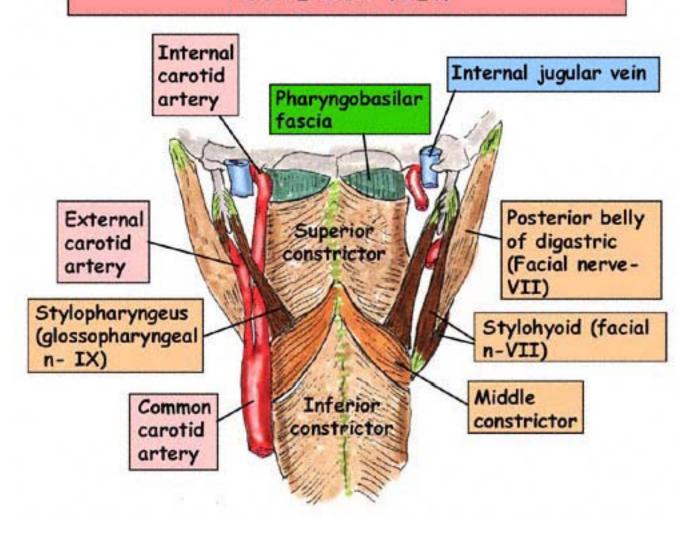
ELDERLY (Edentulous)



# RIGHT STYLOID PROCESS MUSCLE AND LIGAMENT ATTACHMENTS LATERAL VIEW



# MUSCLE AND LIGAMENT ATTACHMENTS POSTERIOR VIEW



# LIGAMENTS ASSOCIATED WITH MANDIBLE AND HYOID BONES

#### SPHENOMANDIBULAR LIGAMENT

Spine of sphenoid to lingula of mandible (1st arch remnant) Is axis of rotation for opening of mouth

# STYLOMANDIBULAR LIGAMENT

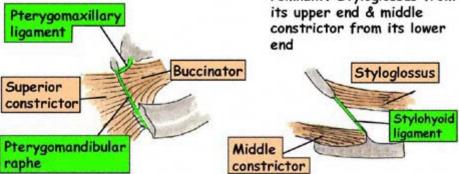
Specialised band of deep cervical fascia. Styloid process to angle of mandible. Is the posteroinferior aspect of the parotid fascia

#### PTERYGOMANDIBULAR RAPHE

Tendinous muscle fibres from pterygoid hamulus to posterior end of mylohyoid line. Medially lies buccal mucosa. Superior constrictor arises posteriorly & buccinator anteriorly from it. Buccinator also extends onto the pterygomaxillary ligament to reach the maxilla

#### STYLOHYOID LIGAMENT

Styloid process to lesser cornu of hyoid. 2nd arch remnant. Styloglossus from its upper end & middle constrictor from its lower end



#### PTERYGOPALATINE FOSSA 3

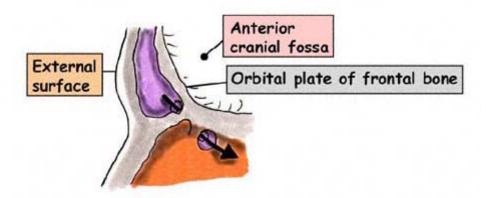
Diagrammatic view of right fossa looking down on it from above to show entry and exit of nerves. The roof (removed) is greater wing of sphenoid

#### POSTERIOR Foramen Pterygoid rotundum canal & nerve Greater wing & Vb of sphenoid Pharyngeal branch Pterygoid process of Vb in of sphenoid palatovaginal canal Pterygomaxillary Sphenopalatine fissure foramen & nasopalatine nerve Posterior LATERAL MEDIAL maxilla Greater palatine Posterior superior Lesser palatine canal & nerves alveolar foramina canals & nerves & nerves

ANTERIOR

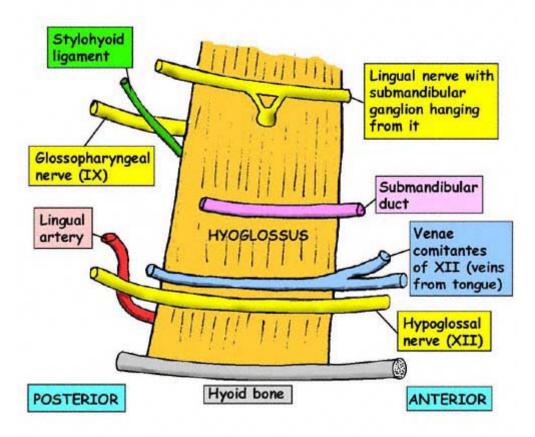
### FRONTAL SINUSES

- Appear at 2 years
- Unequal in size
- Bony septum
- · Lie between orbit and anterior cranial fossa
- Nerves: Supra-orbital & supratrochlear nerves
- Blood supply: Supra-orbital & supratrochlear arteries
- · Lymph drainage: Submandibular
- · Veins: Diploic & superior ophthalmic



- Drainage (diagrammatic)
- Ostium: lower medial aspect
- To middle meatus via frontonasal canal (anterior end of hiatus semilunaris)
- May drain via infundibulum from anterior ethmoidal sinus

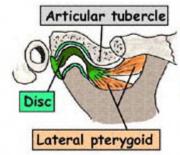
#### HYOGLOSSUS & ITS RELATIONS



- The mylohyoid muscle (not shown) overlaps the anterior edge of hyoglossus
- Hyoglossus is supplied by the hypoglossal nerve as are all the muscles of the tongue except palatoglossus (pharyngeal plexus)
- Further anteriorly, under the mylohyoid, the lingual nerve passes lateral to the submandibular duct, then dips under it to appear on its medial side to enter the tongue
- The venae comitantes of the hypoglassal nerve pass posteriorly to join the facial vein

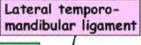
#### TEMPOROMANDIBULAR JOINT 1

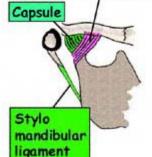
- Synovial
- Condyloid
- Hemicylindrical
- Atypical (fibrocartilage on surfaces)
- Fibrocartilaginous disc
- · Synovial membrane lines capsule
- Nerve supply: Auriculotemporal & nerve to masseter



BETWEEN mandible & mandibular fossa of squamous temporal bone

DISC attached anteriorly to head of mandible, thus moves forward with it. Also at lateral pterygoid plate and capsule

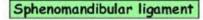




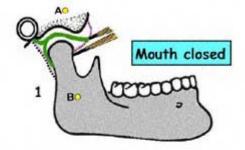
CAPSULE attached to neck of mandible at articular margin. Anterior - at articular tubercle. Posterior - at Squamotympanic fissure. Strong but lax at rest

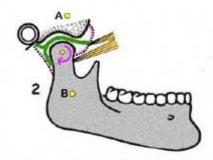
LATERAL TEMPOROMANDIBULAR
LIGAMENT from zygomatic arch to
posterior neck & ramus of mandible.
Fuses with capsule, lax at rest,
tightens with any movement

MOVEMENT in upper compartment is protraction (lateral pterygoids), retraction (posterior temporalis) & gliding side to side. In lower compartment is opening (lateral pterygoids & digastrics & closing (masseters, medial pterygoids & temporalis



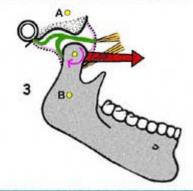
#### TEMPOROMANDIBULAR JOINT 2



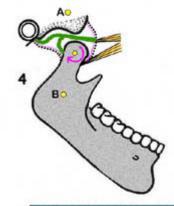


Points A & B represent the 2 ends of the sphenomandibular ligament (spine of sphenoid to lingula of mandible). Distance between them must remain constant at all positions of the joint. Axis for opening must pass through lingula (B) on each side

First few degrees of opening: Rotation only in lower cavity. Mostly gravity



Majority of opening: Further rotation in lower joint cavity.
Major degree of anterior displacement of head of mandible onto articular tubercle achieved by lateral pterygoid and occuring in upper joint cavity

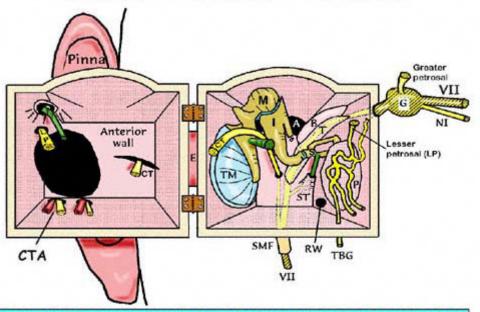


Last few degrees of opening: Further rotation in lower joint cavity only

# RULES OF NERVE SUPPLY FOR MUSCLE GROUPS

ALL MUSCLES OF	SUPPLIED BY	EX <i>C</i> EPT	WHICH IS SUPPLIED BY
PHARYNX	Pharyngeal plexus (IX, X & sympathetic)	Stylopharyngeus	Glossopharyngeal (IX)
PALATE	Pharyngeal plexus (IX, X & sympathetic)	Tensor veli palatini	Nerve to medial pterygoid (Vc)
TONGUE	Hypoglossal (XII)	Palatoglossus	Pharyngeal plexus (IX, X & sympathetic)
FACIAL EXPRESSION & BUCCINATOR	Facial (VII)	Levator palpebrae superioris	Oculomotor (III)
MASTICATION	Mandibular division of Trigeminal (Vc)	Buccinator	Facial (VII)
LARYNX	Recurrent laryngeal	Cricothyroid	External branch of superior laryngeal nerve (X)

# MIDDLE EAR - RIGHT SIDE LOOKING POSTERIORLY



Right hand box is a view of the right middle ear looking posteriorly. The left hand box is the anterior wall of the right box. Hinges are to illustrate how it would close to become the anterior wall

A = Aditus to mastoid air sinus

B = Bony bulge of lateral semicircular canal

CT = Chorda tympani

E = External auditory meatus

G = Geniculate ganglion

I = Incus

LP = lesser petrosal n

M = Malleus

P = Promontory (last turn of cochlea)

RW = Round window

S = Stapes

ST = Stapedius

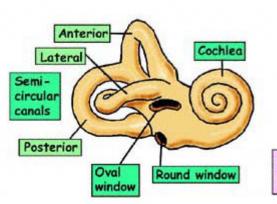
SMF = Stylomastoid foramen (VII emerging)

T = Bony tunnel for facial n

TBG = Tympanic branch of glossopharyngeal

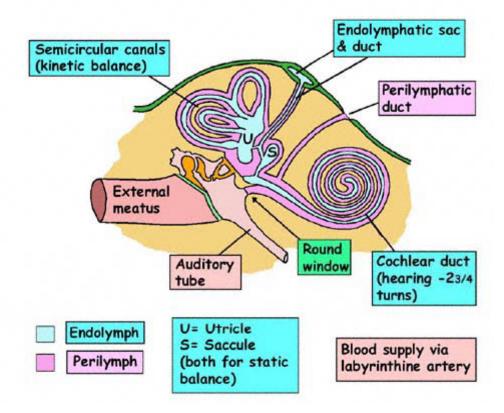
Mucosa covers all contents & is supplied by IX & a little VII. The caroticotympanic arteries (CTA) bring in blood supply & sympathetics for the tympanic plexus on the promontory

# INNER EAR - BONY & MEMBRANOUS LABYRINTHS

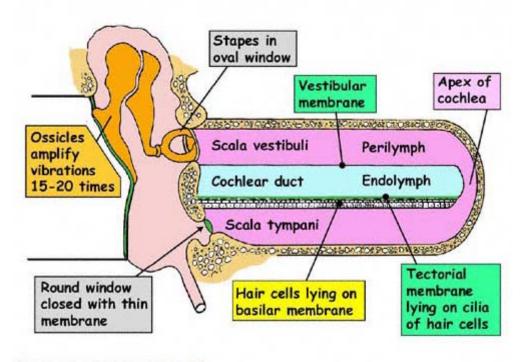


Full size at birth
In petrous temporal bone
One continuous cavity
For hearing & balance
Vestibulocochlear nerve

Membranous labyrinth lies within osseous labyrinth



## INNER EAR - STRAIGHTENED OUT COCHLEA TO AID UNDERSTANDING



#### HEARING MECHANISM

Sound waves 
Pinna 
External meatus 

Tympanic membrane 
Ossicles 
Stapes 

Vibrations in perilymph 
Basilar membrane 
Hair cells (convert acoustic energy to action potentials) 

Tectorial membrane 
Cochlear part of vestibulocochlear nerve (VIII) 
Auditory cortex

#### MENINGES

Lines inside of dura.
Forms villi to drain
CSF into blood.
Several villi give an
arachnoid granulation
(Pacchionian body).
These indent bone &
are mostly in the
superior sagittal sinus

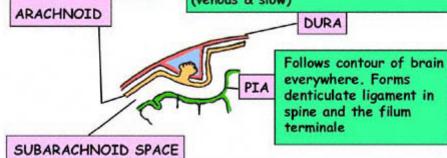
Outer endosteal (periosteal)
Inner meningeal (fibrous) into folds for
TENTORIUM CEREBELLI & FALX
CEREBRI

Outside both: middle meningeal vessels & site of extra-dural haemorrhage Between layers: venous sinuses &

Meckel's cave

Under both: subdural haemorrhage

(venous & slow)



For circulation of CSF which suspends the brain. Larger areas are cisterns (CISTERNA MAGNA, PONTINE, INTERPEDUNCULAR, CHIASMATIC). They are filled via the foramen of Magendie from the fourth ventricle. Subarachnoid haemorrhage into this space is arterial and sudden

#### Blood supply of dura

Middle meningeal artery, meningeal branches of vertebral, ophthalmic, anterior ethmoidal, internal carotid, accessory meningeal

#### Nerve supply of dura in cranial fossae

Anterior: Anterior ethmoidal (Va)

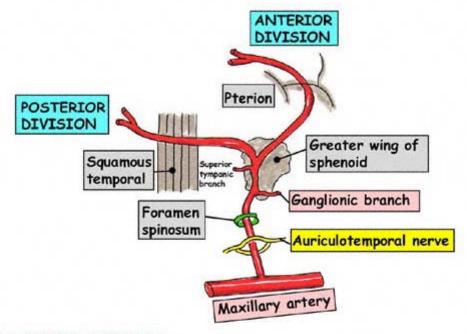
Middle: Nervus spinosus (Vc), Middle meningeal nerve (Vb)

Posterior: Meningeal branches of glossopharyngeal (IX) & Vagus (X)

Foramen magnum: C1-3

Supratentorial: Meningeal branches from Va

#### RIGHT MIDDLE MENINGEAL ARTERY



#### POSTERIOR DIVISION

Where a vertical line from the mastoid process meets a horizontal line form the upper margin of the orbit. Fractured skull leads to extradural haemorrhage and contralateral deafness

#### ANTERIOR DIVISION

3cm above the midpoint of the zygomatic arch. Fractured skull leads to extradural haemorrhage with pressure on the motor area

#### Venous drainage of skull

Diploic veins to sinuses within skull or to veins outside skull Meningeal veins to sphenoparietal sinus within skull or pterygoid plexus in infratemporal fossa

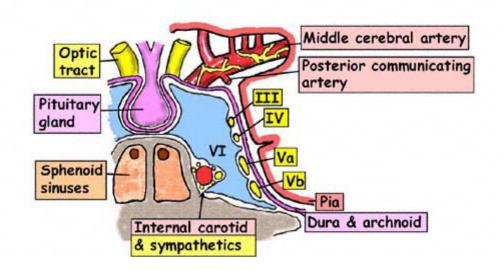
Note: the grooves on the insde of the skull are said to be due to veins and not the arteries. Middle meningeal artery does NOT supply the brain

# INTRACRANIAL SINUSES AND VEINS

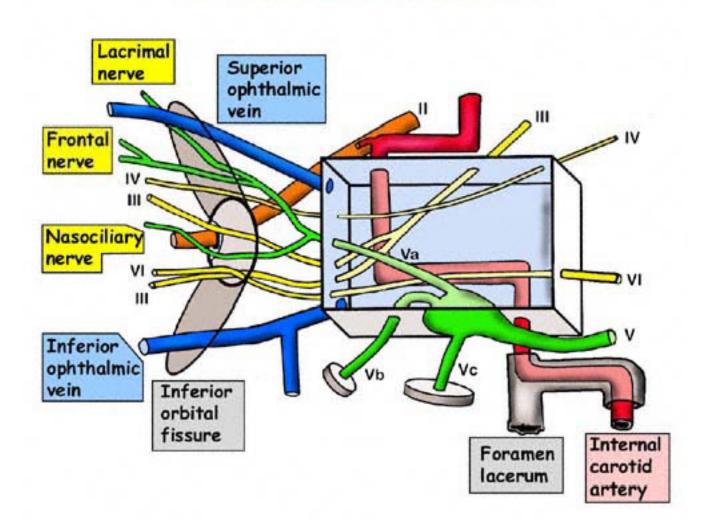
See veins section of INSTANT ANATOMY

# CAVERNOUS SINUS CORONAL (TRANSVERSE) VIEW RIGHT SIDE LOOKING ANTERIORLY

- Lies alongside body of sphenoid in middle cranial fossa
- Between periosteal (endosteal) and meningeal (fibrous) layers of dura
- Roof: Anterior & posterior clinoid processes with uncus of temporal lobe & internal carotid artery on it, III & IV into it
- Lateral wall: Dura, temporal lobe, III, IV, Va, Vb in wall
- Floor: Greater wing of sphenoid
- Medial wall: Dura over sphenoid, sella turcica, pituitary, sphenoid sinus
- Posterior wall: (narrow), dura of posterior fossa, superior and inferior petrosal sinuses, peduncle of brain
- Anterior wall: (narrow), medial end of superior orbital fissure, ophthalmic veins, orbit
- · Contains: Internal carotid artery, VI & blood
- Draining into it: Superior/inferior ophthalmic veins, intercavernous sinuses, sphenoparietal sinuses, superficial middle cerebral vein
- Draining out of it: Superior/inferior petrosal sinuses, emissary veins to pterygoid plexus



## CAVERNOUS SINUS LEFT SIDE LATERAL VIEW



#### MIDDLE EAR - NOTES

#### The middle ear:

- Transfers and enhances vibrations of the tympanic membrane by means of the ossicles -malleus, incus and stapes. The signal is then passed via the foot plate of the stapes in the oval window to the labyrinth of the inner ear.
- Is a small air filled cavity in the petrous part of the temporal bone
- Connects via an aditus posteriorly to the mastoid air sinus which contains air cells
- Connects to the nasopharynx via the auditory tube for access of air & to keep the air pressure equilibrated by opening with each swallow
- Contains two small muscles tensor tympani (Vc) & stapedius (VII)
  which attach to malleus & stapes respectively, which dampen down
  movements of these ossicles to avoid over-vibration during low
  pitched sounds.
- Has the facial (VII) nerve passing through it from the internal acoustic meatus to the stylomastoid foramen. It is joined by nervus intermedius, carrying general sensory, taste & parasympathetic fibres, at the geniculate ganglion. Greater petrosal nerve leaves at this ganglion to pass eventually to the pterygopalatine ganglion. Facial nerve also gives a small motor branch to stapedius and then the chorda tympani leaves it just before it exits the middle ear. The chorda tympani passes back into the middle ear, crosses the pars flaccida of the tympanic membrane then exits forwards from the middle ear finally to join the lingual nerve.
- Has a tympanic branch of the glossopharyngeal nerve (IX) supplying sensation to it & it also supplies parasympathetic to the parotid gland via the lesser petrosal nerve & otic ganglion.
- Has mucous membrane covering all its contents.
- Has a sensory supply largely from glossopharyngeal (IX) with a small contribution from facial (VII)
- Has blood supply from a tympanic branch of maxillary & a stylomastoid branch of posterior auricular artery.
- May fill with fluid or pus when infected & transmission of sound via the ossicles is less efficient than sound passing directly through the bone. This is tested with a tuning fork.

#### EAR - CLINICAL PROBLEMS

#### OUTER EAR

- Wax
- Foreign body
- Otitis externa

#### INNER EAR

- Otitis media -Acute (± blocked auditory tube)
   -Chronic (cholesteatoma, glue ear)
- Perforation of eardrum
  - Infective
  - Traumatic
    - Direct injury
    - Barotrauma
- CSF leak with fractured skull

#### DEAFNESS -Conductive and Neural

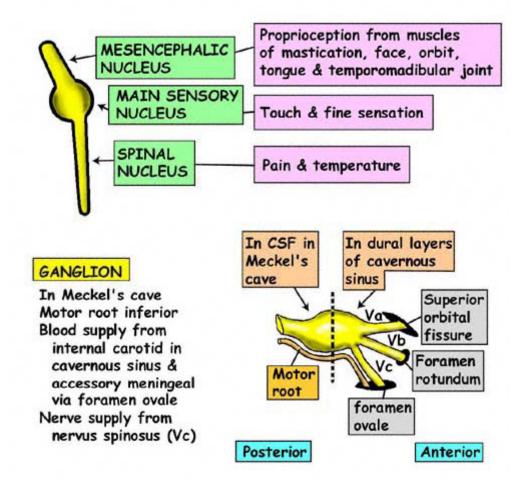
- · Post infection
- Traumatic dislocation of ossicles
- Otosclerosis
- Noise injury
- · Genetic & senile
- Rubella in pregnancy
- Viruses & drugs
- Tumours of nerves (acoustic neuroma)

#### **VERTIGO** (Dizziness)

- Acute labyrinthitis
- Meniere's disease (attacks with deafness & tinnitus)

#### TRIGEMINAL NERVE (V) EXTRA NOTES

- · Nerve of the first pharyngeal arch
- 3 nuclei in brain stem (see below)
- Somatic but carries parasympathetic and sympathetic
- · Mostly sensory but small motor branch in mandibular division
- Motor is branchiomotor (special visceral motor)
- All cell bodies are in the trigeminal ganglion EXCEPT for proprioception and these are in the mesencephalic nucleus in the brain stem



#### 8CM LONG 8MM WIDE

#### BILE DUCT

1cm

Pylorus

10cm

#### SUPRADUODENAL

Upper 1/3 in free edge of lesser omentum, on portal vein & to right of hepatic artery



#### RETRODUODENAL

Middle 1/3 behind 1st part of duodenum, moving to right of portal vein. On inferior vena cava



#### PARADUODENAL

Lower 1/3 in groove between head of pancreas & 2nd part of duodenum on right renal vein and inferior vena cava



IVC

Ampulla of Vater opens into 2nd part of duodenum on posteromedial wall, 10cm from pylorus

GDA is gastroduodenal artery

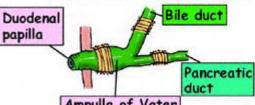


Nerve supply:

Parasympathetic -anterior vagus for contraction of gall bladder, relaxation of sphincter of Oddi (+ cholocystokinase from small bowel) Sympathetic - coeliac

ganglion, relaxes gall bladder, & afferent together with right phrenic

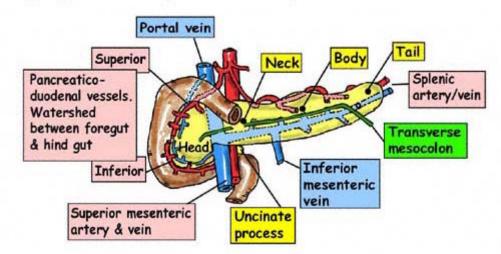
3 sphincters make up the sphincter of Oddi. Biliary always present - others may be missing



Ampulla of Vater hepatopancreatic ampulla)

#### PANCREAS - GENERAL

- Exocrine volume much greater than endocrine
- · Lies retroperoniteal, largely in the transpyloric plane
- 15cm long, lobulated with fine capsule
- Alveoli of serous secretory cells lead to ductules then to principal ducts
- Islets of Langerhans lie between alveoli
- Main duct (Wirsung) leads to ampulla of Vater
- Accessory duct (Santorini) from uncinate process opens proximally, may be absent, often communicates with main duct
- Arteries: Gastroduodenal, inferior/superior pancreaticoduodenal, arteria pancreatica magna from splenic
- Veins: Pancreaticoduodenal. Superior to portal, inferior to superior mesenteric
- Lymphatics: in groove between head and duodenum & root of superior mesenteric artery and vein
- Nerves: Parasympathetic (posterior vagus) to stimulate exocrine secretion. Sympathetic for vasoconstriction and pain
- Secretion: Secretin & cholecystokinase (from small bowel) cause release of tripsin, lipase, bicarbonate. Alpha islet cells give glucogon, beta cells give insulin, delta give somatostatin



### PANCREAS - RELATIONS

Anterior: lesser sac, pylorus, 1st part of duodenum, superior

mesenteric artery & vein, transverse mesocolon, stomach

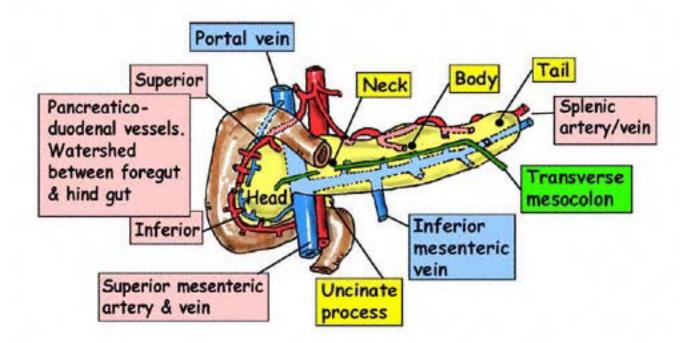
Superior: splenic artery

Lateral on right: 2nd part of duodenum, ampulla of Vater

Lateral on left: hilum of spleen

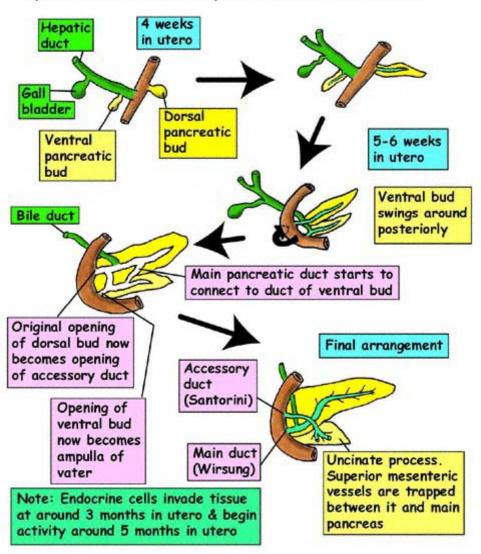
Posterior: left crus of diaphragm, psoas, right renal vein, inferior vena cava, bile duct, spleen, left renal vessels, left kidney, left suprarenal gland, coeliac plexus, inferior mesenteric vein, splenic vein, portal vein, superior

mesenteric artery & vein, aorta

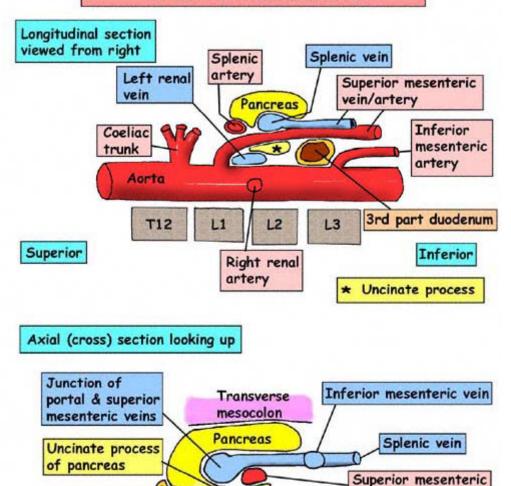


#### DEVELOPMENT OF GALL BLADDER & PANCREAS

A diverticulum grows from the ventral wall of the duodenum which differentiates into hepatic ducts and liver. A second diverticulum from the hepatic duct gives the gall bladder and cystic duct. Pancreas develops from vental and dorsal buds



## AXIAL & LONGITUDINAL SECTIONS AT L1 VERTEBRAL LEVEL



IVC Aorta

L1/2

disc

Right

renal

artery

2nd part

duodenum

Right

artery

Left

renal

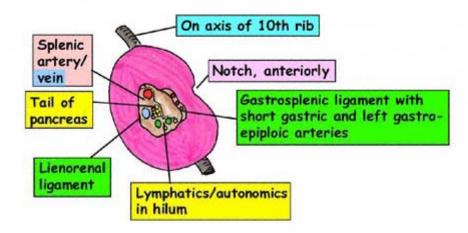
artery

Left renal vein

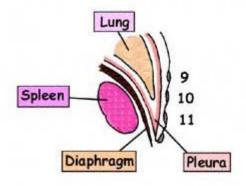
Left

#### SPLEEN - GENERAL

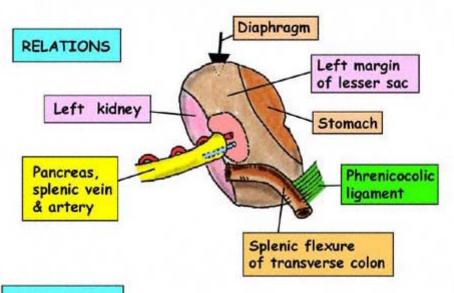
- Size of a fist (1 x 3 x 5 inches) 2.5cm x 8cm x 13cm
- 200g in wieght. Lies on ribs 9-11
- · Part of the reticuloendothelial system
- · Becomes palpable when it is twice normal size
- Thin cspsule, has notch & moves on respiration (cf. kidney)
- Functions: Erythropoeisis, effete erythrocyte removal, immune defence (beta cells) and blood storage
- · Blood supply: Splenic artery from coeliac trunk
- Venous drainage: Splenic vein to portal system
- Lymph: Coeliac (para-aortic)
- Nerve: Sympathetic from coeliac plexus



Note: lower pole is normally no further anteromedial than mid axillary line

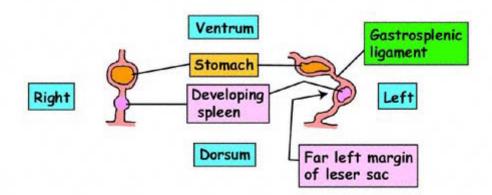


#### SPLEEN - RELATIONS & DEVELOPMENT



#### DEVELOPMENT

In dorsal mesoderm in dorsal mesogastrium



#### DUODENUM - GENERAL

#### 10" (25cm) Greek for 10 fingers

#### SECOND PART (3" or 8cm)

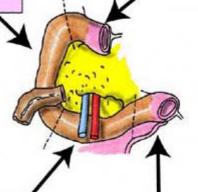
- Retroperitoneal
- In transpyloric plane
- Downwards over hilum of right kidney
- Anterior: Gallbladder, hepatic flexure
- Medial: Pancreas, ampulla (posteromedial, 4" or 10cm from pylorus)
- · Lateral: Ascending colon

Blood supply: Superior & inferior pancreatico-duodenal arteries, right gastric artery, right gastro-epiploic artery

Veins: Splenic, superior mesenteric & portal

#### FIRST PART (2" or 5cm)

- lst 1/2 with mesentery, 2nd 1/2 without.
- Slightly longer in female
- Just above transpyloric plane
- Passes to right, upwards, backwards
- Anterior: Liver & gallbladder
- Superior: Epiploic foramen



#### THIRD PART (4" or 10cm)

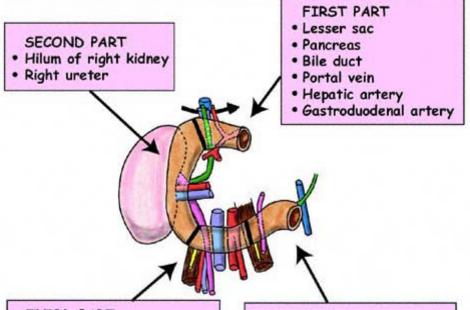
- Retroperitoneal
- Below subcostal plane
- Passes forwards & to left
- Anterior: Small bowel mesentery, superior mesenteric artery & vein
- Superior: head of pancreas
- Inferior: Jejunum

#### FOURTH PART (1" or 2.5cm)

- · Mesentery begins
- · Ascends to L2
- Ends as duodenojejunal junction
- Anterior: Transverse colon & mesocolon
- •Left: Left kidney & ureter
- Superior: Body of pancreas

#### DUODENUM - POSTERIOR RELATIONS & LIGAMENT OF TREITZ

#### POSTERIOR RELATIONS OF DUODENUM



#### THIRD PART

- Right psoas
- · Right genitofemoral nerve
- · Right gonadal artery & vein
- · Right ureter
- Inferior vena cava
- Aorta
- L3 vertebra

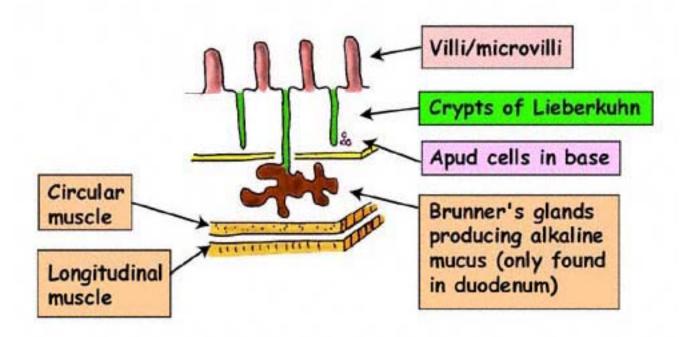
#### FOURTH PART

- Left sympathetic chain
- Left psoas
- · Left genitofemoral nerve
- · Left renal artery & vein
- · Left gonadal artery & vein
- · Inferior mesenteric vein

#### LIGAMENT OF TREITZ

- 2 parts, probably neither attached to crura
- 1. Slip of striated muscle from diaphragm at oesophageal opening, ending in connective tissue at coeliac artery
- 2. Fibromuscular (non striated) band from region of coeliac artery to duodenojejunal junction and 3th & 4th parts of duodenum

## DUODENUM - HISTOLOGY



Note: Mucosa is thrown into folds called plicae circulares or valvulae conniventes

#### SMALL INTESTINE

- Average length 6 metres (24 feet)
- Range 3-10 metres (10-33 feet)
- Patients can survive with 2/3 removed. Little if any effect by removing 1/3

#### **JEJUNUM**

ILEUM

General

2/5, red, wide bore, thick wall

3/5, pink, narrow bore, thin wall,

Macroscopic

Valvulae conniventes, plicae circulares ++, sparce arcades

Smooth wall, Peyer's patches, multiple arcades



\*\*\*

Mesentery

Lies superiorly, attached to left of aorta, less fat Lies inferiorly, attached to right of aorta, fatty mesentery

Histology

Tall villi Long crypts Short villi Short crypts





Note: At base of crypts are Paneth cells that produce lysozyme

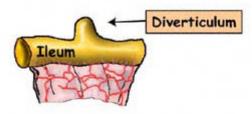
#### MECKEL'S DIVERTICULUM SMALL BOWEL MESENTERY SMALL BOWEL SECRETIONS

#### MECKEL'S DIVERTICULUM

Said to be present in 2-3% of people, 2-3 inches" long and 2-3 feet from the ileocaecal valve but these statements are probably only 2/3 true!

May contain gastric, pancreatic, liver, carcinoid or lymph tissue May attach to umbilicus via a vitello-intestinal tract which may or may not leak but may cause intestinal obstruction as a volvulus can wrap around it

Symptoms very similar to appendicitis Lies on antemesenteric border of ileum



#### ORIGIN OF SMALL BOWEL MESENTERY

6 inches (15cm) long
Starts at the duodenojejunal junction, just to left of L2
vertebra and extends down and to the right to reach the
right sacro-iliac joint at S2 sacral level
Contains superior mesenteric vessels, lymphatics and
autonomic nerves

#### SECRETIONS FROM SMALL BOWEL

Mucus, lysozyme, secretin, somatostatin, cholecystokinase, serotonin and endomorphin

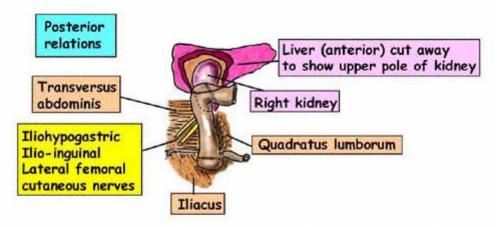
### LARGE BOWEL - GENERAL

- Approximately 5 foot (1.4m)
- Partially retroperitoneal (see individual segments of bowel)
- Outer longitudinal muscle in three flat bands Taenia Coli
- Taenia only in colon and caecum not in rectum or appendix
- As taenia are shorter than the bowel they cause inner haustrations called Valvulae Conniventes
- Inner circular muscle
- Appendices epiplociae are little tags of fat at the bowel/ mesentery border - not in appendix, caecum or rectum
- Crypts with goblet cells but no villi
- Lymphatics: Alongside superior/inferior mesenteric vessels to para-aortics to coeliac and on upwards
- Nerves: Parasympathetic vagus to 2/3 along transverse colon then 52,3,4 to rest of bowel. With sympathetics T10-L2 for vasoconstriction and pain. Note some pelvic organ pain is with parasympathetics

#### ASCENDING AND TRANSVERSE COLON

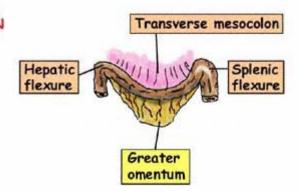
#### ASCENDING COLON

- 15cm (6")
- From ileocaecal valve to hepatic flexure
- Retroperitoneal
- · Anterior: Coils of small bowel & omentum



#### TRANSVERSE COLON

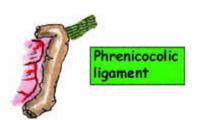
- 45cm (18")
- Between hepatic and splenic flexures
- · Fixed at both ends
- Hangs on transverse mesocolon



#### DESCENDING AND SIGMOID COLON

#### DESCENDING COLON

- 30cm (9-12")
- From splenic flexure to brim of pelvis
- Retroperitoneal
- · Appendices epiploicae ++
- · Lies on psoas, iliacus, transversus abdominis, quadratus lumborum
- Posterior relations
  - Left subcostal artery/vein/nerve
  - · Iliohypogastric nerve
  - · Ilio-inguinal nerve
  - · Lateral femoral cutaneous nerve
  - · Genitofemoral nerve
  - Gonadal artery/vein
  - · External iliac artery/vein



#### SIGMOID COLON

- 15-45cm (5-30")
- From pelvic brim to S3 midline
- · On mesentery
- · Appendices epiploicae +++
- Taenia become progressively more as a longitudinal coat

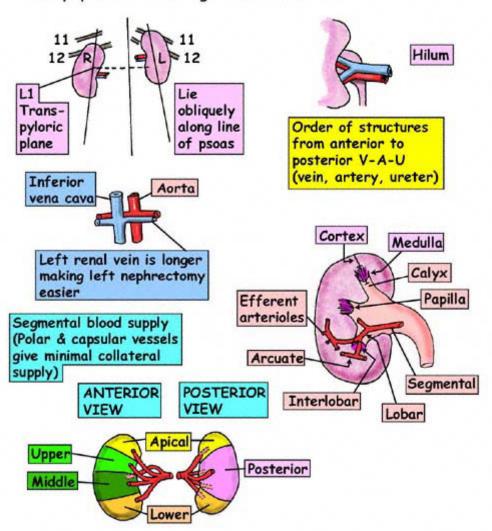


Sigmoid colon is excised to expose the base of its mesentery which crosses:

- · Common iliac artery bifurcation
- · Left ureter
- left sacro-iliac joint

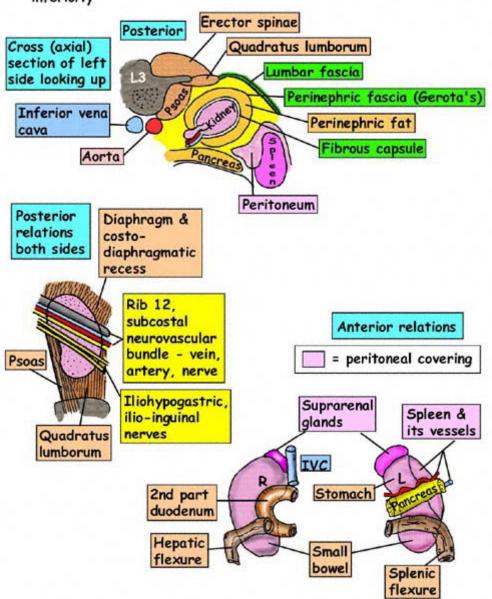
#### KIDNEYS - GENERAL

- 120g each, 11x6x4cm, 1200ml blood/minute
- Retroperitoneal, move 2.5cm on respiration
- Pelvis faces medially/anterior
- 1 million nephrons/kidney
- Lymphatics to para-aortics
- Sympathetic from T12-L1 for vasoconstriction & pain
- · Parasympathetics from vagus. Function unknown



#### KIDNEY - RELATIONS

Note: The perirenal fascia is attached around the renal pelvis but is open below so that pus or extravasated urine can track inferiorly



#### SUPRARENAL (ADRENAL) GLANDS

Medulla: Neural ectoderm

· Cortex: Mesoderm

• Lie: Outsdie Gerota's fascia

· Colour: Yellowy/brown

• Arteries: Suprarenal direct from aorta, Branches of inferior

phrenic and renal

· Veins: Right short to inferior vena cava, left to renal

Shape: Right pyramidal (hat-shaped)
 Left crescentic (cap-shaped)

#### RELATIONS

Anterior: Right lobe of liver

Inferior vana cava

Posterior: Right crus of

diaphragm

Anterior: Lesser sac

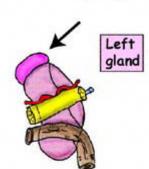
Stomach

Posterior: Left crus of

diaphragm







Medial: Coeliac ganglia Inferior phrenic arteries

Note: The short length of the right suprarenal vein can make it difficult to ligate it at surgery.

The right gland is tucked up under the inferior vena cava

#### URETER

25cm long

Kidney to bladder

 Posterior: Psoas, genitofemoral nerve sacroiliac joint, common iliac artery bifurcation

 Anterior: Right- Duodenum, right gonadal artery, right colic artery, ileal mesentery, superior mesenteric artery Left- Left gonadal artery, left colic artery, sigmoid mesentery

· Passing under it: Vas, uterine artery

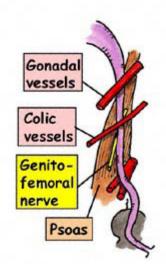
• Related to it: Lateral fornix in female

 Blood supply: Renal, gonadal, common iliac, vesical, vaginal & occasional small branches from aorta

Nerves: Autonomic

Points of potential hold up:

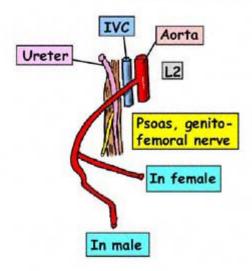
Pelviureteric junction, pelvic brim, ureterovesical junction



#### It is recognisable as it:

- Is the most superficial structure in the pelvis
- Shows peristalsis
- Sticks to the posterior surface of the peritoneum
- Passes around the pelvic brim to 1cm short of the ischial spine the swings medially.
- Enters the bladder at the level of the pubic tubercle on a plain abdominal X-ray

#### GONADAL VESSELS



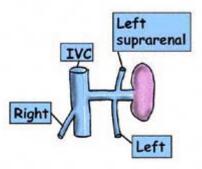
#### IN MALE

Gonadal artery crosses pelvic brim 1/2 way between sacro-iliac joint and inguinal ligament to reach the deep inguinal ring

#### IN FEMALE

Gonadal artery enters suspensory ligament of ovary at pelvic brim

#### GONADAL VEINS



#### VARICOCELE

Distension of the pampiniform plexus of veins above the testis occurs because of retrograde filling back down the left testicular vein. It is secondary to incompetence of the valve where the testicular vein joins the left renal vein, perhaps due to the angle of entry. Sigmoid colic pressure, adrenal products entering the vein or a renal tumour may all make a varicocele worse

#### BLADDER - GENERAL

 Epithelium: Transitional - Rubbery, watertight, lax, stretchy no glands

· Muscle: Whorls of smooth muscle - detrusor

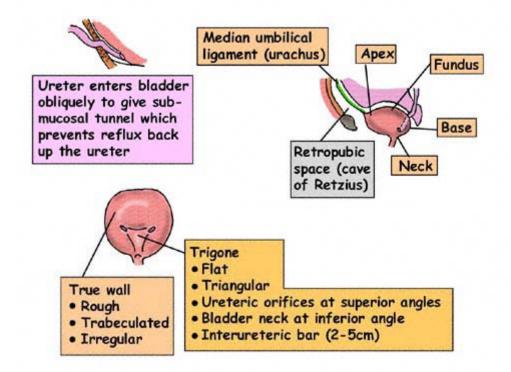
3 layers- Inner & outer longitudinal, middle circular

 Arteries: Superior/inferior vesical, obturator, inferior gluteal, uterine, vaginal

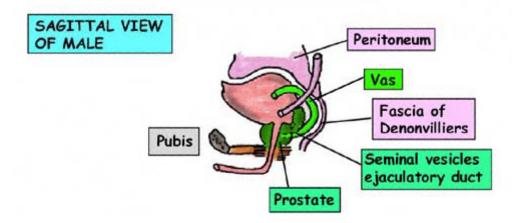
Veins: Converge to vesicoprostatic plexus in males
 Converge to plexus at base of broad ligament in female
 Then to internal iliac

· Lymphatics: Internal & external nodes

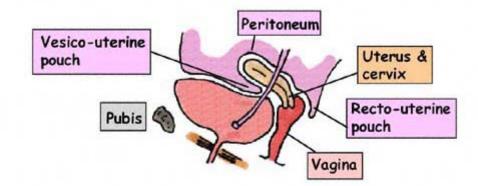
 Nerves: Sympathetic (male only at bladder neck) closes bladder neck at ejaculation. Inhibitory, vasomotor, pain in both sexes
 Parasympathetic - motor to detrusor, sensory for full bladder, some pain, autonomic stretch reflex in infants, later modified by cortical inhibition



## BLADDER - RELATIONS



# SAGITTAL VIEW OF FEMALE



## PROSTATE - GENERAL

Produces 30% of ejaculate volume

Pyramidal, size of a chestnut (2x3x4cm)

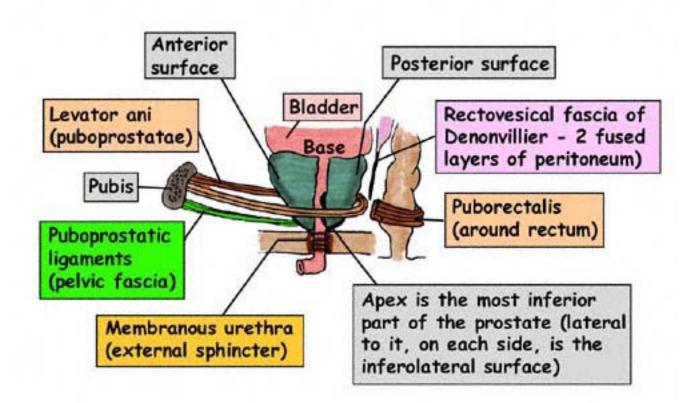
Has a posterior groove

· Apex on pelvic floor, base above

• Arteries: Inferior vesical, middle rectal, +/- pudendal

Veins: Plexus around sides & base of gland to internal iliac

 Nerves: Sympathetic for ejaculation & smooth muscle contraction Parasympathetic for erection & secretomotor of acini

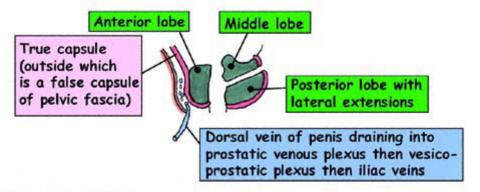


#### PROSTATE - LOBES

There are two ways of viewing the lobes of the prostate Old surgical view:

Anterior lobe Middle lobe

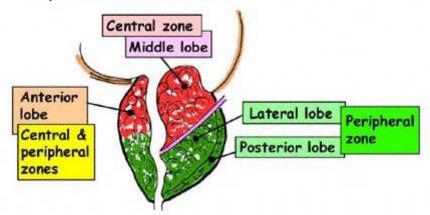
Posterior lobe (lateral extensions of which gave lateral lobes which were only significant if the prostate was hypertrophied)



#### Modern zonal view:

Now the lobes are arranged in zones

- A central zone, above the ejaculatory duct, with a middle lobe and part of the anterior lobe
- A peripheral zone, below the ejaculatory duct with posterior and lateral lobes



#### PROSTATE - DEVELOPMENT

Endodermal outpouch of glands from urethral part of the orogenital sinus. Firbromuscular stroma forms from the surrounding mesenchyme. Female equivalent is paraurethral glands.

Between 13-15 weeks the cords develop a lumen and glandular acini under the influence of high levels of dihydrotestosterone. The tissue is invaded by blood vessels and autonomic nerves

Bulbo-urethral glands develop in deep perineal pouch by lateral budding from urethra

At 16 weeks there is the classical layering of ducts into mucosal (periurethral) opening directly into urethra (1). Plus short ducts from submucosal glands, also in central zone (2). In peripheral zone are main prostatic ducts from paraurethral glands (3).

Muscle

Capsule

Median
sulcus

Inner (central) zone - glands develop later

Vas

Vesicle

Outer (peripheral) zone – glands develop here first, mostly lateral

Posterior prostatic urethral wall

Verumontanum

Urethral crest

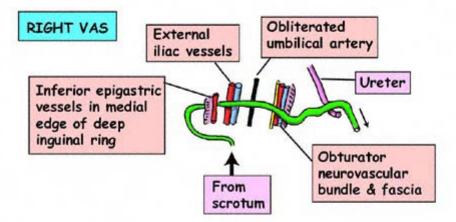
Ejaculatory ducts

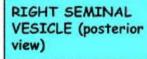
Prostatic ducts

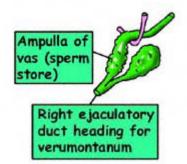
Prostatic utricle (utriculus masculinis - Mullerian)

#### VAS & SEMINAL VESICLE

- 45cm (18") long (as is femur, thoracic duct, spinal cord, transverse colon & teeth to cardia of stomach!!)
- · Artery: Superior (or inferior) vesical artery
- Nerve: Sympathetic for motor activity
- · Origin: Mesonephric duct
- Course: Nothing lies between vas and peritoneum in pelvis



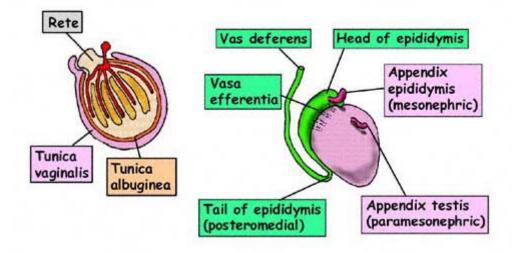




- 70% of ejaculate
- · Does not hold sperm
- · Thin walled sac
- · Covered by Denonvillier's fascia
- Artery: Vesical and middle rectal
- Origin: Mesonephric duct
- Nerve: Sympathetic from L1
- Muscle: Outer longitudinal, inner circular

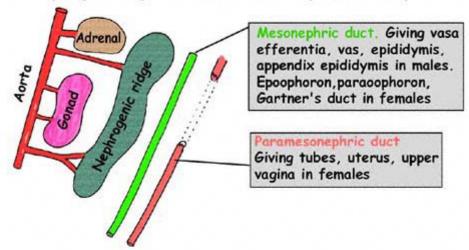
# TESTIS

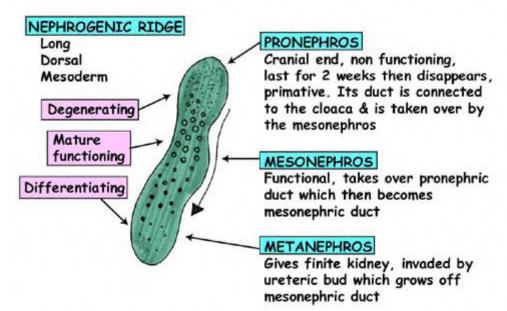
- 400 spaces divided by fibrous septa
- Each contains 2-4 convoluted seminiferous tubules
- Tubules are 60cm long & drain to 15-20 vasa efferentia which drain to the epididymis and then to vas deferens
- Complete cycle of production takes 64-70 days
- · Left testis lies slight lower than right
- Coverings: Skin, dartos (with sympathetic supply), Colles fascia, external spermatic fascia, cremasteric fascia, internal spermatic fascia, tunica vaginalis
- Blood supply: Testicular artery, cremasteric/vas artery
- Venous drainage: Pampiniform plexus to testicular vein
- Lymph: Para-aortic nodes
- Nerve: Sympathetic (greater/lesser splanchnics) via coeliac ganglia. No parasympathetics
- Cells: Interstitial (Leydig) for hormones
   Sertoli for support and Mullerian Inhibiting Substance
   Germ cells for spermatogonia, primary spermatocytes,
   meiosis, secondary spermatocytes, spermatids, sperm



# GENITOURINARY SYSTEM DEVELOPMENT - 1

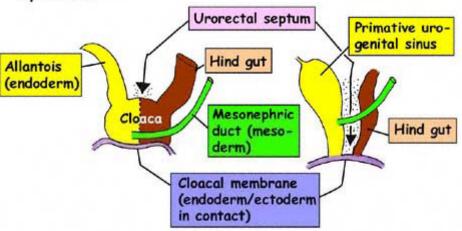
Left urogenital ridge giving
Genital ridge from which the gonad develops
Nephrogenic ridge from which the urinary tract develops





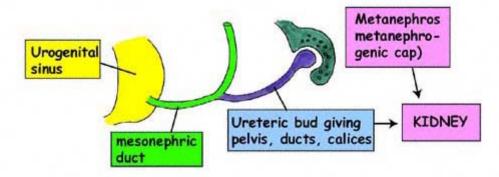
# GENITOURINARY SYSTEM DEVELOPMENT - 2

The CLOACA is a structure common to both the alimentary and the urogenital systems. It is split coronally by the urorectal septum to give the rectum posteriorly and the primative urogenital sinus anteriorly, starting at 4 weeks and finishing by 6 weeks



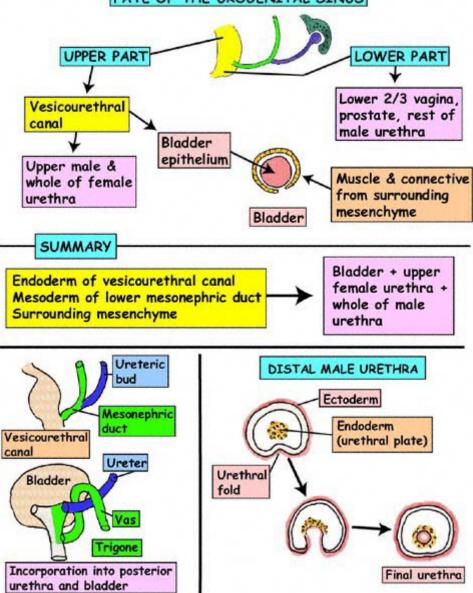
### URETER & KIDNEY DEVELOPMENT

From the mesonephric duct, the ureteric bud grows upwards to fuse with the metanephros (the metanephrogenic cap). Together The metanephros and the ureteric bud give the finite kidney. The bud gives the renal pelvis, collecting ducts and calices. The metanephrogenic cap gives the renal substance



# GENITOURINARY SYSTEM DEVELOPMENT - 3

## FATE OF THE UROGENITAL SINUS



## UTERUS - GENERAL

- Pear shaped
- Usually anteverted to 90 degrees & anteflexed to 170 degrees
- Has no submucosa
- Histology Cervix: Tall columnar epithelium becoming squamous outside, alkaline mucus

Rest of uterus: Endometrium with glands, arterioles, smooth whorls of muscle, columnar epithelium

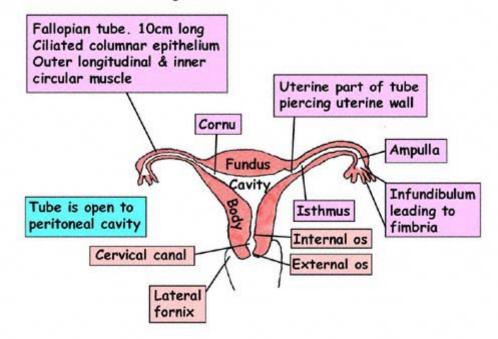
Nerves - Motor: Parasympathetic activate muscle

Sympathetic relax muscle. Both from pelvic plexus

Sensory: Parasympathetic for cervix Sympathetic for uterus

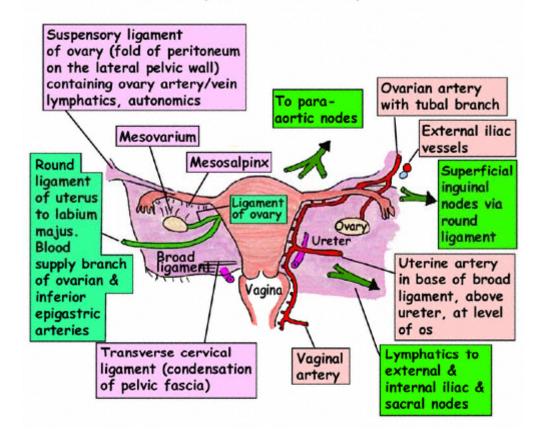
- Blood supply (see broad ligament)
- Venous drainage: Highly plexiform to vesical and rectal plexuses
   Relations: Anterior- vesicouterine pouch, posterior/superior bladder anterior fornix, small bowel

Posterior- Pouch of Douglas, ileum, sigmoid Lateral- Uterine vessels, ureter, lateral fornix, broad ligament



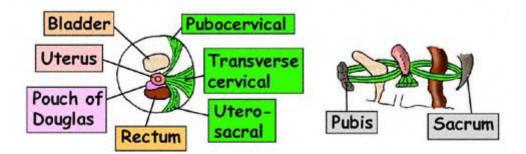
## UTERUS - BROAD LIGAMENT

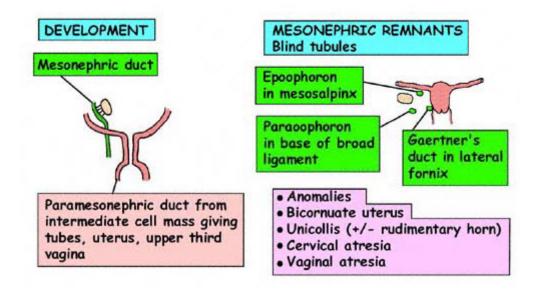
- Double layer of peritoneum draped over uterus and tubes
- Distal ends of tubes stick out of posterior layer of it and lie free
- Between two layers are arteries and veins, round ligament, ligament of ovary, lymphatics. The ovary is partially covered by a separate posterior fold of the broad ligament (mesovarium) but the surface of the ovary is devoid of peritoneum to allow exit of the ova.
- The tubes lie in the upper edge of the broad ligament which is termed the mesosalpinx
- The ureters pass through the base of the broad ligament in close relationship to the uterine artery



## UTERUS - SUPPORTS & DEVELOPMENT

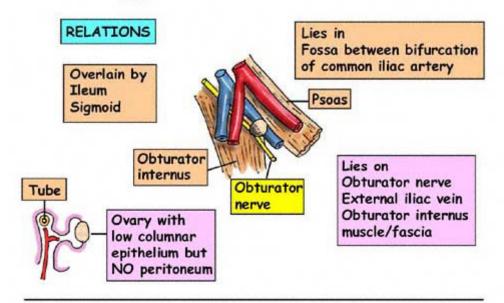
- · Supports are condensations of fascia known as parametrium
- Suspensory ligament of ovary, round ligament & broad ligament are NOT supportive
- · Ligaments:
  - LATERAL: Transverse cervical (cardinal, Mackenrodt's)
  - POSTERIOR: Uterosacral
     ANTERIOR: Pubocervical
- Muscles: Pubovaginalis 7 puborectalis are part of levator ani Perineal body and urogenital diaphragm





# OVARY

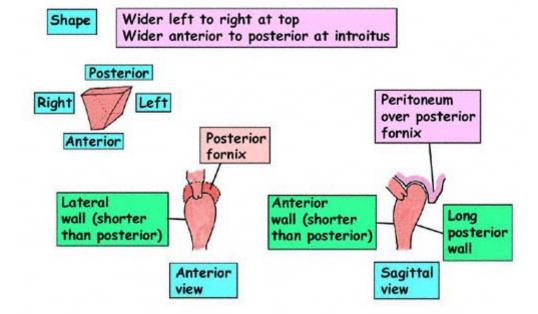
- Almond shaped cm x 2cm
- Attached to posterior aspect of broad ligament by mesovarium
- · Attached to uterus by ligament of ovary
- Attached to lateral pelvic wall by suspensory ligament of ovary
- · Artery: Ovarian from aorta at L2
- · Vein: Left to left renal. Right to inferior vena cava
- Lymphatics: Para-aortics. (Inguinal via round ligament & opposite ovary in disease
- Nerves: Sympathetic fom aortic plexus. Vasoconstriction & pain Parasympathetics from pelvic plexus (?? vasodilatory & sensory but activity not known)
- Development: Intermediate cell mass of genital ridge. Mesonephric remnants are epoophoron, paroophoron, Gaertner's duct



Oogonia (primative germ cells) give primary oocytes. Add single layer of granulosa cells to give primary follicle. Add more layers to give secondary follicle (6 million of these by 5 months interuterine, one million at birth, 40,000 at puberty). At maturation these secondary follicles give ovarian follicle. With meiosis these give secondary a oocyte (ovum)

# VAGINA - GENERAL

- 10cm long
- Potential space apart from posterior fornix which is real space
- Fornices: Anterior, lateral & posterior
- Artery: Vaginal branch of uterine, middle rectal, inferior vesical gives vaginal
- Veins: Pelvic floor plexus to internal iliac
- Nerves: Sympathetic from pelvic plexus for vasoconstriction, smooth muscle action, stretch sensation
   Somatic - perineal branches of pudendal, ilio-inguinal at anterior introitus
- Lymphatics: External/internal iliac, sacral, superficial inguinal below hymen
- Support: levator ani (pubovaginalis) & perineal body
- Structure: Non keratinising stratified squamous epithelium, smooth muscle, sweat glands, no mucous glands
- Development: Upper third from paramesonephric ducts Lower third from urogenital sinus



# VAGINA - RELATIONS

## ANTERIOR

- Bladder
- Urethra



## POSTERIOR

- Pouch of Douglas
- Ampulla of rectum
- · Perineal body
- · Anal canal

## LATERAL

- Ureter
- Uterine artery
- Levator ani
- Urogenital diaphragm

## VESTIBULE OF VAGINA

Greater vestibular glands



# Deep perineal pouch

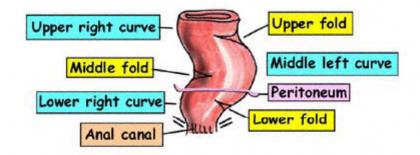
Superficial pouch containing:

- Hymen
- Greater vestibular glands (Bartholin's glands)

Interrupted line gives site of hymen

# RECTUM - GENERAL

- 12cm long
- Starts at S3, ends at puborectalis (pelvic floor)
- No appendices epiploicae, no sacculations, no mesentery
- 3 folds of mucosa & circular muscle = Valves of Houston.
   2 on left, 1 on right
- · Peritoneum:
  - Upper 4cm front and sides
  - Middle 4cm front only
  - Lower 4cm beneath peritoneum of pelvic floor
- Muscle: Wide bands of longitudinal muscle anterior & posterior becoming a fibrous layer within the sphincters Circular muscle complete but thickened below as internal sphincter
- Nerves: Sympathetic contract smooth muscle sphincters, relax bowel, transmit pain
   Parasympathetic - Relax smooth muscle sphincters, contract bowel, transmit feeling of fullness
- Lower third empty except during defaecation. Can distend laterally into ischio-anal fossae
- Upper two thirds distensible into abdominal cavity & can store faeces in constipation



## RECTUM - VESSELS/LYMPHATICS

Blood supply: Superior rectal artery from inferior mesenteric

Middle rectal artery from internal iliac. May be small

Inferior rectal artery from internal pudendal

Median sacral may contribute All arteries supply all layers

· Venous drainage: Superior rectal vein to inferior mesenteric which

is portal. Middle rectal to internal iliac (systemic) Inferior rectal to internal pudendal to internal

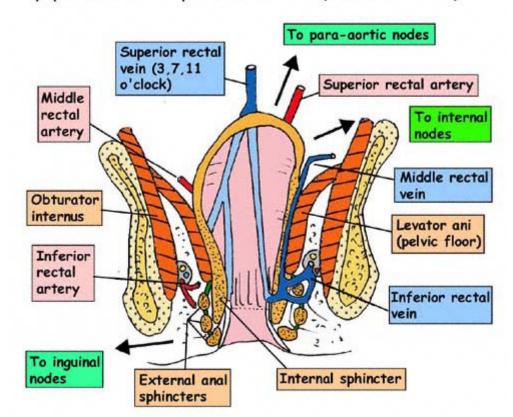
iliac (systemic)

Portosystemic
 In upper anal canal where internal & external

anastomosis venous plexuses meet. Superior rectal vein (portal)

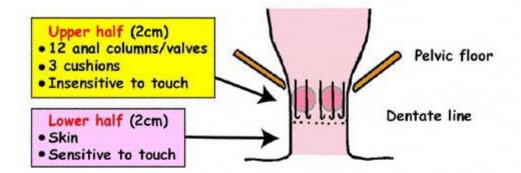
meet middle/inferior (systemic)

Lymphatics: Follow deep veins and arteries (black arrows below)



# ANAL CANAL - GENERAL

- · 4cm long, from pelvic floor (puborectalis) to outside
- Two distinct halves of 2cm separated by dentate (pectinate) line





3 spongy mucosal cushions in upper half, level with venous plexuses at 3, 7 & 11 o'clock. Contain arterial & venous blood. Help with continence, air tightness & mucus production. Enlargement leads to haemorrhoids (piles)

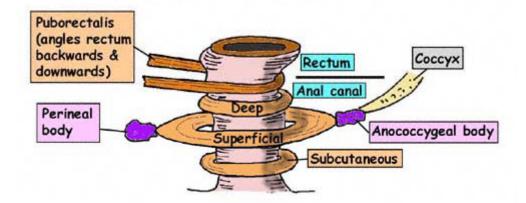
## UPPER HALF

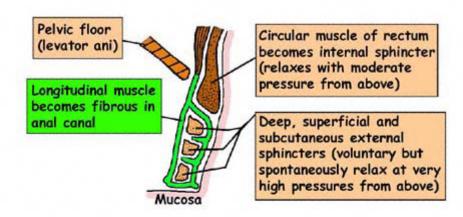
- Endoderm origin
- Columnar mucosa
- Columns, valves & cushions
- · Autonomic nerves
- Mainly superior rectal artery
- Portal venous drainage
- Para-aortic lymph nodes
- Adenocarcinoma
- · Site of haemorrhoids

## LOWER HALF

- Ectoderm origin
- Squamous mucosa
- Skin
- Somatic nerves
- Mainly inferior rectal artery
- Systemic venous drainage
- Superficial inguinal nodes
- Squamous carcinoma
- No haemorrhoids

## ANAL CANAL - SPHINCTERS





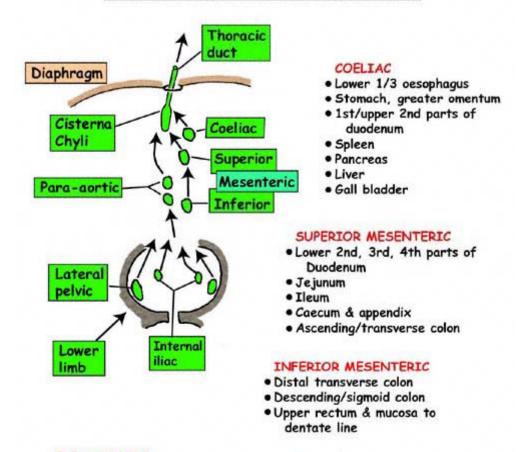
### CONTINENCE

Internal sphincter (involuntary)
External sphincter (voluntary)
Recto-anal angle (puborectalis)
Anal cushions & mucosal folds
Abdominal pressure on upper
anterior part of lower rectum

#### NOTE:

Incontinence can be due to overflow around impacted faeces in constipation

# ABDOMINOPELVIC LYMPHATICS



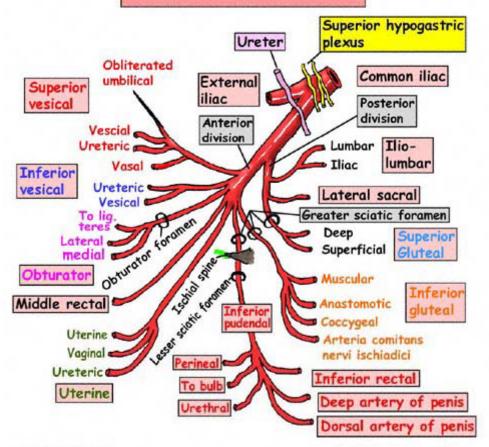
#### PARA-AORTIC

- Inferior surface diaphragm
- Bare area of liver
- Suprarenal glands
- Kidneys & ureters
- Gonads (+ tube in female)
- Superior/lateral uterus
- Posterior abdominal wall

#### LATERAL PELVIC

- · Lower rectum & dentate line
- Bladder
- Urethra
- Lower ureter
- Uterus, cervix, upper vagina, clitoris, labia minora (female)
- Vas, seminal vesicles, prostate, bulk of penis (male)

# INTERNAL ILIAC ARTERY



#### ILIOLUMBAR

Passes laterally, behind obturator nerve & psoas. Lumbar branch to psoas, quadratus lumborum & spine. Iliac branch to iliacus, iliac bone, anastomosis at anterior superior iliac spine

### LATERAL SACRAL

Passes inferiorly, lateral to anterior sacral foramina, anterior to roots to piriformis, spine (meninges, roots) & muscles on posterior sacrum

### ARTERY TO VAS

Usually off superior vesical (or inferior vesical)

#### UTERINE ARTERY

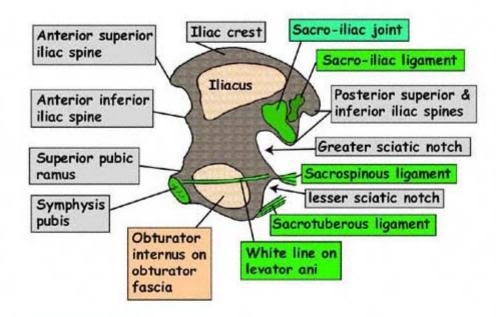
In female it replaces inferior vesical (or middle rectal)

# LUMBAR PLEXUS

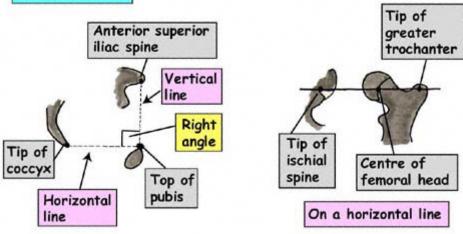
L1,2,3,4,5

See peripheral nerve section of Instant Anatomy for full details

# PELVIC BONES - GENERAL & ORIENTATION

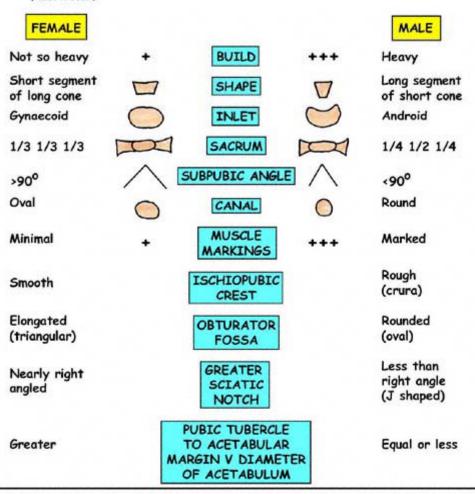






## PELVIC BONES - SEX DIFFERENCES

Looking at the pelvic bones it should be possible to tell whether they come from a male or a female. Many of the pointers here will be helpful. Remember that the purpose of bones is to give form, provide muscle attachments, give protection, provide movement and they also have metabolic functions.



OUTLET: From coccyx to inferior border of symphysis pubis
INLET: From promontary ot sacrum to superior border of
symphysis pubis

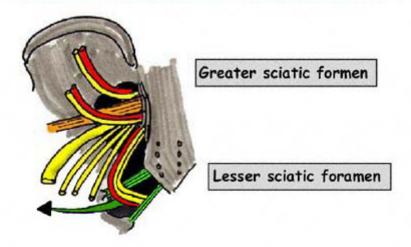
# SACRAL PLEXUS

L4,5,51,2,3,4,5

On piriformis and covered by parietal pelvic fascia

See peripheral nerve section of Instant Anatomy for full details

# SCIATIC FORAMINA STRUCTURES ENTERING & LEAVING



## LEAVING GREATER SCIATIC FORAMEN

- Superior gluteal nerve (L4,5,S1) & vessels
- Piriformis muscle (S1,2)
- Inferior gluteal nerve (L5,S1,2) & vessels
- Sciatic nerve (L4,5,51,2,3)
- Posterior femoral cutaneous nerve (\$1,2,3)
- Perforating cutaneous nerve (\$2,3)
- Nerve to quadratus femoris (L4,5,S1)
- Nerve to obturator internus ((L5,S1,2)
- Pudendal nerve (52,3,4)
- Internal pudendal artery

## ENTERING LESSER SCIATIC FORAMEN

- Internal pudendal artery
- Pudendal nerve
- Nerve to obturator internus

# EXITING LESSER SCIATIC FORAMEN

- Tendon of obturator internus
- Internal pudendal vein

# BRANCHES FROM THE SACRAL ROOTS OF THE SACRAL PLEXUS

There are 6 branches from the sacral roots before they divide into anterior and posterior divisions. They all begin with the letter "P"

#### 6 BRANCHES OF THE SACRAL ROOTS

- Nerve to piriformis (\$1,2)
- Perforating cutaneous nerve (52,3)
   (perforates sacrotuberous ligament)
- Posterior femoral cutaneous nerve (\$1,2,3)
- Pudendal nerve (52,3,4)
- Perineal branch of 54 (to levator ani)
- Pelvic splanchnics (52,3,4)

Parasympathetic motor to bladder, hind gut, erection. Sensory for distension & pain of bladder, lower uterus, lower colon & rectum

# FROM ANTERIOR DIVISONS

- Nerve to quadratus femoris (L4,5,51)
- Nerve to obturator internus (L5,S1,2)
- Tibial portion of sciatic nerve (L4,5,51,2,3)

# FROM POSTERIOR DIVISIONS

- Superior gluteal (L4,5,51)
- Inferior gluteal (L5,S1,2)
- Common peroneal portion of sciatic nerve (L4,5,S1,2)

## POSTERIOR ABDOMINAL WALL

- 5 vertebrae
- Transverse process of L3 is largest
- · Transverse process of L5 is conical

#### PSOAS MAJOR

Origin: Intervertebral discs T12/L1 to L4/5

Bodies of L1-5, transverse processes L1-5

Inserts: Lesser trochanter

Nerve: L1,2,3 Action: Flexes hip

#### PSOAS MINOR

Origin: Bodies T12,L1

Inserts: Fascia over psoas major

behind inguinal ligament

Nerve: L1

Action: Weak spine flexor

## QUADRATUS LUMBORUM

Origin: Transveerse process L5

Iliolumbar ligament & posterior 1/3 iliac crest

Inserts: Medial 1/2 12th rib 8

transverse process L1-4

Nerve: T12-L4

Action: Holds down 12th rib

### ILIACUS

Origin: Hollow of iliac fossa

Inserts: Psoas tendon &

below lesser trochanter

Quadratus

lumborum

Action: Flexes hip

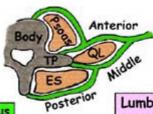
Nerve: Femoral (L2,3,4)

## LAYERS OF THORACOLUMBAR FASCIA

TP= Transverse process

ES= Erector spinae QL= Quadratus lumborus

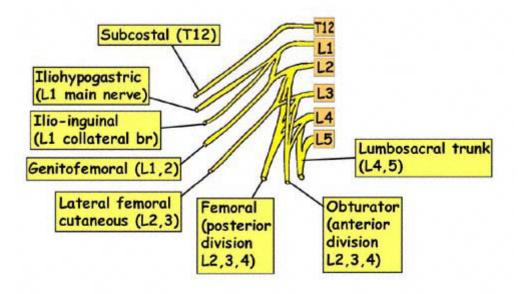
Spine/supraspinous ligaments

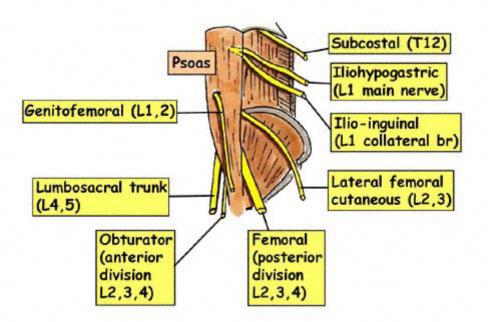


Attachment of transversus & internal oblique

Lumbar regions all 3 layers are present, thoracic region has posterior layer only

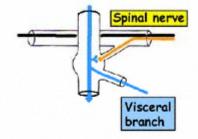
# LUMBAR PLEXUS - TOPOGRAPHICAL

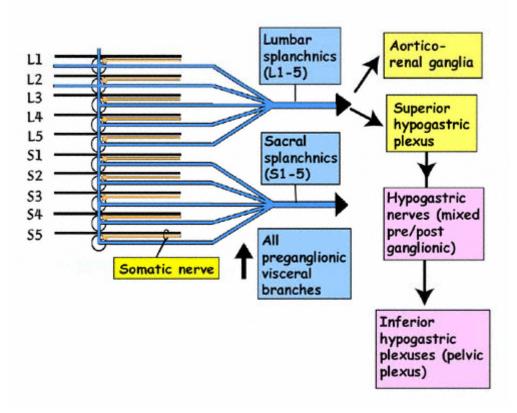




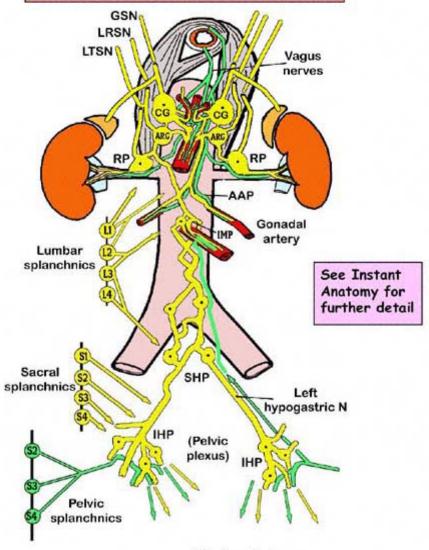
# LUMBOSACRAL SYMPATHETICS

Lumbar & sacral splanchnic nerves leave the sympathetic chain ganglia as preganglionic fibres. They do not synapse if they are destined to go to the gut. They synapse later in the hypogastric and pelvic plexuses





# ABDOMINOPELVIC AUTONOMICS



GSN: Greater splanchnic nerve LRSN: Lesser splanchnic nerve

LTSN: Least splanchnic nerve

CG: Coeliac ganglion

ARG: Aorticorenal ganglion

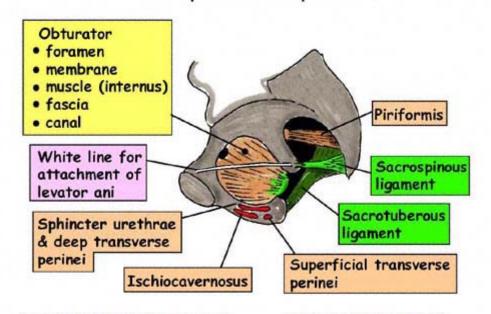
RP: Renal plexus

SRP: Suprarenal plexus

AAP: Abdominal aortic plexus IMP: Inferior mesenteric plexus SHP: Superior hypogastric plexus IHP: Inferior hypogastric plexus

# PELVIS - GENERAL

- True pelvis is below pelvic brim
- · False pelvis is above pelvic brim

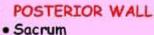


## LATERAL WALL

- · Ilium, ischium, pubis
- Obturator membrane & internus muscle
- · Sacrotuberous & sacrospinous ligaments
- · Pelvic fascia
- · Piriformis

## ANTERIOR WALL

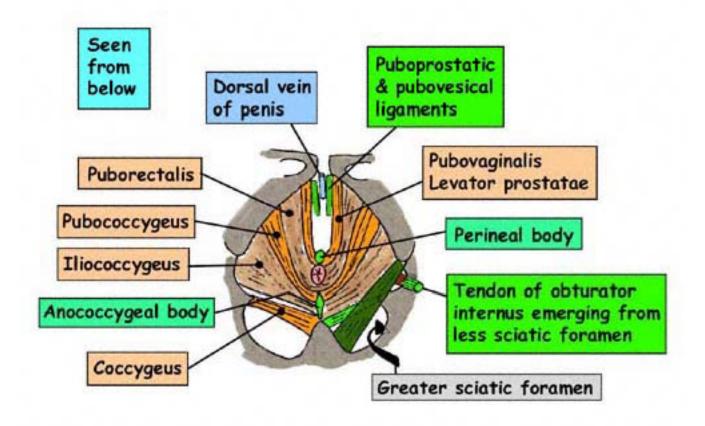
- Symphysis pubis
- · Body of pubis
- · Pubic rami



- Coccyx
- · Piriformis
- Sacral plexus
- Sacralfascia

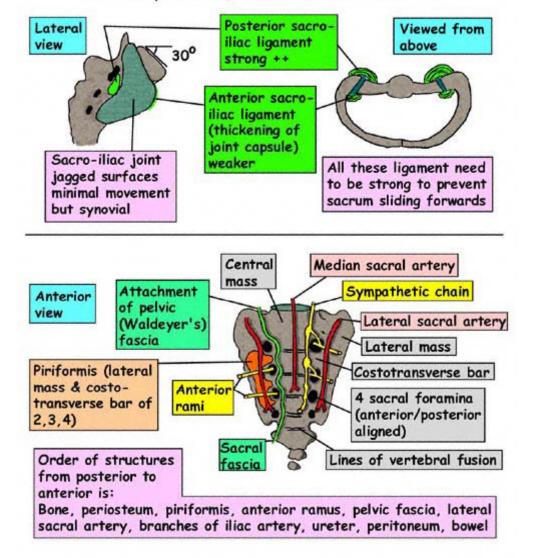
# PELVIC FLOOR

- Covered superiorly and inferiorly with fascia (epimysium)
- Nerve supply for levator ani is perineal branch of S4. S5 for coccygeus

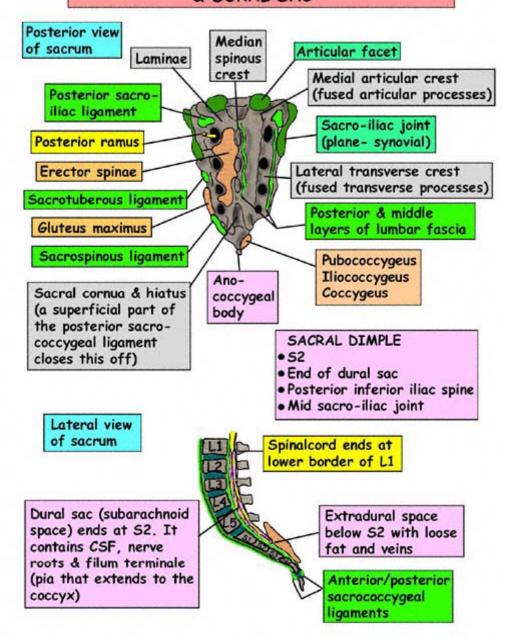


# SACRUM - GENERAL & SACRO-ILIAC JOINT

- 5 fused vertebrae (may be 6 or 7)
- · L5 may be sacralised
- Spinabifida occulta common
- Iliolumbar ligament from iliac crest to tip of 5th lumbar transverse process. Quadratus lumborum arises from it

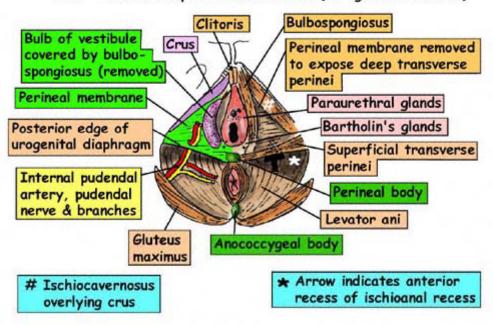


# SACRUM - POSTERIOR ATTACHMENTS & DURAL SAC



# FEMALE PERINEUM - GENERAL

- The perineum is that part of the trunk distal to the pelvic diaphragm
- 2 triangles lying at nearly a right angle to each other
   Urogenital covered in below with urogenital diaphragm
   Anal covered only with skin & fascia (+/- gluteus maximus)



## Greater vestibular glands (Bartholin)

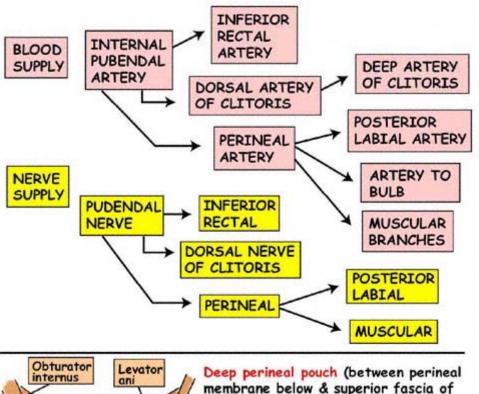
Round (<1cm) glands at 4 & 8 o'clock behind bulb. 2cm duct into posterolateral vaginal orifice. In superficial perineal pouch. Homologues of Cowper's glands in males. Cysts & infection possible Paraurethral glands (Skene)

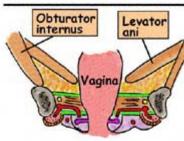
Mucous glands opening just inside urethra. Homologue of prostate Lesser vestibular glands

Not shown. Multiple small mucous glands opening between vagina & urethra

Labia majora - joined back & front by anterior & posterior commissures. Round ligament of uterus ends in front of each. labia minora give clitoral prepuce. Clitoris - 2 small corpora cavernosa. Bulb - spongy erectile tissue in labia minora

# FEMALE PERINEUM VESSELS AND POUCHES





Coronal section

of vagina

through urogenital

diaphragm at level

membrane below & superior fascia of urogenital diaphragm above)

- Vagina
  - Deep tranverse perinei
- Urethra
- · Dorsal nerve of clitoris
- Sphincter Dorsal/deep clitoral arteries urethrae

## Superficial perineal pouch

(everything below perineal membrane)

- · 2 crura & ischiocavernosus
- · Bulb & bulbospongiosus
- Superficial transverse perinei
- · Perineal body
- Perineal artery/nerve/branches
- Vestibular glands

# ISCHIOANAL (ISCHIORECTAL) FOSSA

· Wedge shaped & filled with fat

· Crossed by inferior rectal nerve & artery

Has Alcock's canal in its lateral wall

• Base: Perineal skin

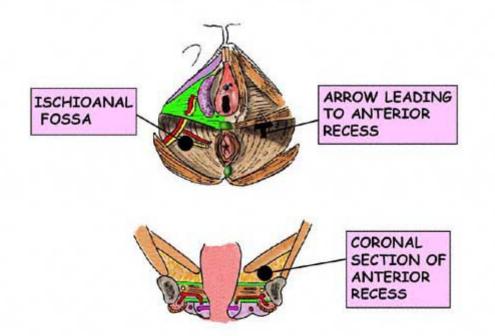
• Medial: Anal canal, levator ani

· Lateral: Ischial tuberosity, obturator internus

· Apex: White line

Anterior: Perineal body, urogenital diaphragm, anterior recess
 Posterior: Posterior recess, gluteus maximus, sacrotuberous ligament, anococcygeal body, horseshoe connection

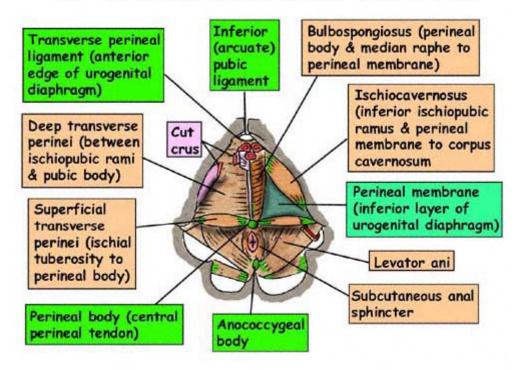
 Contains: Fat, Alcock's (pudendal) canal, internal pudendal artery, pudendal nerve, inferior rectal artery/nerve, perineal branch of S4, perforating cutaneous nerve



# MALE PERINEUM

The perineum is that part of the trunk distal to the pelvic diaphragm

2 triangles lying at nearly a right angle to each other
Urogenital - covered in below with urogenital diaphragm
Anal - covered only with skin & fascia (+/- gluteus maximus)

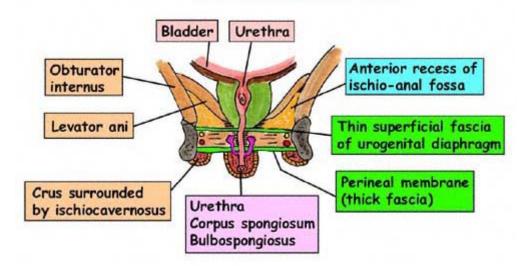


For anterior recess of ischioanal fossa, see female perineum

## MALE PERINEUM - DEEP PERINEAL POUCH

Deep perineal pouch (between perineal membrane below & superior fascia of urogenital diaphragm above). Contains

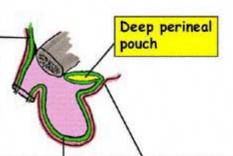
- Membranous urethra
- · Deep transverse perinei
- Sphincter urethrae (external sphinster)
- Bulbourethral glands (Cowper's). They drain into urethra below the perineal membrane
- Internal pudendal vessels
- · Dorsal nerve of penis
- Note that the external sphincter has striated muscle extensions around lower prostatic urethra, above the urogenital diaphragm that are called the intrinsic urethral mechanism



# MALE PERINEUM SUPERFICIAL PERINEAL POUCH

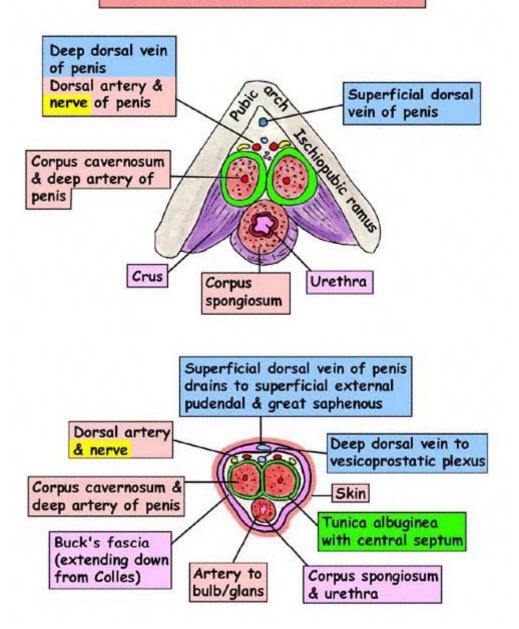
- All perineal structures below the perineal membrane are in the superficial perineal pouch
- 2 crura & 2 ischiocavernosus muscles over them
- Urethra; bulb & corpus spongiosum around it
- Bulbospongiosus muscle
- Superficial transverse perinei muscles
- Perineal body
- · Perineal branches of internal pudendal artery
- Pudendal nerve & branches
- · Colles fascia
- Ducts of Cowper's glands
- Deep & superficial external pudendal arteries
- Spermatic cords, testes, penis
- Dartos muscle (panniculus carnosus)
- Branches of ilio-inguinal and genitofemoral nerves
- Scrotal blood supply: Deep/superficial external pudendal, branches of internal pudendal. Veins to external pudendal
- Nerves to scrotum: Anterior 1/3 ilio-inguinal, posterior 2/3 posterior scrotal branches of perineal & perineal
  branches of posterior femoral cutaneous nerve
- · Lymph: superficial inguinal glands

Scarpa's fascia is fused to the pubis then extends into the scrotum as Colles' fascia and around the penis as buck's fascia



Colles' fascia (superficial perineal fascia) Attached posteriorly to ischiopubic ramus & posterior part of perineal membrane

# PENIS - CORONAL SECTION AT PUBIS AND MORE DISTALLY



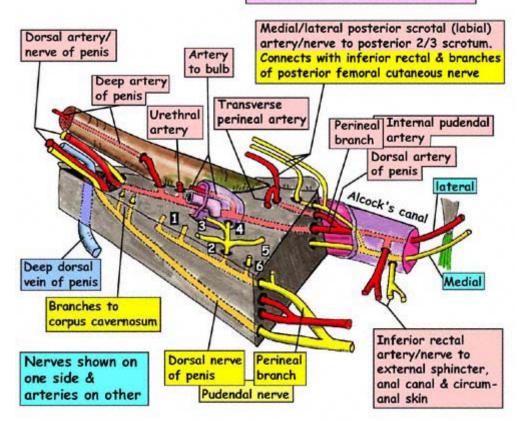
## MALE PERINEUM - VESSELS AND NERVES

This rather complicated diagram below depicts the arrangement of vessels and nerves in the male perineum but it largely applicable to both sexes. The grey wedge represents the urogenital diaphragm seen from below. The small diagram is the key to the larger one to show the orientation



Branches of the perineal nerve

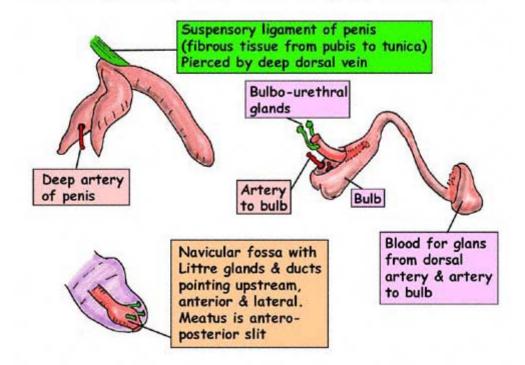
- 1, Deep transverse perinei & external sphincter
- 2. Ischiocavernosus
- 3. Bulbospongiosus
- 4. Sensory to urethra
- 5. Superficial transverse perinei
- 6. Posterior scrotal/labial



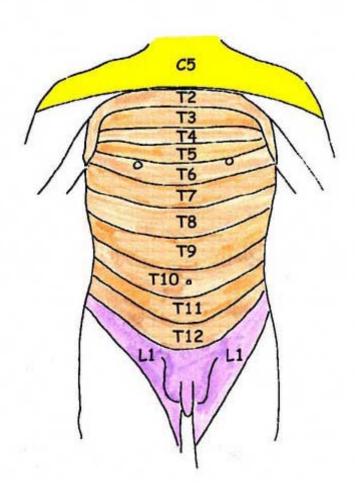
## PENIS - CONSTITUENT PARTS & URETHRA

#### URETHRA

- Prostatic approximately 2.5cm
- Membranous 2cm
- These two together make the posterior urethra
- Bulbous & pendulous make the anterior urethra. Approximately 20cm
- Blood: Artery to bulb to glans & corpus spongiosum
   Deep artery to penis to corpus cavernosum
   Dorsal artery of penis to skin, fascia, glans
   Urethral artery from dorsal artery
- · Veins: Superficial & deep dorsal veins of penis
- Lymph: Skin to superficial inguinal nodes. Glans, corpora, urethra to deep inguinalnodes
- Nerves: Skin & glans from posterior scrotal & dorsal nerve of penis from pudendal. Sympathetics for ejaculation, parasympathetics to corpora for erection.
- Receives: Ejaculatory ducts, bulbourethral glands, urethral glands

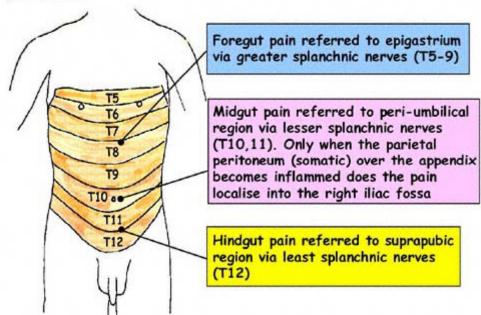


# DERMATOMES OF THORAX AND ABDOMEN



## ABDOMINAL REFERRED PAIN

There are two types of referred pain. The first is detected by visceral sensory fibres travelling with the sympathetics such as bowel irritation, distension or inflammation. This is carried back to the sympathetic chain & spinal cord at the relevant level & referred to the appropriate dermatome. For instance, pain from the foregut (e.g. stomach) is referred to T5-9 dermatome (epigastrium) via the greater splanchnic nerves, small bowel problems to the peri-umbilical region via lesser splanchnic nerves & large bowel to suprapubic region via least splanchnic nerves. Pain is midline as gut is embryologically a midline structure. Kidneys (renal pain) can lateralise as they are not of midline origin. Note that pain from some pelvic organs (e.g. uterus) travels via the parasympathetics (52,3,4) to give backache. A second type of referred pain involves the somatic system only. The best example is irritation of the peritoneum over an inflammed gall bladder which is detected by the phrenic nerve (C3,4,5). The pain is then referred to the shoulder tip via the C4 dermatome, also somatic. It is only because the C4 nerve has two areas of distribution so far away from each other that this type of referred pain occurs.



## HEART - SURFACES & SEPTUM

· Midline in middle mediastinum · Valved muscular pump Size of a fist - 300g · Cone shaped · Surfaces: see figure but Base (posterior) note that base is the posterior surface (left Left atrium atrium) Left surface Left ventricle Anterior surface 2/3rds right ventricle 1/3rd left ventricle Apex (anterior inferior tip) Inferior surface 1/3rd right ventricle 2/3rds left ventricle INTERVENTRICULAR SEPTUM Right Left Superior membraneous part (from AV cushions) 3-5cm 10cm · Bulges to right Inferior muscular · Lies vertically part (from ventricular · In coronal plane

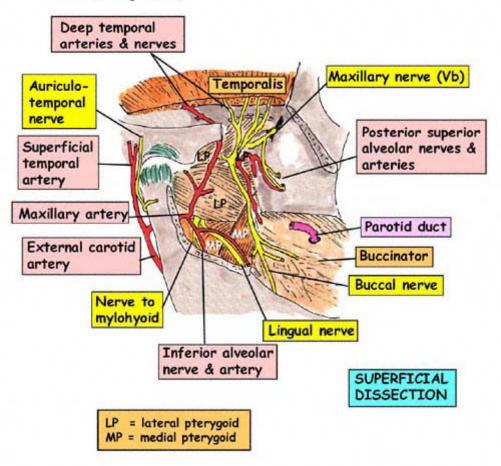
wall)

· Attaches to AV rings

## INFRATEMPORAL FOSSA - CONTENTS

#### CONTENTS

- · Pterygoid muscles
- Fat
- · Insertion of temporalis
- Chorda Tympani
- Posterior superior alveolar branches of Vb (maxillary branch of trigeminal)
- Pterygoid venous plexus
- · Mandibular nerve & branches
- · Otic ganglion
- · Maxillary artery & branches

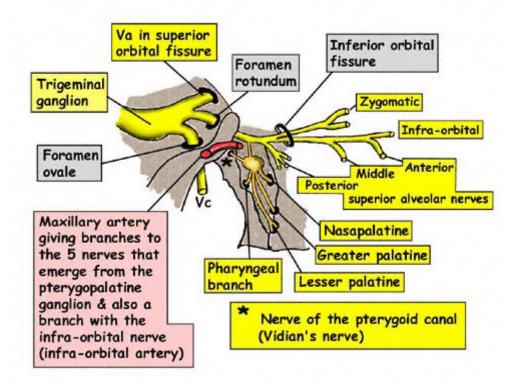


### PTERYGOPALATINE FOSSA 1

Right side of skull cut away to show trigeminal ganglion lying in Meckel's cave and the maxillary division entering the pterygopalatine fossa through foramen rotundum. The nerve of the pterygoid canal is seen entering the pterygopalatine ganglion and connecting to Vb so that sensory fibres can be distributed with the parasympathetic fibres from the ganglion and so that parasympathetics can pass on Vb to be distributed to sinuses and lacrimal gland.

The contents of the pterygopalatine fossa are:

- Terminal branches of the maxillary artery
- · Maxillary nerve (Vb) to upper teeth, floor of orbit, face/skin
- Pterygopalatine ganglion for distribution of parasympathetics to nose and palate



## SOFT PALATE

#### Consists of:

- Aponeurosis
- Tensor veli palatini
- · Levator veli palatini
- Palatoglossus
- · Palatopharyngeus
- Muscles of uvula
- Mucosa
- Mucous & serous glands
- · A few taste buds

Epithelium: Stratified squamous

Blood: Lesser palatine (maxillary) Ascending palatine (facial)

> Palatine branch of ascending pharyngeal (external carotid)

Veins: Pharyngeal & pterygoid plexus

Lymph: Retropharyngeal & antero-

superior deep cervical

Nerve: Secretomotor - Vb via pterygo-

palatine ganglion

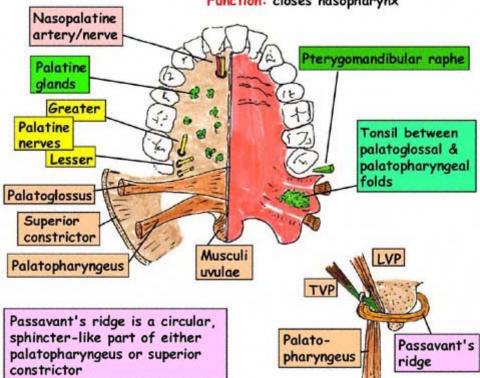
Sensation - Vb, lesser palatine

+ (IX)

Taste - Greater petrosal then

lesser palatine

Function: closes nasopharynx



# PTERYGOPALATINE GANGLION: DETAILED PATHWAYS TO AND FROM IT

CENTRAL NUCLEUS

Superior salivary (pons)

EMERGING WITH CRANIAL NERVE

VII (facial)

NERVE CARRYING PREGANGLIONIC FIBRES

Nervus intermedius then VII then greater petrosal then nerve of pterygoid canal

PATHWAY & FORAMEN

Internal acoustic meatus then middle ear then middle cranial fossa then ptergoid canal then pterygopalatine fossa

SITE OF GANGLION

Pterygopalatine fossa

NAME OF GANGLION

Pterygopalatine

NERVE CARRYING POSTGANGLIONIC FIBRES

Vb: 1. Maxillary branches

 Infra-orbital then zygomatic then zygomaticotemporal then lacrimal (Va)

ORGAN(S) SUPPIED  Mucosal glands of nose, nasopharynx, sinuses, soft palate

2. Lacrimal gland

SOURCE OF SYMPATHETIC THROUGH GANGLION Deep petrosal nerve off internal carotid just before it enters the cavernous sinus. It joins the greater petrosal nerve to become, together, the nerve of the pterygoid canal

## SPINAL CORD - VEINS & SOME LIGAMENTS

Internal vertebral plexus 21 111 (11)

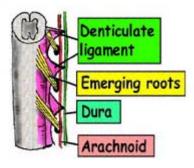
Basivertebral veins emerge from foramina in posterior vertebral bodies & drain into the internal vertebral plexus (anterior/posterior) which drains via the intervertebral segmental veins (with the nerve roots) into the external vertebral plexuses which, in turn connect above & below the diaphragm to the inferior & superior vena cavas via vertebral, azygos, lumbar & lateral sacral veins.

These veins are VALVELESS and thus cancer cells from thyroid, breast, kidney & prostate can easily enter the bones

The posterior longitudinal ligament attaches to the discs only and not to the vertebral bodies so that there is free drainage of the basivertebral veins

The dural sac finishes at S2 but the PIA MATER in the form of the filum terminale continues below S2 and attaches to the back of the coccyx

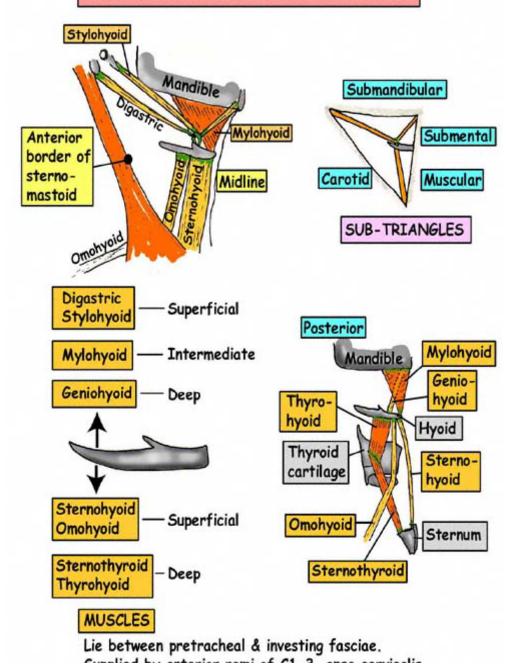
The DENTICULATE (dentate) ligament is pia mater that connects the cord to the dura mater laterally between the exits sites for the nerves. It pierces the arachnoid mater. Note that the spinal roots of the accessory nerve (C1-5) emerge doral to the denticulate ligament, whereas the sensory roots emerge dorsal and the motor roots ventral to it.



### SPINAL SUB-ARCHNOID SPACE

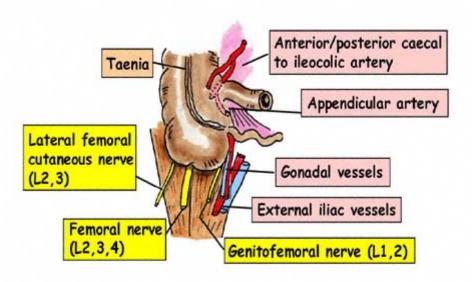
- · Volume 75ml
- Tapped during spinal puncture or anaesthetic below L2

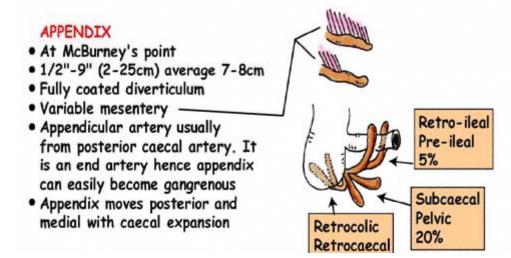
# SUB-TRIANGLES SUPRAHYOID AND STRAP MUSCLES



#### CAECUM

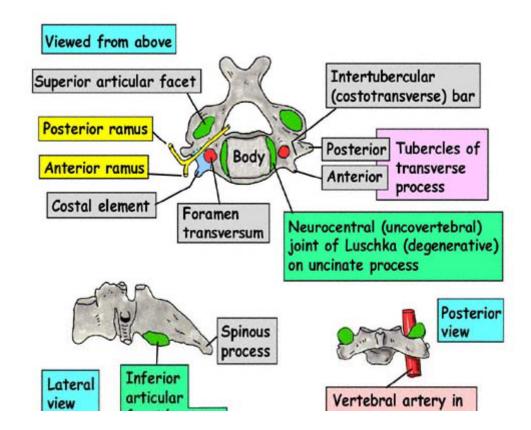
- On mesentery
- Below ileocaecal valve
- · Retrocaecal fossa behind it
- 3 taenia meet at base of appendix in child
- Ileocaecal valve is a double fold of mucosa & circular muscle of ileum which acts as an anti-reflux mechanism





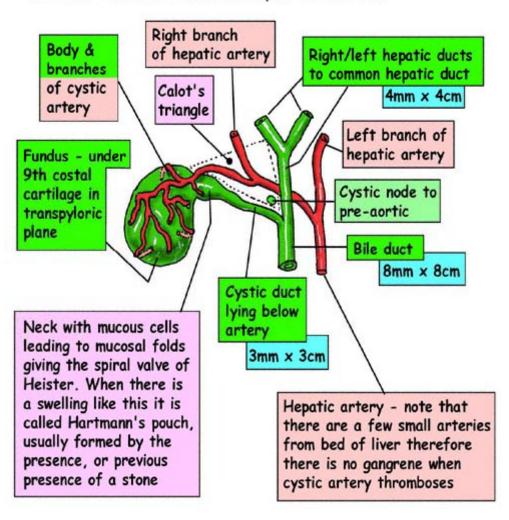
THE TOND SERVED TEXTED IN

- · C3-6
- Bifid spinous process
- · Large triangular foramen
- Short wide pedicle
- Small body
- Foramen transversum
   Artery, vein, sympathetic from C6 to C1
- C6: Has carotid tubercle of Chassaignac (enlarged anterior tubercle over which passes the common carotid artery
- C7: Vertebra prominens has vestigial anterior tubercle, long, non-bifid spinous process, small foramen transversum containing vein only (no artery). Note that C7 nerve is above C7 vertebra and C8 nerve is below it



#### GALL BLADDER

- Fibromuscular sac stores & concentrates bile. Holds 50ml
- Lined by simple columnar epithelium. Mucous cells at neck only
- Veins directly to liver bed then to hepatic veins. Occasionally join the portal vein
- Lymphatics to porta hepatis
- Parasympathetics & sympathetics (see liver)
- · Anterior: liver and abdominal wall
- Posterior: transverse colon & 1st part of duodenum



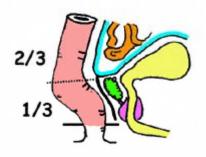
## **RECTUM - RELATIONS**



#### ANTERIOR

## Female

- Recto-uterine pouch (of Douglas)
- Small bowel
- Vagina (posterior fornix)
- Uterus & bladder



## Male

- Rectovesical pouch
- · Small bowel
- · Denonvillier's fascia
- Bladder
- Vas, seminal vesicle
- Prostate

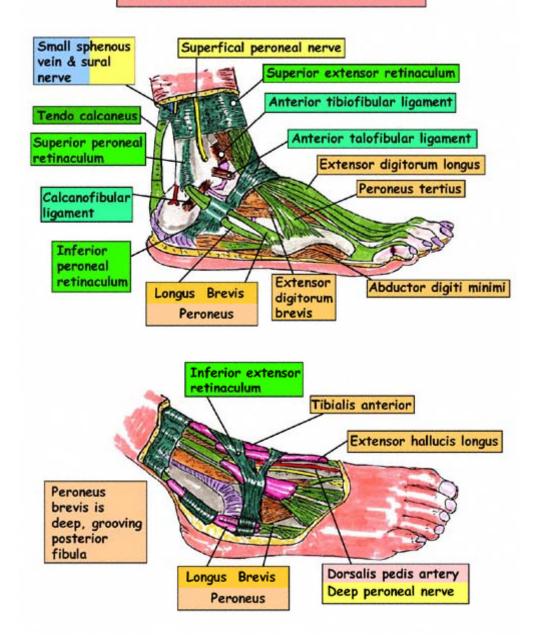
## POSTERIOR

Fascia, median sacral & rectal vessels, sympathetic trunk, pelvic splanchnic nerves, piriformis, sacral & coccygeal roots, sacrum, coccyx, anococcygeal body

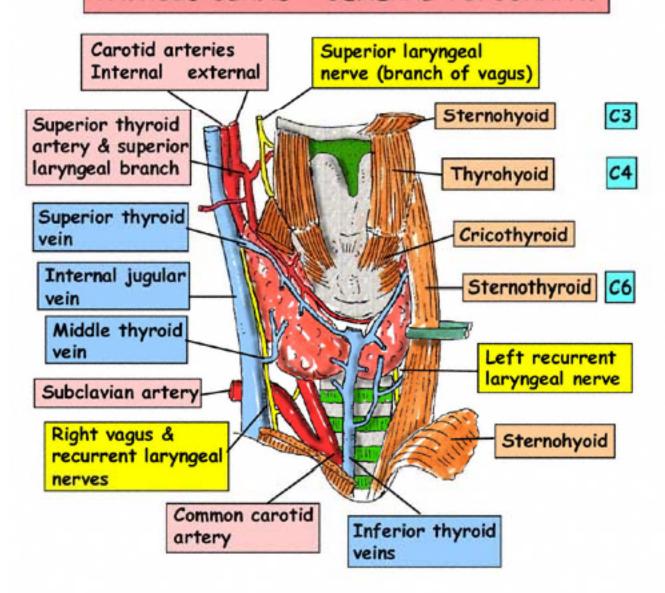
#### LATERAL

Peritoneum, fat, nodes, obturator internus & its fascia, Alcock's canal & contents, levator ani & coccygeus, ischio-anal fossa, lateral (fascial) ligaments of rectum

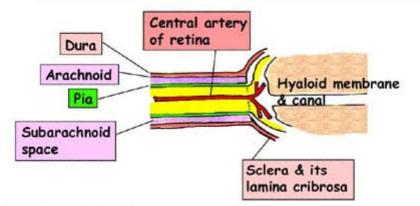
## LATERAL ANKLE & DORSAL FOOT



# THYROID GLAND - GENERAL TOPOGRAPHY



#### EYE - OPTIC NERVE & ITS COVERINGS



#### OPTIC NERVE

- · 3cm in orbit
- · Blood supply
  - Intracranial portion Anterior cerebral artery
  - Posterior 2cm in orbit Ophthalmic artery
  - · Anterior 1cm in orbit Central artery of retina

#### COVERINGS

#### **FIBROUS**

- · Sclera (nearly avascular)
- · Canal of Schlemm (drains aqueous)
- Cornea (anteriorly is stroma between Bowman's membrane, posteriorly is Descement's membrane)

#### VASCULAR

- Choroid (thin, pigmented, capillaries & 4-5 venae vorticosae)
- · Ciliary body and muscle
- Iris

#### **NERVOUS**

Retina

#### Lies on

## A modified sweat gland

- Pectoralis major
- · Serratus anterior
- External oblique (tail may curl round posterior to pectoralis minor)

#### Position

- On ribs 2-6 in mid-clavicular line
- Nipple in 4th intercostal space

## Lymphatics

- Run deep to capsule in sub mammary space to:
- Axilla (anterior, apical & central nodes)
- Infraclavicular nodes
- Internal thoracic nodes (parasternal)

## In disease lymphatics may go to:

- · Other side
- Deep cervical
- Into peritoneum
- Inguinal

## Support

fascia

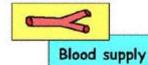
Capsule

Posterior to

breastThickened

Scarpa's

Suspensory ligaments of Astley Cooper from deep fascia to dermis



#### Structure

15-20 lobes Each with 1 lactiferous duct leading to: Internal thoracic (1st part subclavian)
Lateral thoracic (2nd part axillary)
Thoraco-acromial(2nd part axillary)
Intercostal (internal thoracic)

## THORAX - SURFACE MARKINGS CLINICAL IMPLICATIONS

#### Access to thoracic aorta

Through the left chest (left thoracotomy)

#### Access to oesophagus

Through right chest (right thoracotomy)

(Both of these are usually through the 5th intercostal space by stripping up the periosteum of the rib below and incising through the rib bed)

#### Thoraco-abdominal incision

This is for large access to upper abdomen or chest Through the 9th intercostal space on either side 9th Costal cartilage is usually excised The diaphragm is incised radially to avoid damaging its nerve

#### Pericardial aspiration

Insert needle just to left of xiphoid

#### Pericardial window

Through left thoracotomy 5th costal cartilage excised Pericardial flap cut

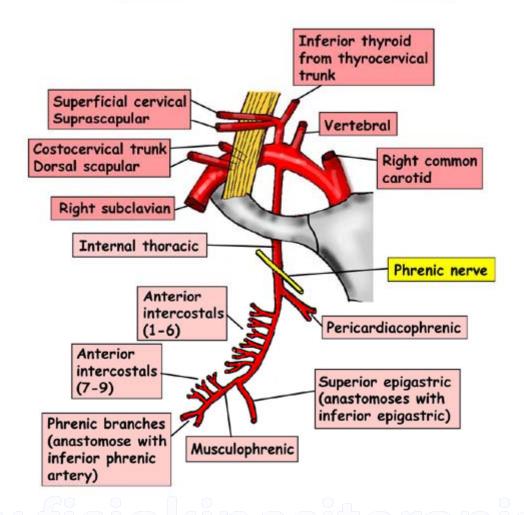
#### Heart transplantation

Via median sternotomy
En bloc - aorta, pulmonary trunk, both atriae
SVC, IVC, SA node are all left

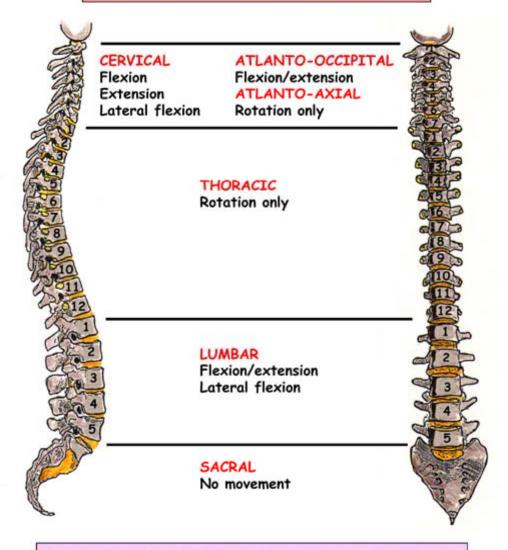
#### Aspiration of pleural cavity

Siting of drain in 4th space in mid axillary line

## RIGHT SUBCLAVIAN & INTERNAL THORACIC ARTERIES



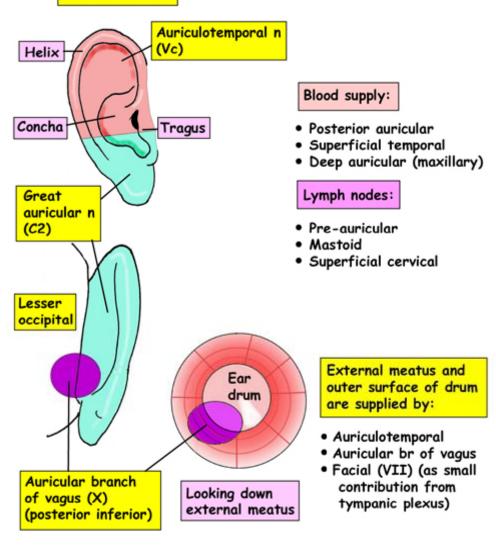
# VERTEBRAL COLUMN - MOVEMENTS



Movements at facet & intervertebral joints are individually small but accumulatively considerable

## EAR - RIGHT PINNA & EXTERNAL MEATUS

## NERVE SUPPLY



## OTIC GANGLION: DETAILED PATHWAYS TO AND FROM IT

CENTRAL

Inferior salivary (medulla)

EMERGING WITH CRANIAL NERVE

IX (glossopharyngeal)

NERVE CARRYING PREGANGLIONIC FIBRES IX then tympanic branch then lesser

petrosal

PATHWAY & FORAMEN

Tympanic branch of IX enters middle ear through petrous temporal bone then into middle cranial fossa as lesser petrosal then foramen ovale then infratemporal

fossa

SITE OF GANGLION Below foramen ovale on nerve to tensor

tympani & palati

NAME OF GANGLION

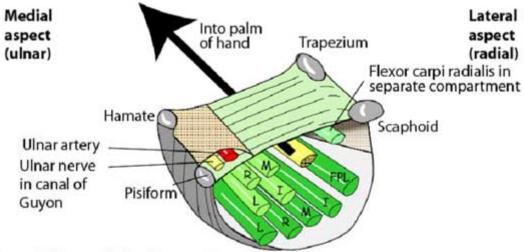
Otic

NERVE CARRYING POSTGANGLIONIC FIBRES Auriculotemporal (Vc).

ORGAN(5) SUPPIED Parotid gland

SOURCE OF SYMPATHETIC THROUGH GANGLION Middle meningeal artery (external

carotid)

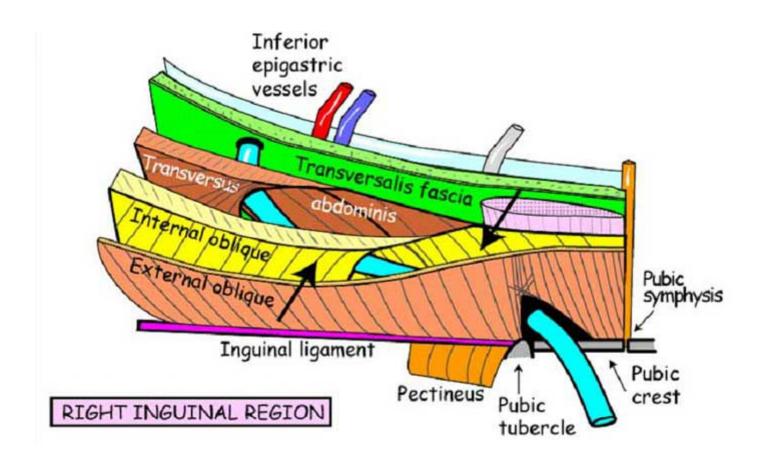


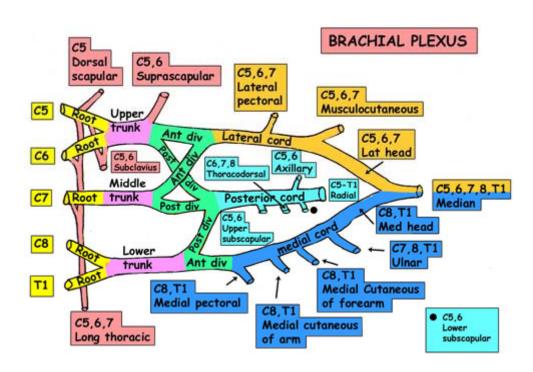
#### Beneath (deep to) the flexor retinaculum

- Median nerve
- 2 4 tendons of flexor digitorum profundus
- 3 4 tendons of flexor digitorum superficialis
- 4 Tendon of flexor pollicis longus
- 5 Flexor carpi radialis (in its own compartment)

#### Superficial to the flexor retinaculum but in their own tunnel (Canal of Guyon)

6 Ulnar nerve and ulnar artery





#### INTEROSSEOUS MUSCLES

## PALMAR (PAD)

Origin: Anterior shafts

2,4,5- metacarpals

Insertion: Dorsal expansion

& proximal phalanx

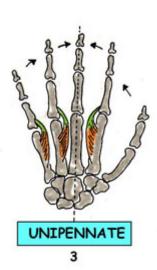
Action: Flex metacarpophalangeal

& extend both

interphalangeal joints Adduct as per arrows

below

Nerve supply: Ulnar



DORSAL (DAB)

Origin: Inner shafts all

metacarpals

Insertion: Dorsal expansion

& proximal phalanx

Action: Flex metacarpophalangeal

& extend both

interphalangeal joints Abduct as per arrows

below

Nerve supply: Ulnar



They act by taking up the slack in the extensor expansion so that the pull of the long extensor is not wasted wholly on the metacarpophalangeal joints

#### **Further** notes

#### 3 branches from roots

- Dorsal scapula n
  - Levator scapulae
  - Rhomboids
- N to subclavius
- Long thoracic n
  - Serratus anterior

#### 1 branch from upper trunk

- Suprascapular n
  - Supraspinatus
  - Infraspinatus

#### Lateral cord

- Lateral pectoral
  - · Pectoralis major
  - · Pectoralis minor
- Musculocutaneous
  - Coracobrachialis
  - Biceps
  - Brachialis
  - Elbow joint
  - Lateral cutaneous n of forearm
- Lateral head of median

#### Medial cord

- Medial pectoral
  - Pectoralis major
  - Pectoralis minor
- Medial cutaneous n of arm
- Medial cutaneous n of forearm
- Ulnar
  - · Elbow joint
  - Flexor carpi ulnaris
  - 1/2 flexor digitorum profundus
  - Hypothenar muscles (FDM,ODM,AbDM)
  - All intersecti

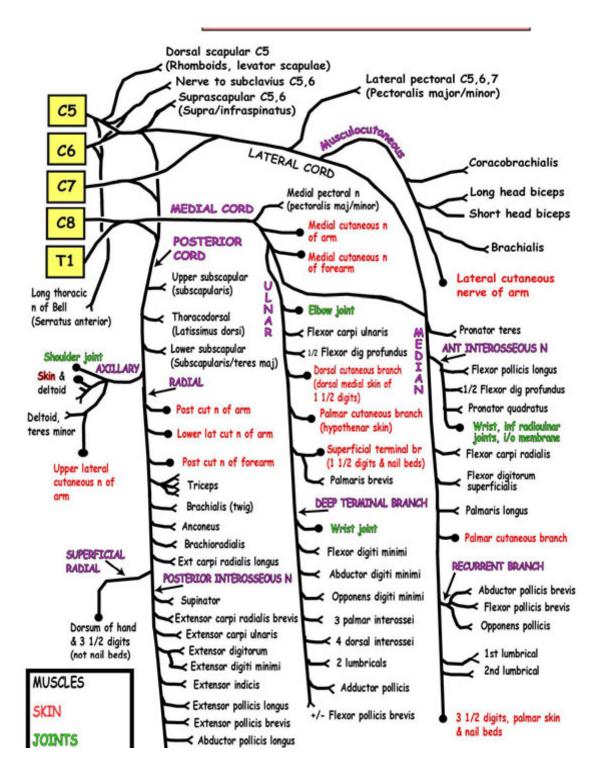
DIVISIONS - Behind clavicle

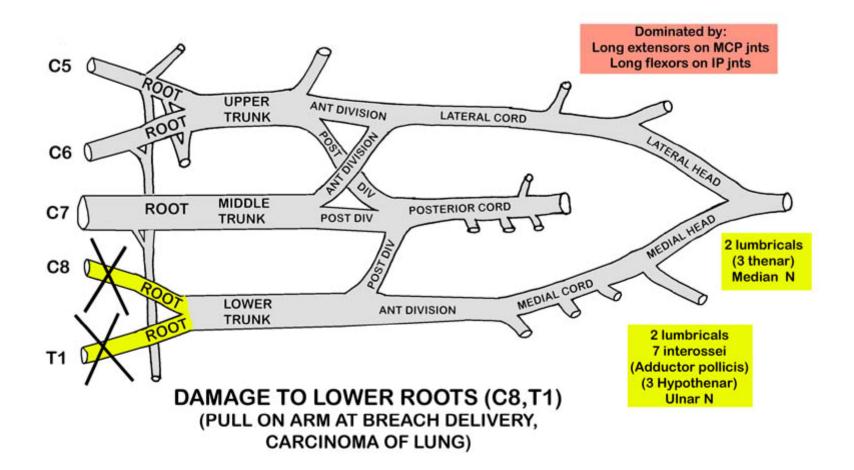
CORDS - In axilla

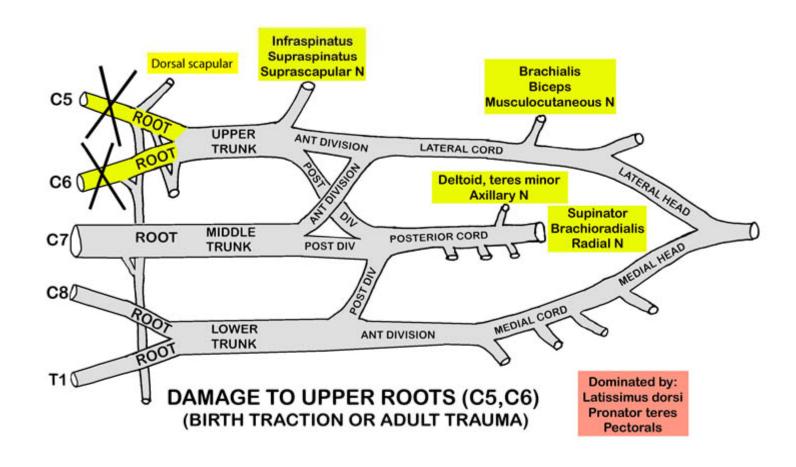
- Median n
  - Joints
  - Pronator teres
  - · Flexor carpi radialis
  - Palmaris longus
  - Flexor digitorum superficialis
  - Lateral 2 lumbricals
  - Skin 3 1/2 fingers
  - Recurrent branch
    - · Opponens pollicis
    - · Abd poll brevis
    - · Flex poll brevis
  - Anterior interosseous branch
    - · Flexor pollicis longus
    - · 1/2 flexor digitorum profundus
    - · Pronator quadratus

#### Posterior cord

- Upper subscapular
  - Subscapularis
- Lower subscapular
  - Subscapularis
  - Teres major
     Thoracodorsal
  - Latissimus dorsi
- Axillary
  - Deltoid
  - Teres minor
  - · Shoulder joint
  - Upper lateral cutaneous n of arm
- Radial
- · Triceps (+ bit of brachialis)
- Anconeus
- Brachioradialis
- Extensor carpi radialis longus
- Lower lateral cutaneous n of arm
- Posterior cutaneous n's of arm & forearm
- · Skin of lateral dorsum







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