

Bone Functions

- **Support**
- **Protection**
- **Assistance in Movement**
- **Mineral Homeostasis**
- **Blood cell production**

Hemopoiesis in red bone marrow

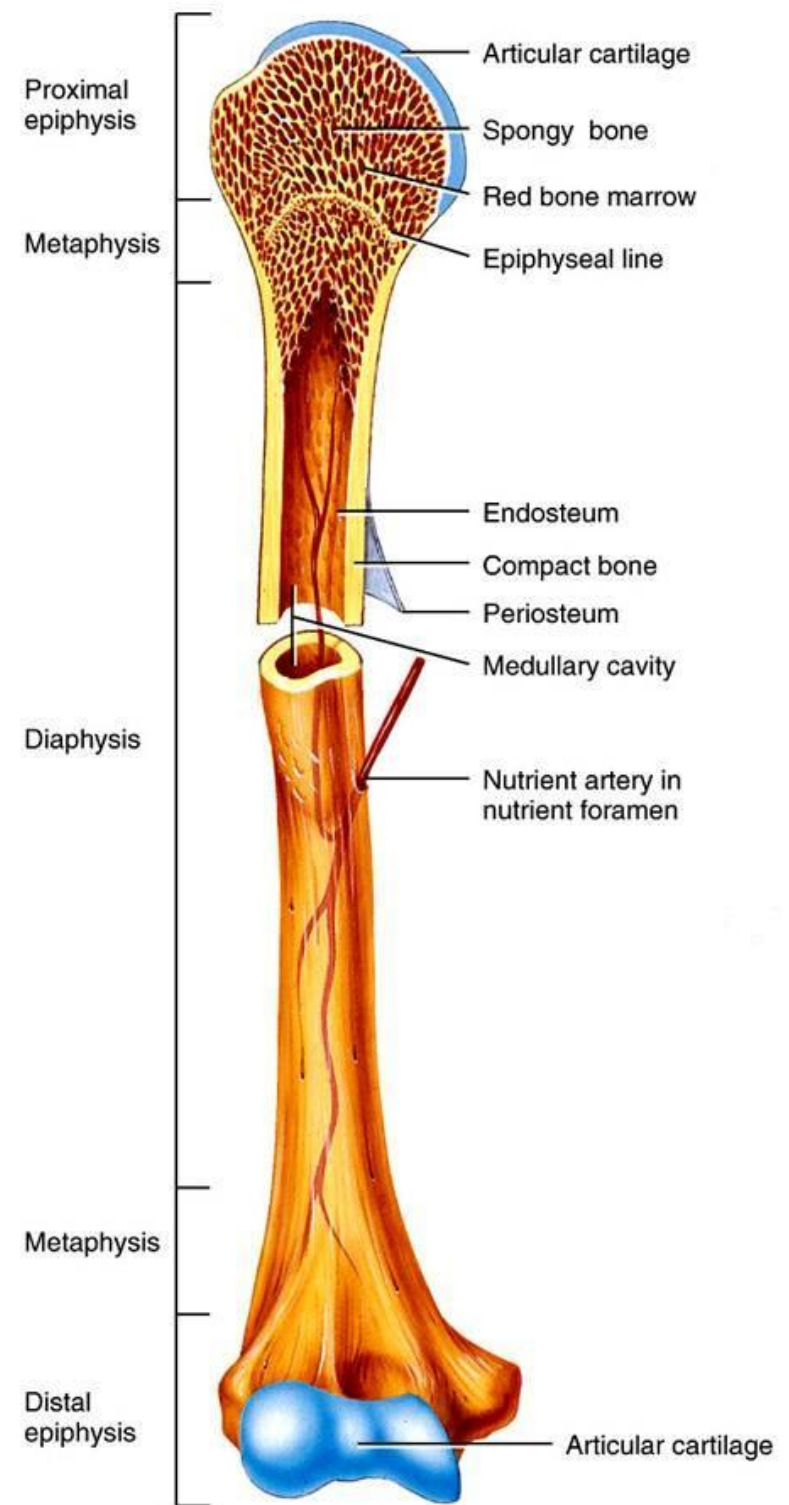
- **Triglyceride storage**

Energy storage in yellow bone marrow



Long Bone Anatomy

- **Diaphysis** = shaft
- **Epiphysis** = one end of a long bone
- **Metaphysis** = **growth plate** region
- **Articular cartilage** = over joint surfaces acts as **friction & shock absorber**
- **Medullary cavity** = marrow cavity
- **Endosteum** = lining of marrow cavity
- **Periosteum** = tough membrane covering bone but not the cartilage
 - fibrous layer = dense irregular CT
 - osteogenic layer = bone cells & blood vessels that **nourish or help with repairs**



(a) Partially sectioned humerus (arm bone)

Histology of Bone Tissue

- Extracellular matrix surrounding widely separated cells (ECM: 25% water+25% collagen fibers+50% crystallized mineral salts)
- The most abundant mineral salt is **calcium phosphate**
- A process called **calcification (mineralization)** is initiated by bone-building cells called **osteoblasts**
- Mineral salts are deposited and crystalize in the framework formed by the collagen fibers of the extracellular matrix
- Bone's flexibility depends on **collagen fibers**
- Bone's hardness depends on **mineral salts**

Histology of Bone Tissue

Four types of cells in bone tissue

- Osteogenic cells

- Undergo cell division; the resulting cells develop into osteoblasts

- Osteoblasts

- Bone-building cells

- Synthesize extracellular matrix of bone tissue

- Osteocytes

- Mature bone cells

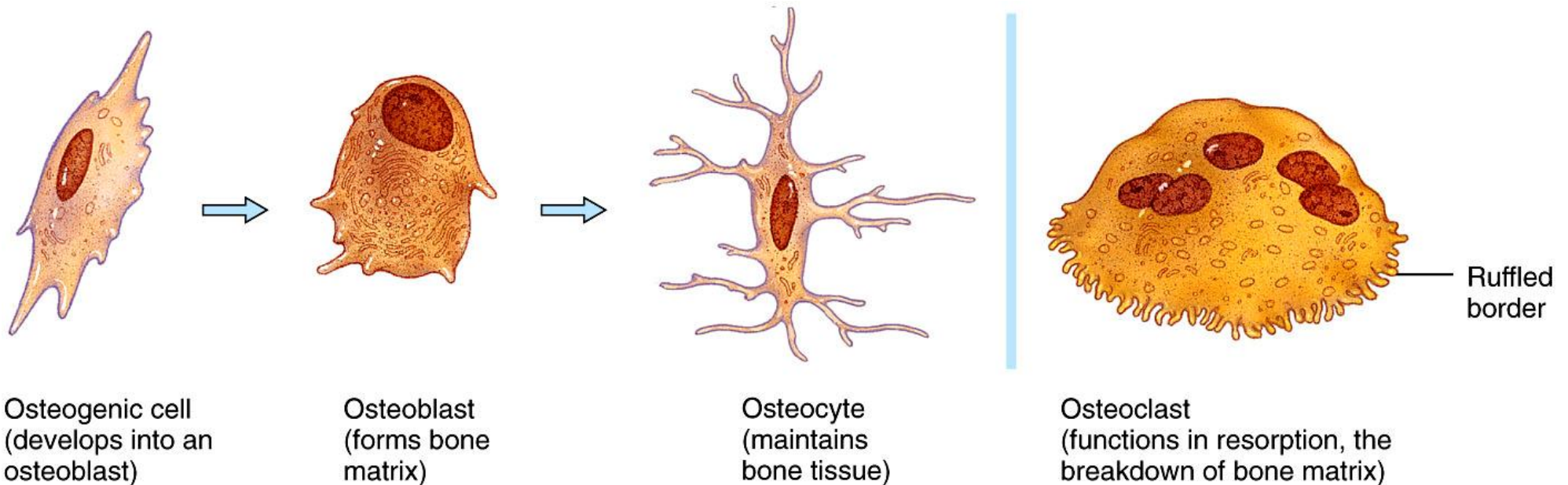
- Exchange nutrients and wastes with the blood

- Osteoclasts

- Release enzymes that digest the mineral components of bone matrix (**bone resorption**)

- Regulate blood calcium level

Types of Cells in Bone Tissue

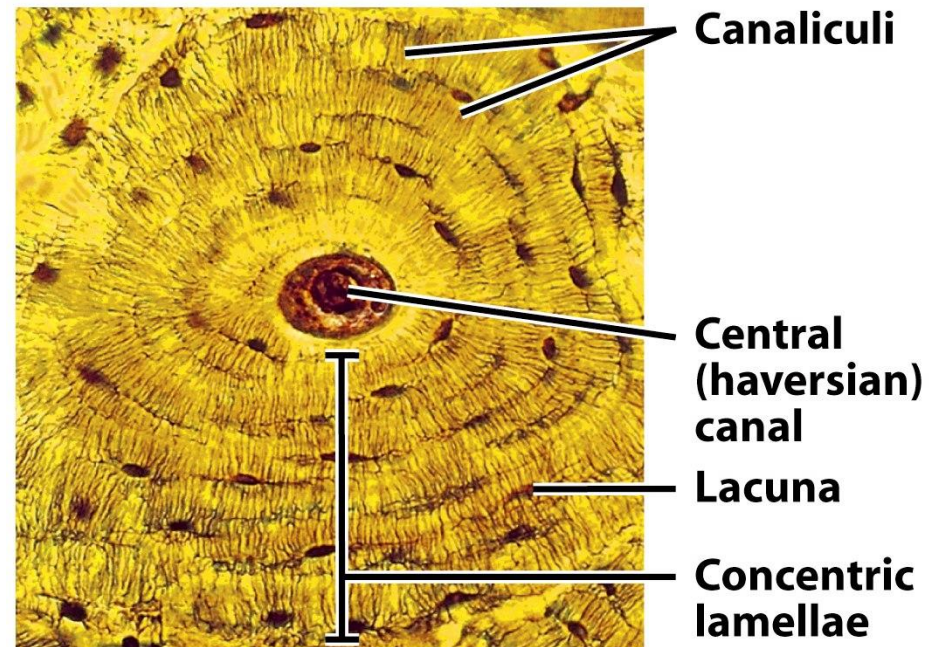


- **Osteogenic cells** ---- **undifferentiated cells**
 - can divide to replace themselves & can become osteoblasts
 - found in inner layer of **periosteum and endosteum**
- **Osteoblasts** --- form matrix & collagen fibers but can't divide
- **Osteocytes** --- mature cells that no longer secrete matrix
- **Osteoclasts** --- huge cells from fused monocytes (WBC)
 - function in **bone resorption at surfaces such as endosteum**

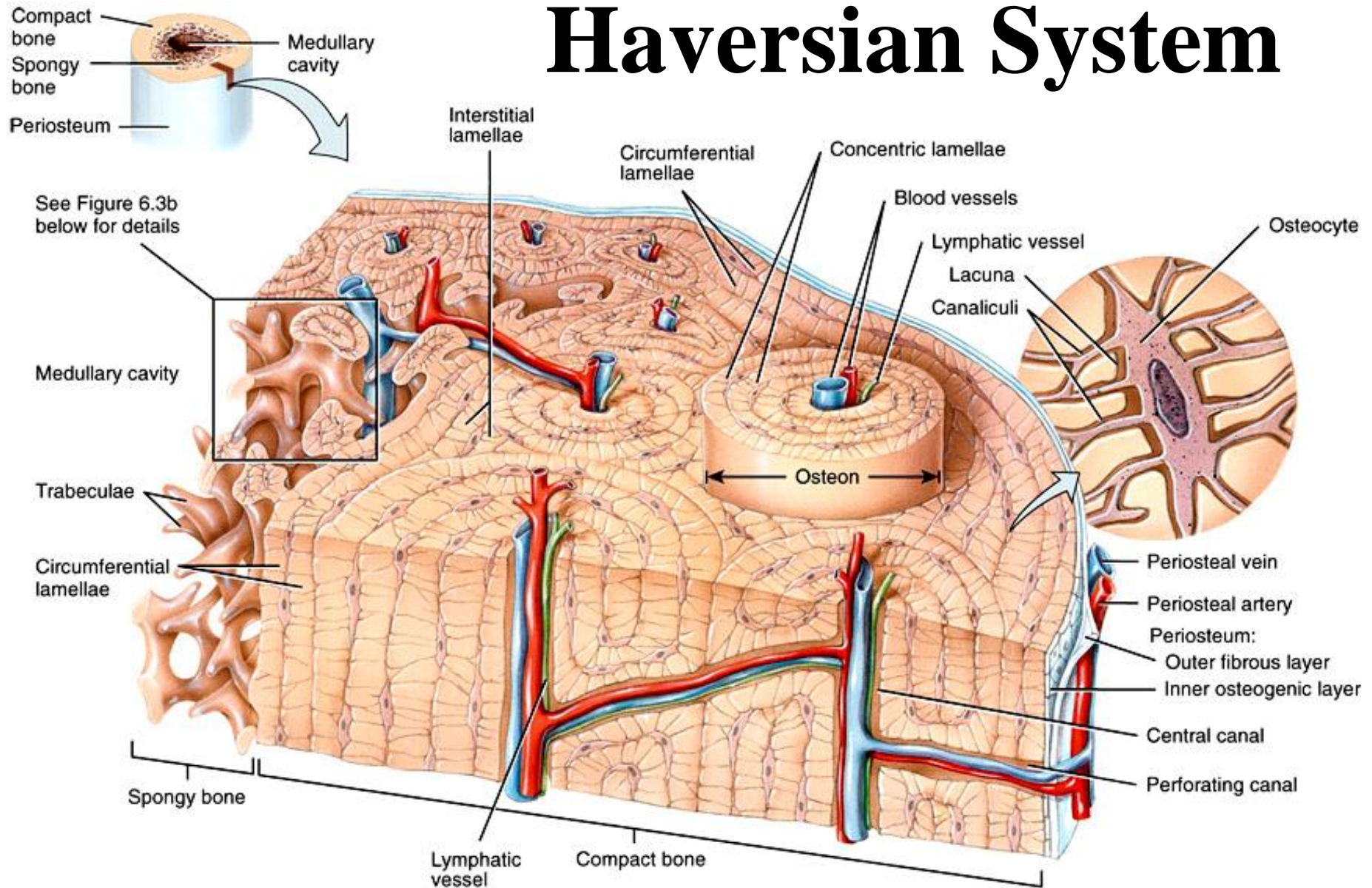
Compact & Spongy Bone

● Compact Bone

- Resists the stresses produced by weight and movement
- Components of compact bone are arranged into repeating structural units called **osteons** or **Haversian systems**
- Osteons consist of a central (Haversian) canal with concentrically arranged lamellae, lacunae, osteocytes, and canaliculi



Haversian System

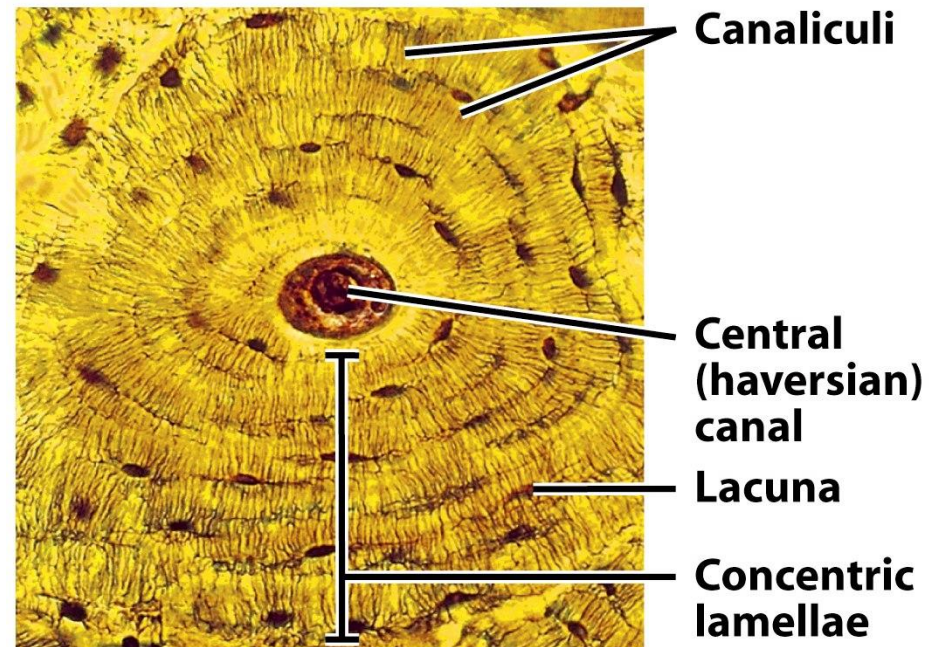


➤ **Canaliculi** connect **lacunae**, forming a system of interconnected canals
 --Providing routes for nutrients and oxygen to reach the osteocytes

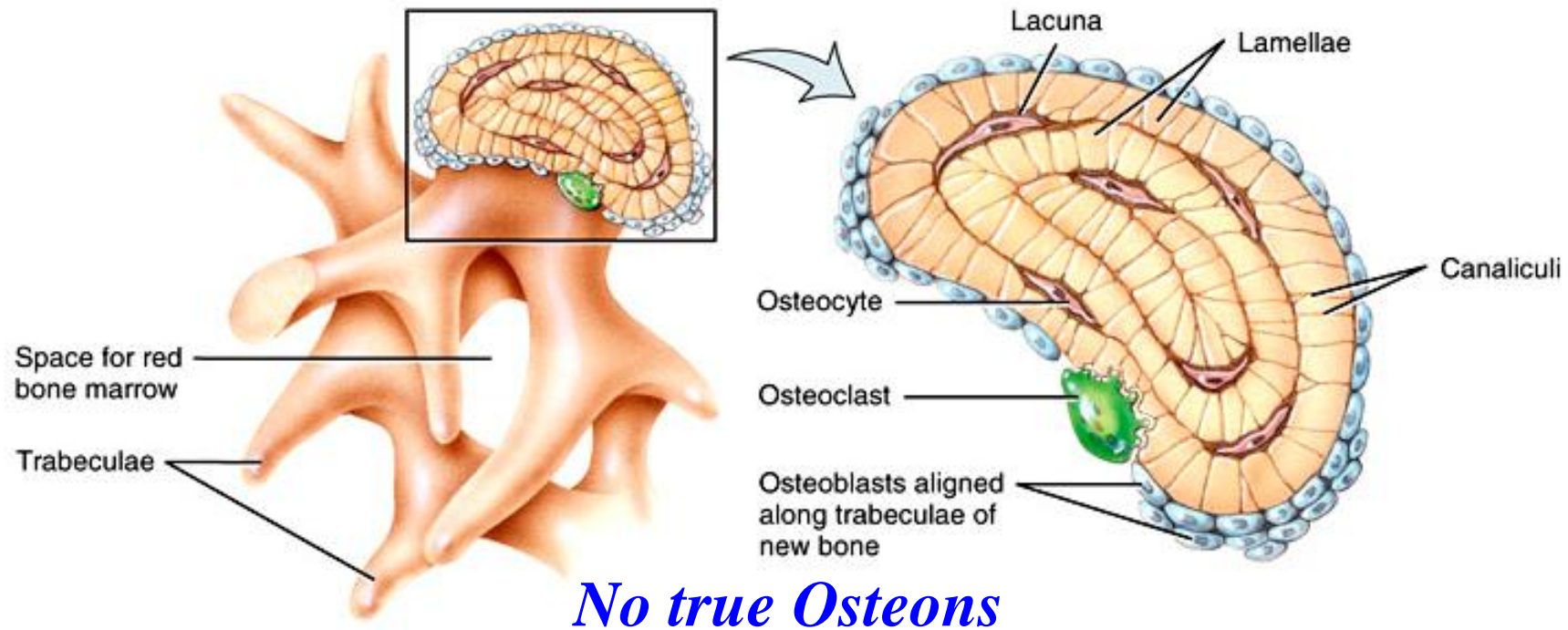
Compact Bone

● Osteon

- Central canals run longitudinally through bone
- Around the central canals are **concentric lamellae** (rings of calcified matrix)
- Between the lamellae are small spaces called **lacunae** which contain osteocytes
- Radiating in all directions from the lacunae are tiny **canaliculi** filled with extracellular fluid



Spongy Bone



(b) Enlarged aspect of spongy bone trabeculae

(c) Details of a section of a trabecula

No true Osteons

- Latticework of thin plates of bone called **trabeculae** oriented along lines of stress (helps bones resist stresses)
- Spaces in between these struts are filled with **red marrow** where blood cells develop
- Found in **ends of long bones** and inside flat bones such as the **hipbones, sternum, sides of skull, and ribs.**

● Spongy Bone

- Lamellae are arranged in a lattice of thin columns called **trabeculae**
 - Spaces between the trabeculae make bones lighter
 - Trabeculae of spongy bone support and protect the red bone marrow
 - Hemopoiesis occurs in spongy bone
- Within each trabecula are lacunae that contain **osteocytes**
- Osteocytes are nourished from the blood circulating through the trabeculae
- Interior bone tissue is made up primarily of spongy bone

Blood and Nerve Supply of Bone

- **Bone is richly supplied with blood**

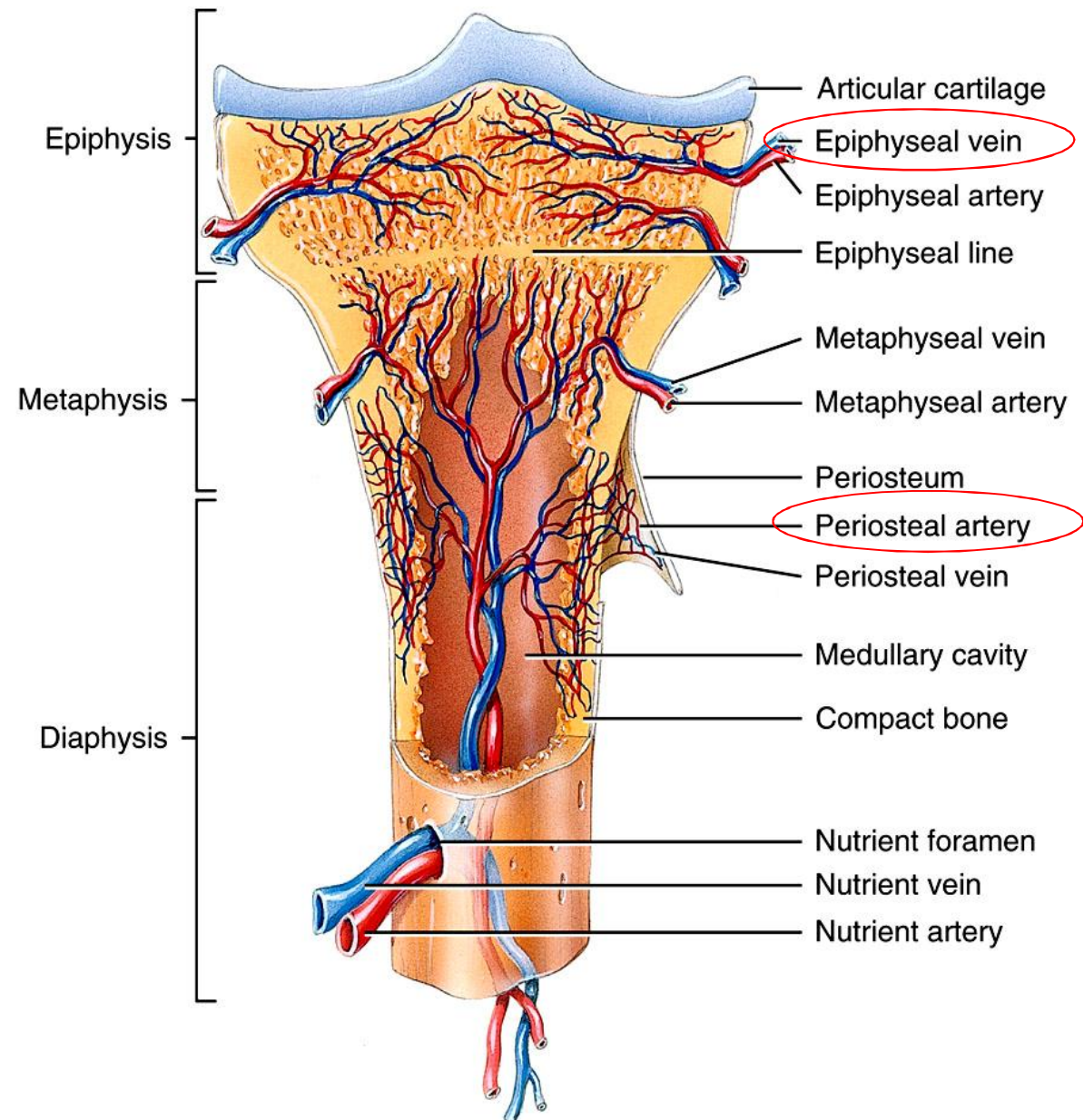
- **Periosteal arteries**

- accompanied by nerves supply the periosteum and compact bone

- **Epiphyseal veins** carry blood away from long bones

- **Nerves accompany the blood vessels that supply bones**

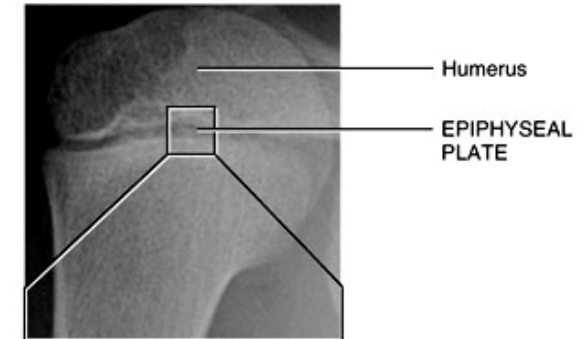
- The **periosteum** is rich in sensory nerves sensitive to tearing or tension



Bone Formation

- The process by which bone forms is called **ossification**
- Bone formation occurs in four situations:
 - 1) **Formation of bone in an embryo**
 - Cartilage formation and ossification occurs during the **sixth week** of embryonic development
 - 2) **Growth of bones until adulthood**
 - 3) **Remodeling of bone**
 - Old bone is continually destroyed and new bone is formed in its place throughout an individual's life
 - 4) **Repair of fractures**

Bone Growth until Adulthood



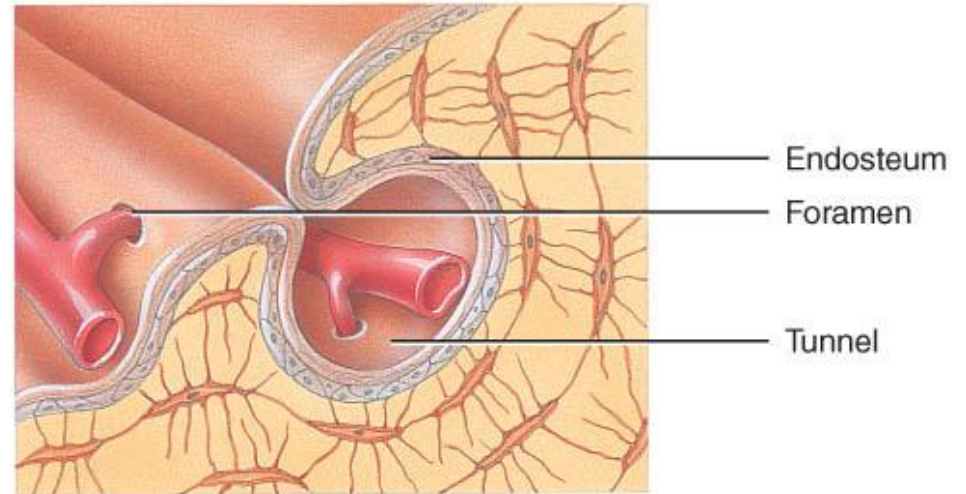
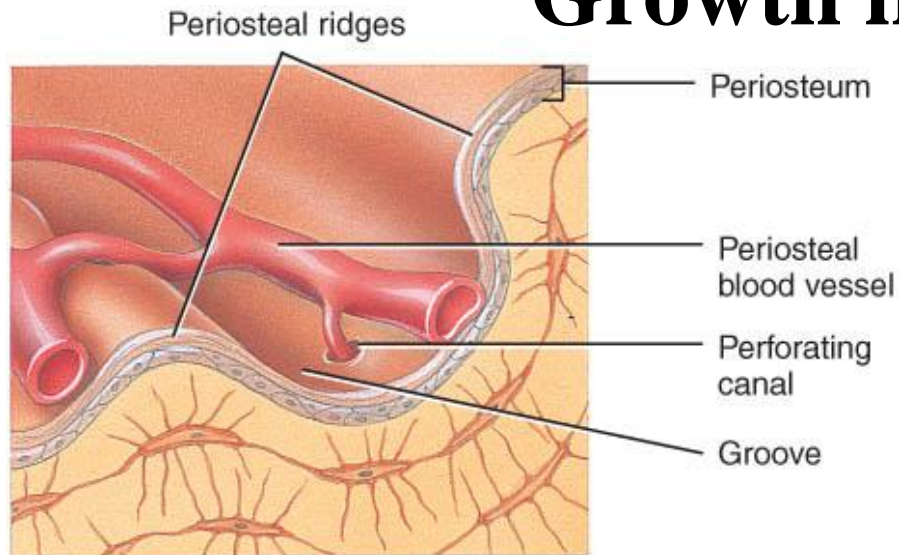
Growth in Length

- The growth in length of long bones involves two major events:
 - 1) Growth of cartilage on the **epiphyseal plate**
 - 2) Replacement of cartilage by bone tissue in the epiphyseal plate
- Between ages **18-25**, epiphyseal plates close
 - cartilage cells stop dividing and bone replaces the cartilage (**epiphyseal line**)

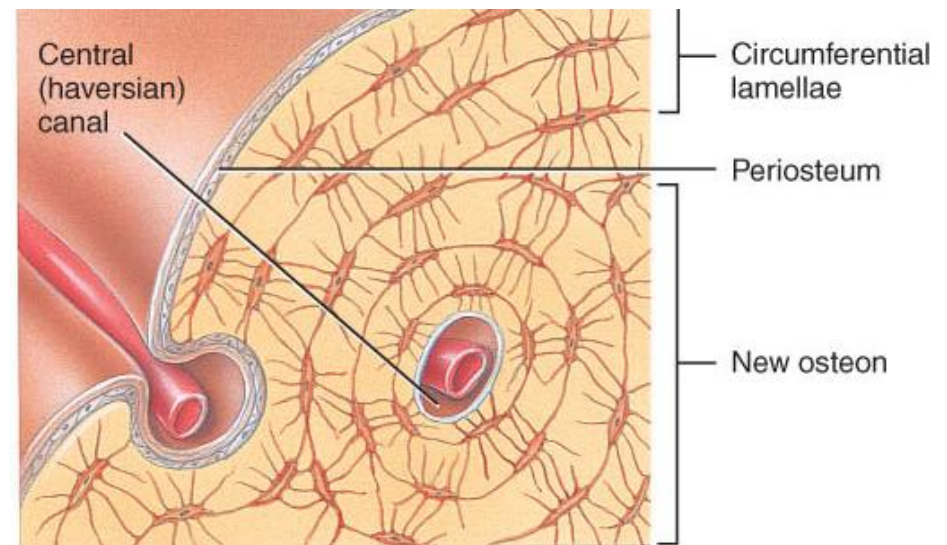
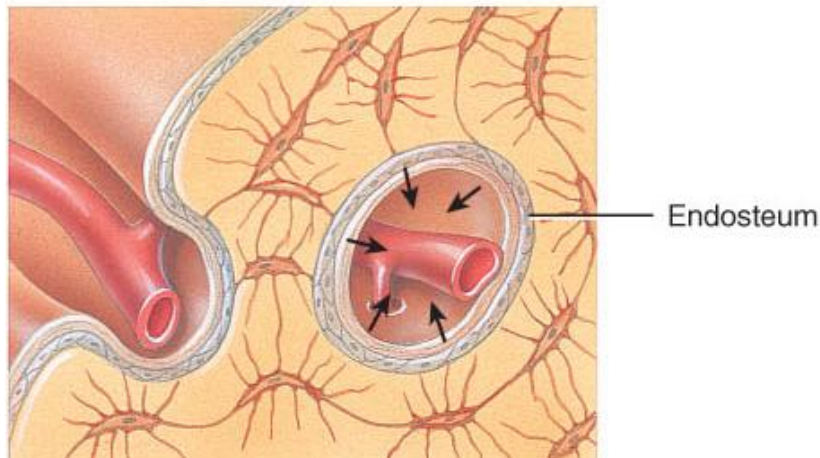
Growth in Thickness

- Bones grow in thickness at the **outer surface**

Growth in Thickness



- Only by appositional growth at **the bone's surface**
- Periosteal cells differentiate into **osteoblasts** and form bony ridges and then a tunnel around periosteal blood vessel
- Concentric lamellae fill in the tunnel to form an osteon



Factors Affecting Bone Growth and Bone Remodeling

Normal bone metabolism depends on several factors

- **Minerals**

- Large amounts of calcium and phosphorus and smaller amounts of magnesium, fluoride, and manganese are required for bone growth and remodeling

- **Vitamins**

- Vitamin **A** stimulates activity of osteoblasts

- Vitamin **C** is needed for synthesis of collagen

- Vitamin **D** helps build bone by increasing the absorption of calcium from foods in the gastrointestinal tract into the blood

- Vitamins **K and B12** are also needed for synthesis of bone proteins

● Hormones

- During childhood, the hormones most important to bone growth are growth factors (**IGFs**), produced by the liver
 - IGFs stimulate osteoblasts, promote cell division at the epiphyseal plate, and enhance protein synthesis
- **Thyroid hormones** also promote bone growth by stimulating osteoblasts
- **Insulin** promotes bone growth by increasing the synthesis of bone proteins
- **Estrogen** and **testosterone** cause a dramatic effect on bone growth
 - Cause of the sudden “growth spurt” that occurs during the teenage year
 - Promote changes in females, such as widening of the pelvis
 - Shut down growth at epiphyseal plates
- **Parathyroid hormone**, **calcitriol**, and **calcitonin** are other hormones that can affect bone remodeling

Factors Affecting Bone Growth and Bone Remodeling

Summary of Factors That Influence Bone Metabolism

FACTOR	COMMENT
MINERALS	
Calcium and phosphorus	Make bone extracellular matrix hard.
Magnesium	Helps form bone extracellular matrix.
Fluoride	Helps strengthen bone extracellular matrix.
Manganese	Activates enzymes involved in synthesis of bone extracellular matrix.
VITAMINS	
Vitamin A	Needed for the activity of osteoblasts during remodeling of bone; deficiency stunts bone growth; toxic in high doses.
Vitamin C	Needed for synthesis of collagen, the main bone protein; deficiency leads to decreased collagen production, which slows down bone growth and delays repair of broken bones.
Vitamin D	Active form (calcitriol) is produced by the kidneys; helps build bone by increasing absorption of calcium from gastrointestinal tract into blood; deficiency causes faulty calcification and slows down bone growth; may reduce the risk of osteoporosis but is toxic if taken in high doses.
Vitamins K and B ₁₂	Needed for synthesis of bone proteins; deficiency leads to abnormal protein production in bone extracellular matrix and decreased bone density.

HORMONES

Human growth hormone (hGH)	Secreted by the anterior lobe of the pituitary gland; promotes general growth of all body tissues, including bone, mainly by stimulating production of insulinlike growth factors.
Insulinlike growth factors (IGFs)	Secreted by the liver, bones, and other tissues upon stimulation by human growth hormone; promotes normal bone growth by stimulating osteoblasts and by increasing the synthesis of proteins needed to build new bone.
Thyroid hormones (thyroxine and triiodothyronine)	Secreted by thyroid gland; promote normal bone growth by stimulating osteoblasts.
Insulin	Secreted by the pancreas; promotes normal bone growth by increasing the synthesis of bone proteins.
Sex hormones (estrogens and testosterone)	Secreted by the ovaries in women (estrogens) and by the testes in men (testosterone); stimulate osteoblasts and promote the sudden “growth spurt” that occurs during the teenage years; shut down growth at the epiphyseal plates around age 18–21, causing lengthwise growth of bone to end; contribute to bone remodeling during adulthood by slowing bone resorption by osteoclasts and promoting bone deposition by osteoblasts.
Parathyroid hormone (PTH)	Secreted by the parathyroid glands; promotes bone resorption by osteoclasts; enhances recovery of calcium ions from urine; promotes formation of the active form of vitamin D (calcitriol).
Calcitonin (CT)	Secreted by the thyroid gland; inhibits bone resorption by osteoclasts.

EXERCISE

Weight-bearing activities stimulate osteoblasts and, consequently, help build thicker, stronger bones and retard loss of bone mass that occurs as people age.

AGING

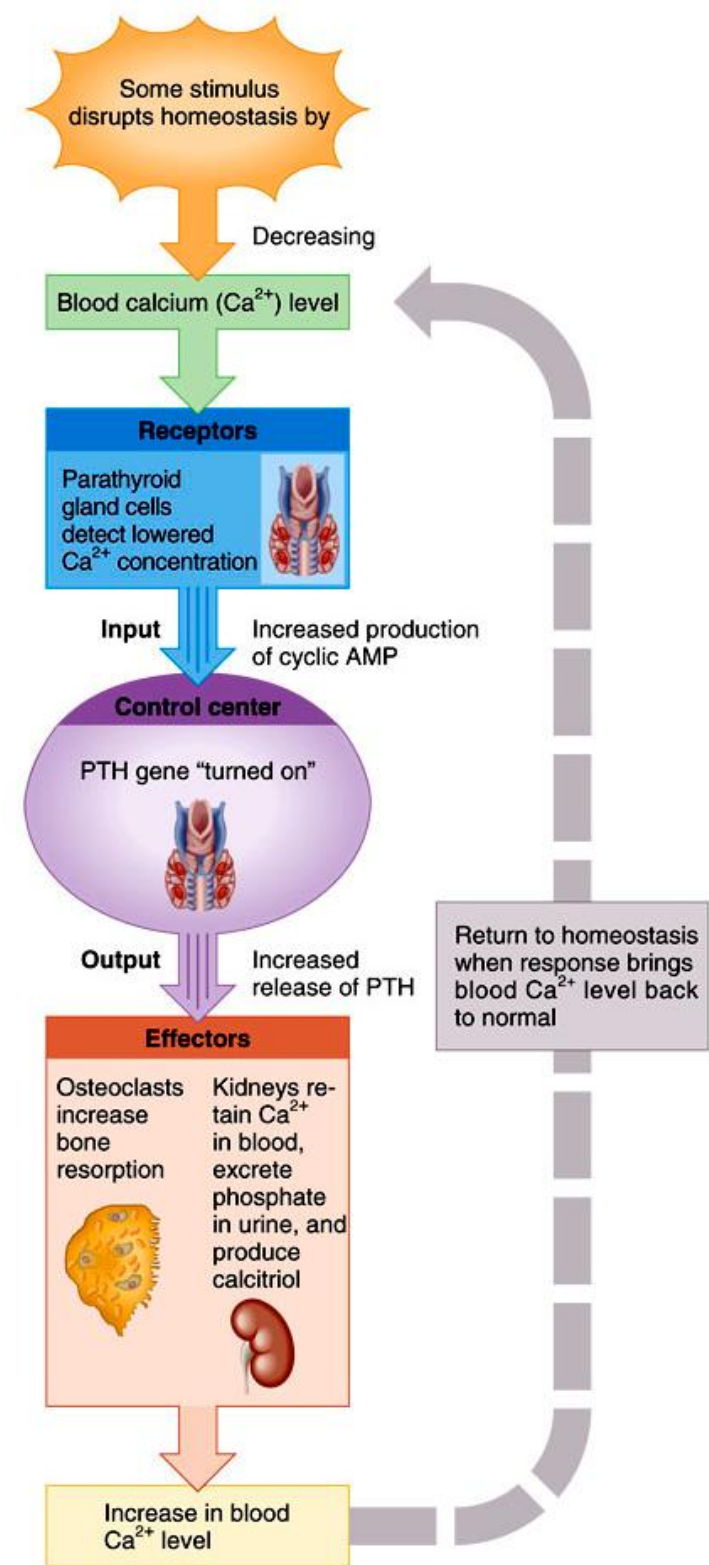
As the level of sex hormones diminishes during middle age to older adulthood, especially in women after menopause, bone resorption by osteoclasts outpaces bone deposition by osteoblasts, which leads to a decrease in bone mass and an increased risk of osteoporosis.

Calcium Homeostasis

- Bone is a reservoir of **Calcium & Phosphate**
- Levels of calcium in the blood are maintained by controlling the rates of calcium resorption from bone into blood and of calcium deposition from blood into bone
- Calcium ions involved with many **body functions** (nerve & muscle cell function, blood clotting, enzyme function etc.)
- Small changes in blood levels of Ca^{+2} can be deadly (plasma level maintained **9-11mg/100mL**)
 - cardiac** arrest if too high
 - respiratory** arrest if too low

Calcium Homeostasis

- **Parathyroid hormone (PTH)** is secreted if Ca^{+2} levels falls
 - PTH gene is turned on & more PTH is secreted from gland
 - osteoclast activity increased, kidney retains Ca^{+2} and produces calcitriol
- **Calcitonin** hormone is secreted from parafollicular cells in thyroid if Ca^{+2} blood levels get too high
 - inhibits osteoclast activity
 - increases bone formation by osteoblasts



Clinical Application: Rickets & Osteomalacia

- **Rickets** (vitamin D deficiency) in children

- calcium salts are not deposited properly

- bones of growing **children** are soft

- bowed legs, skull, rib cage, and pelvic deformities result

- **Osteomalacia** (soft bones) in adults

- new **adult** bone produced during remodeling fails to ossify

- hip fractures are common

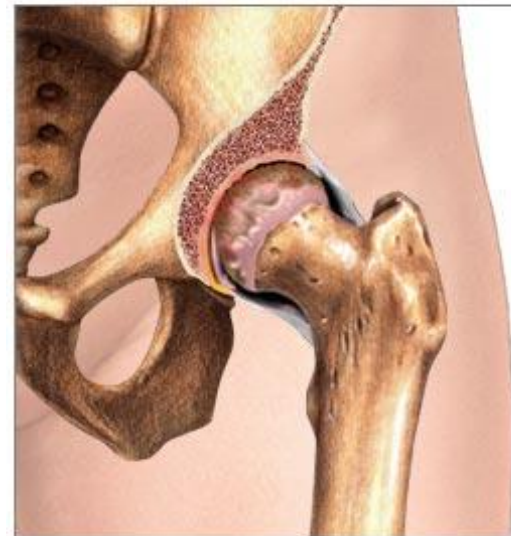
Normal anatomy



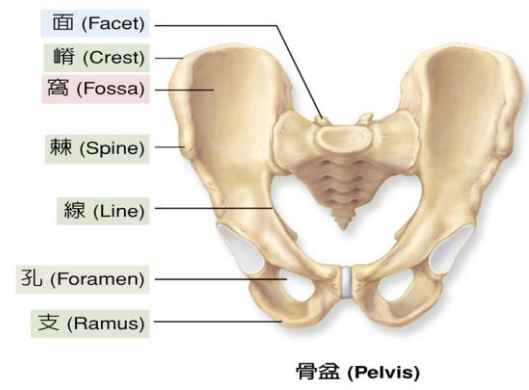
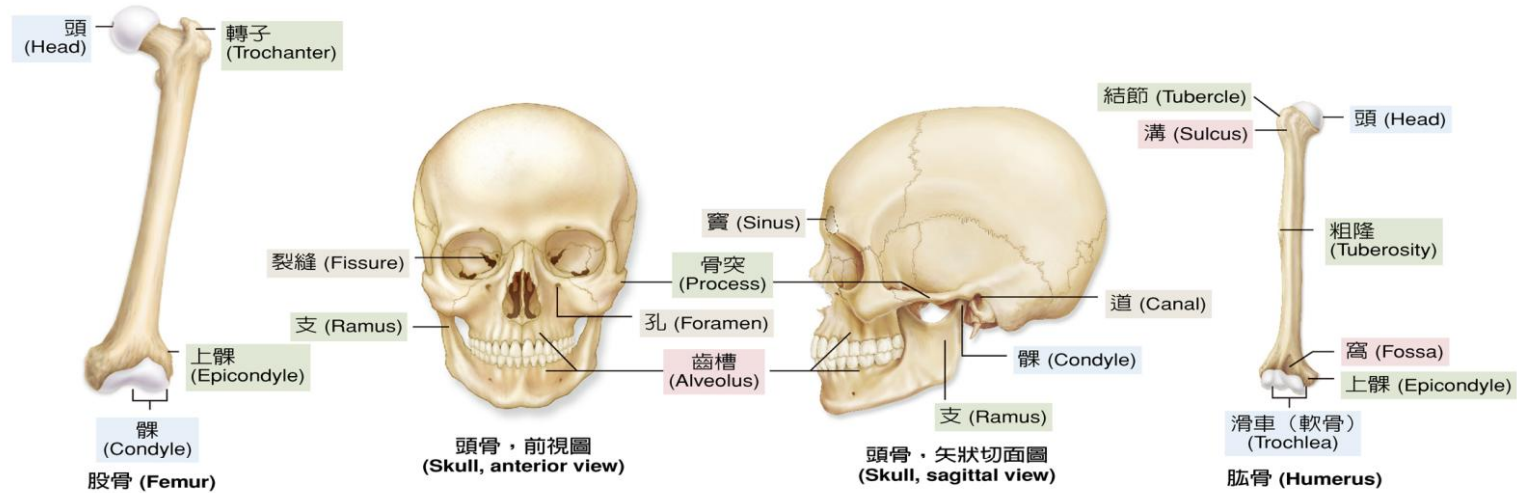
Rickets



Diseased hip joint



Anatomical Features of Bones



一般結構	解剖項目	描述
關節表面	髁	大、滑順、環繞接合卵形的結構。
	面	小、平坦、淺的連接表面。
	頭	突起的，環繞骨節。
	滑車 (軟骨)	平滑、有溝、似滑輪般接合骨突。
凹陷區	齒槽	深孔或在下顎或顏的槽臼。
	窩	下垂或淺的凹槽。
	溝	狹窄的溝。
使肌腱、韌帶附著的突出物	脊	狹窄的突起，嵴狀的突出物。
	上髁	在髁附近周圍的突起物。
	線	低的嵴。
	突起	任何標示成骨骼的突起。
	分支	骨骼的角狀延伸，相連接、被支撐在結構裡。
	脊柱	點狀、細長的突起。
	轉子	實心、粗糙的突起物，只有在股骨可見。
	結節	小的，圍繞於突起物周圍。
開口及空腔	粗隆	大且粗糙的突出物。
	通道	通過骨骼的通道。
	裂縫	骨骼裡狹窄且縱裂狀的開口。
	孔	骨骼裡圍繞的通道。
	竇	腔室或骨骼內中空的空間。

Types of Bones

- **5 basic types of bones:**

- Long** = compact

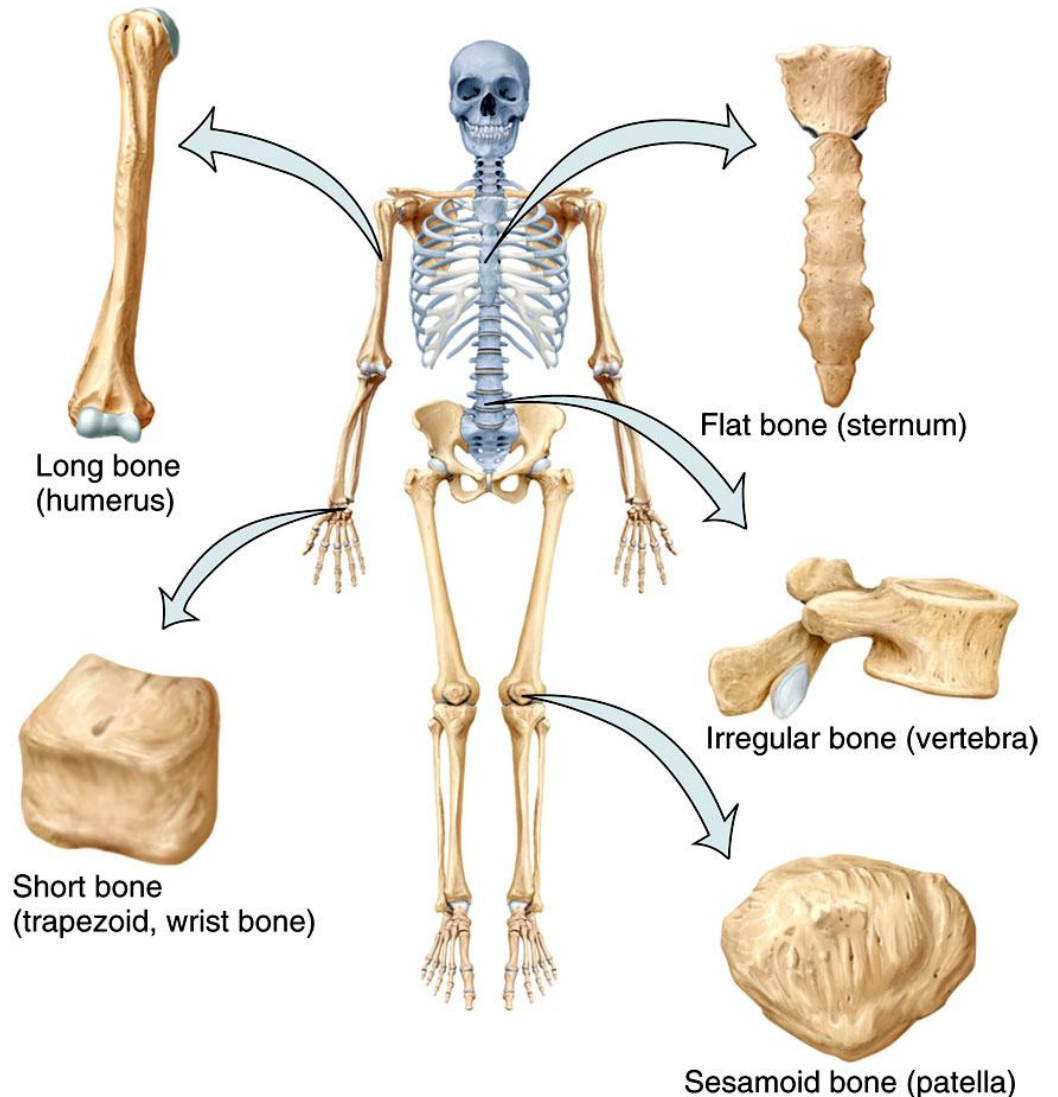
- Short** = spongy except surface

- Flat** = plates of compact enclosing spongy

- Irregular** = variable

- Sesamoid** = develop in tendons or ligaments (patella)

- **Sutural bones** = in joint between skull bones



Axial Skeleton (80)

A. Skull (28)

-- **Cranium (8)**

-- **Facial bone (14)**

-- **Ear bone (6)**

B. Spine (26)

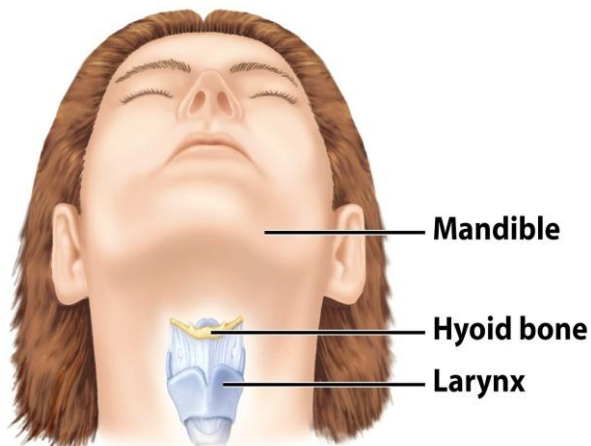
-- **Vertebrae (26)**

C. Thoracic Cage (25)

-- **Ribs (24)**

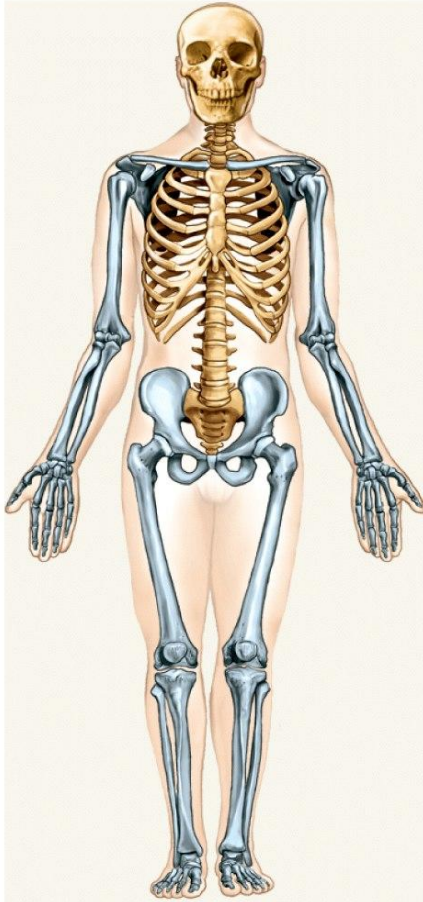
-- **Sternum (1)**

D. Hyoid Bone (1)



Position of hyoid

Appendicular Skeleton (126)



A. Upper Limb (64)

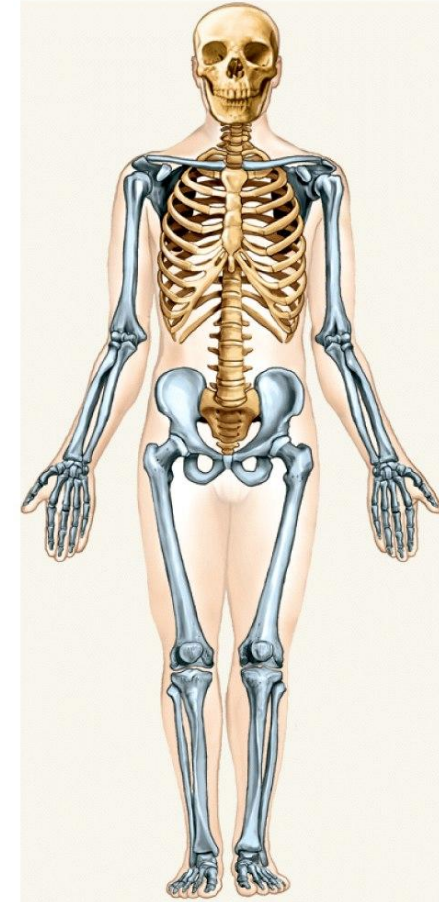
-- Pectoral girdle

-- Upper arm

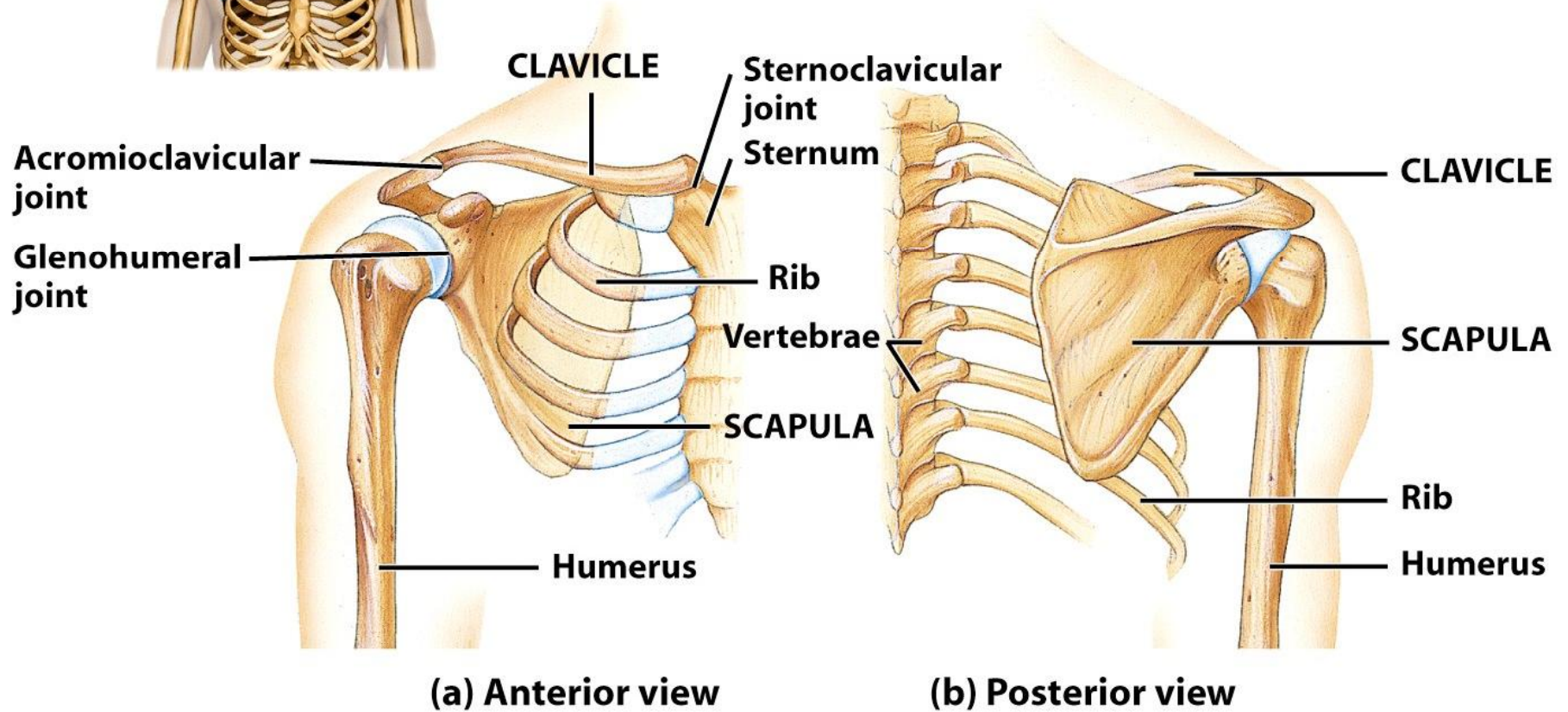
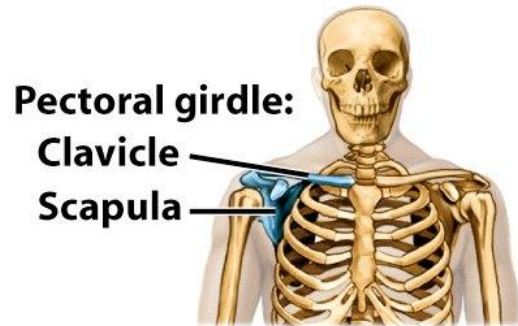
B. Lower Limb (62)

-- Pelvic girdle

-- Lower leg

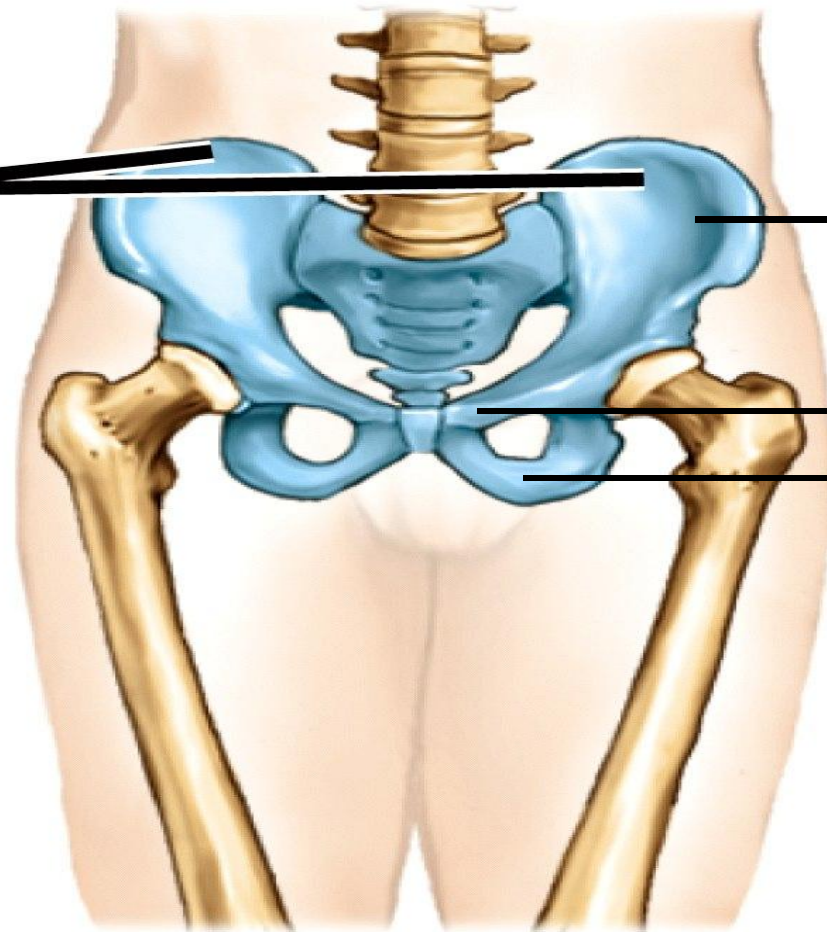


Pectoral (Shoulder) Girdle



Pelvic (Hip) Girdle

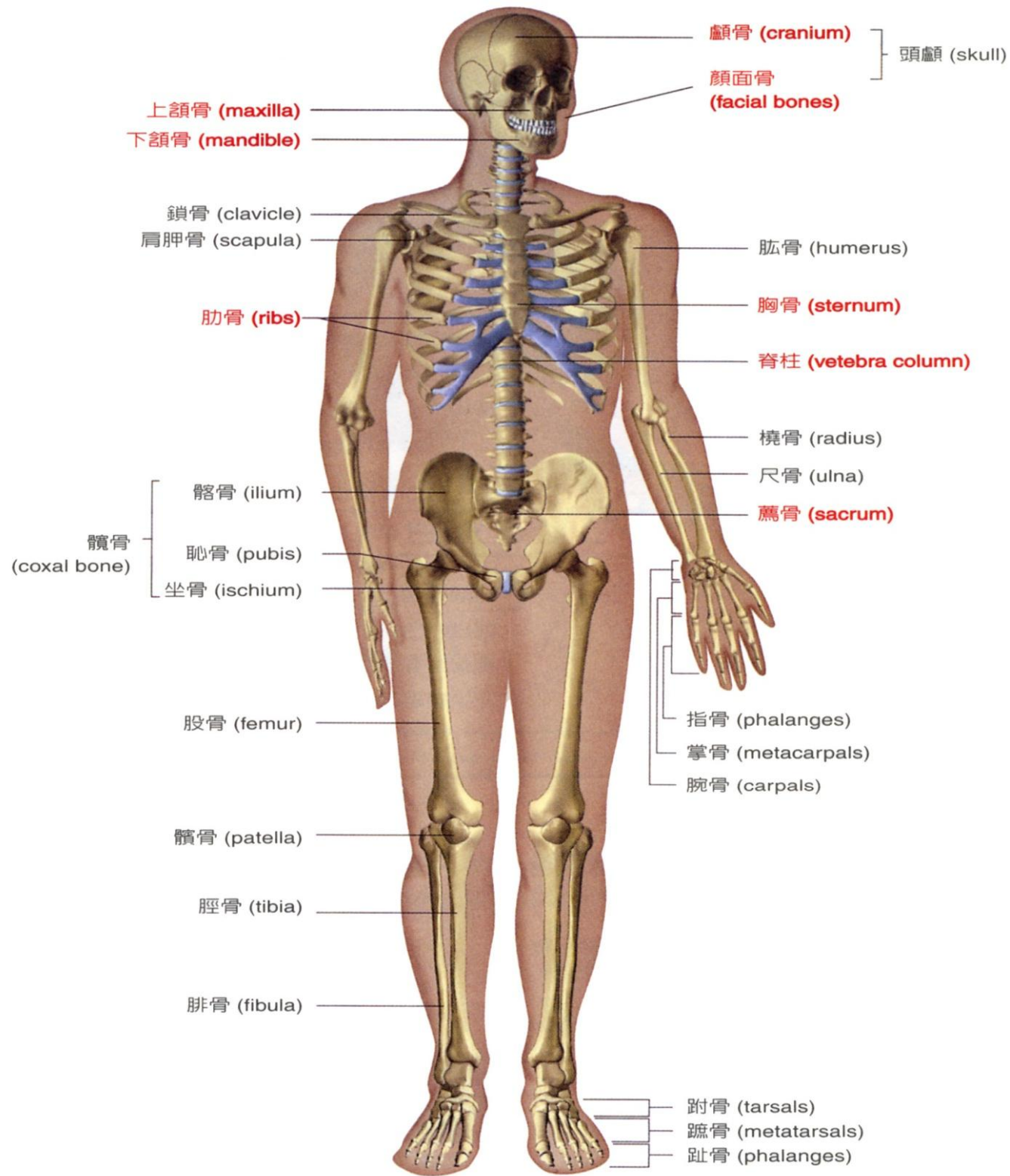
**Pelvic
(hip)
girdle**



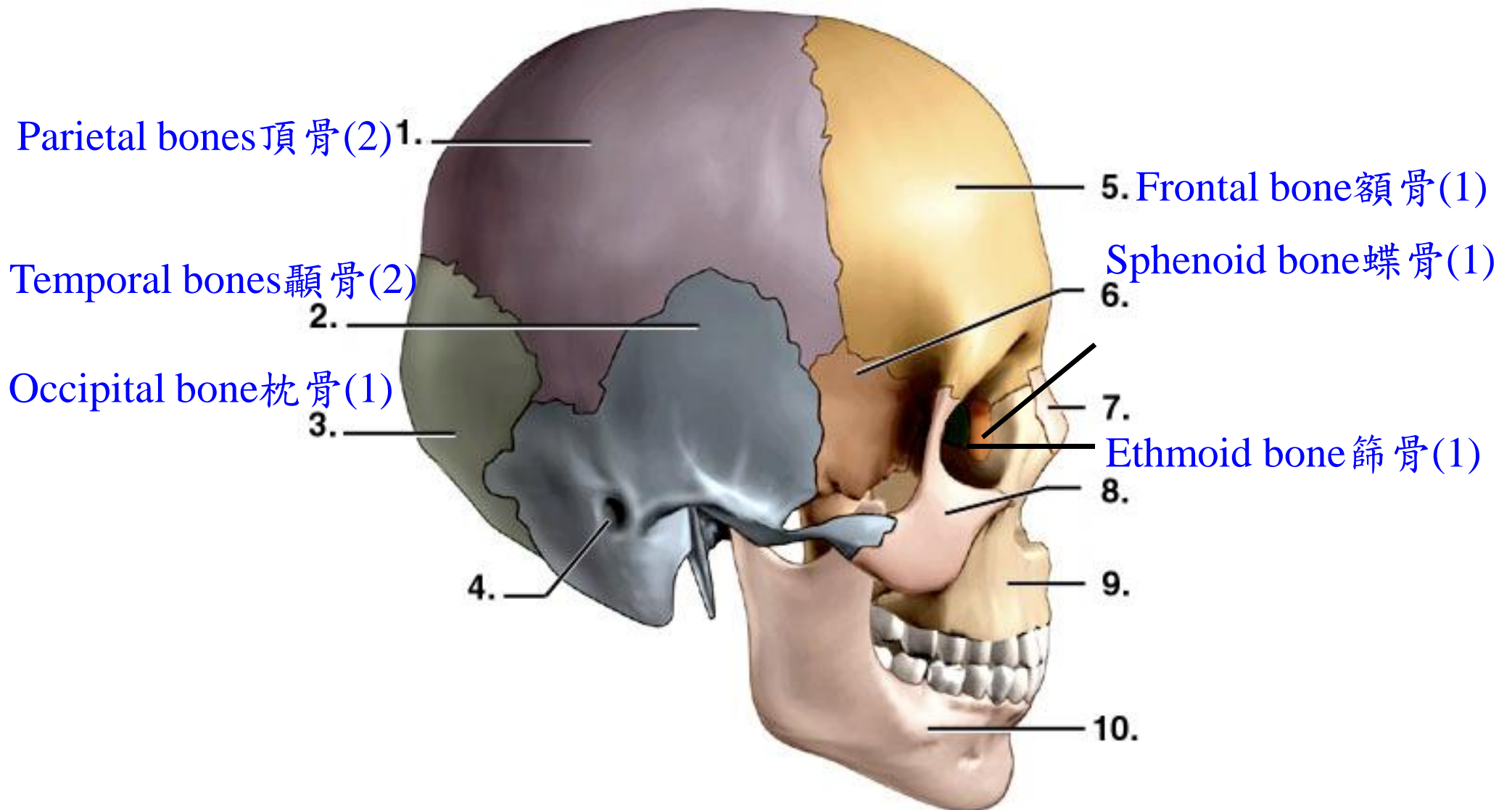
Ilium

Pubis

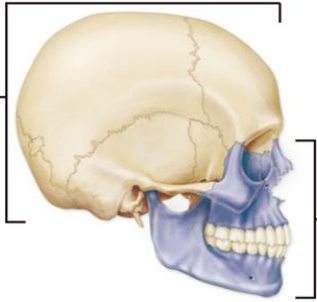
Ischium



Skull: Cranium (8)



頭蓋骨 (顱骨)
(Cranial bones)



顏面骨
(Facial bones)



蝶骨

頂骨
(Parietal bone)

額骨
(Frontal bone)

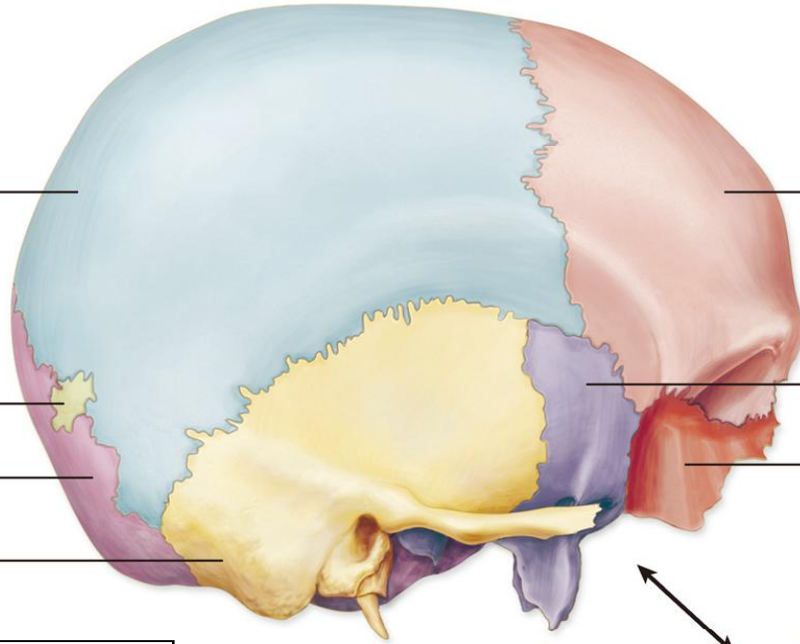
縫間骨
(Sutural bone)

蝶骨
(Sphenoid bone)

枕骨
(Occipital bone)

篩骨
(Ethmoid bone)

顳骨
(Temporal bone)



顴骨
(Zygomatic bone)

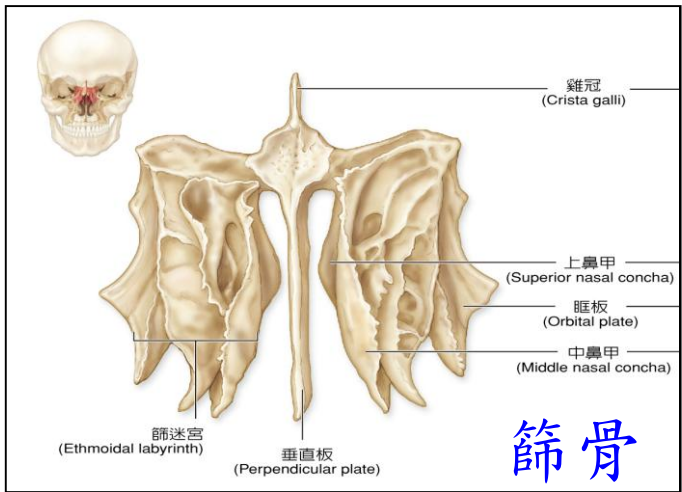
鼻骨
(Nasal bone)

犁骨
(Vomer)

淚骨
(Lacrimal bone)

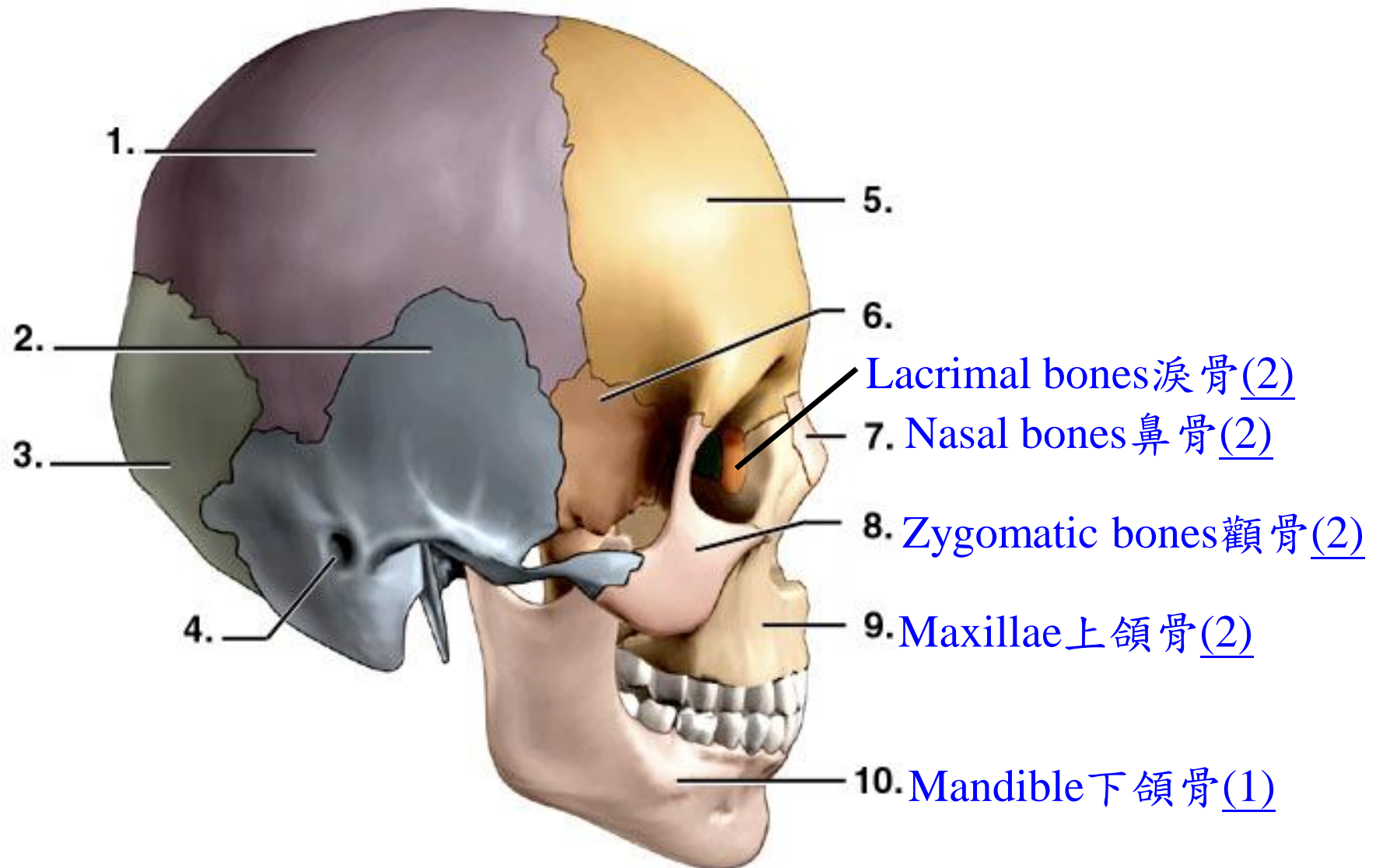
下頷骨
(Mandible)

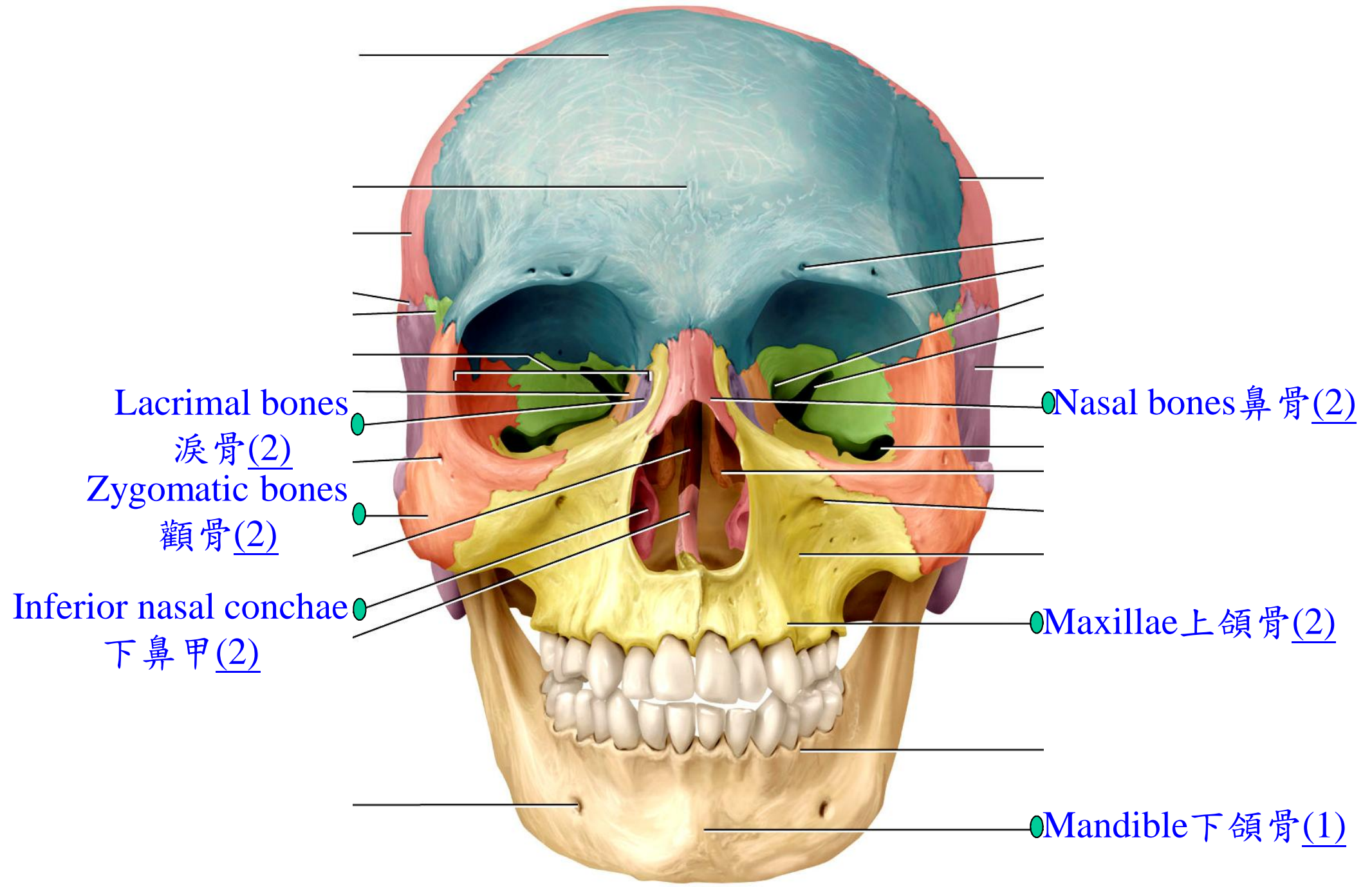
上頷骨
(Maxilla)



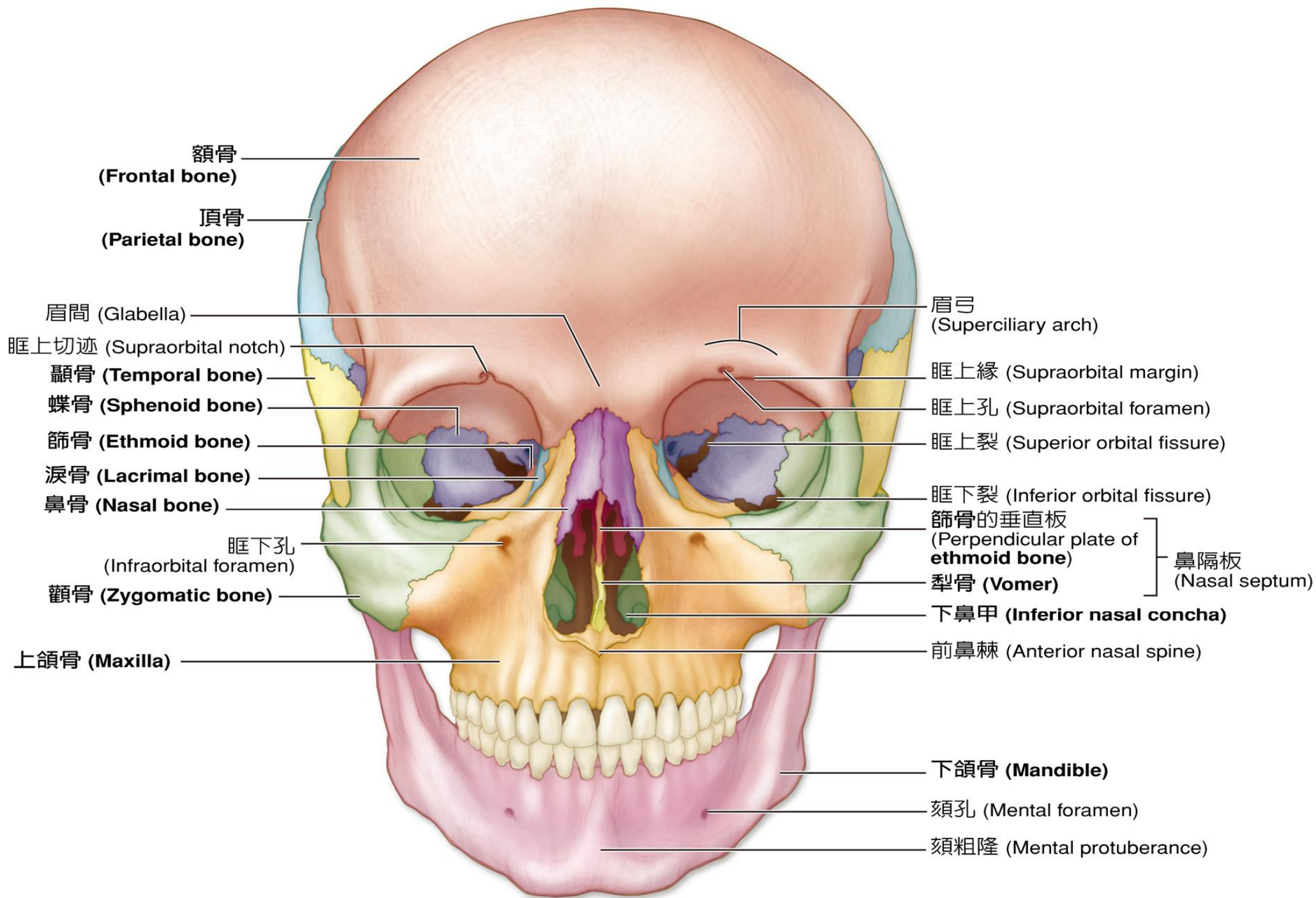
篩骨

Skull: Facial bone (14)

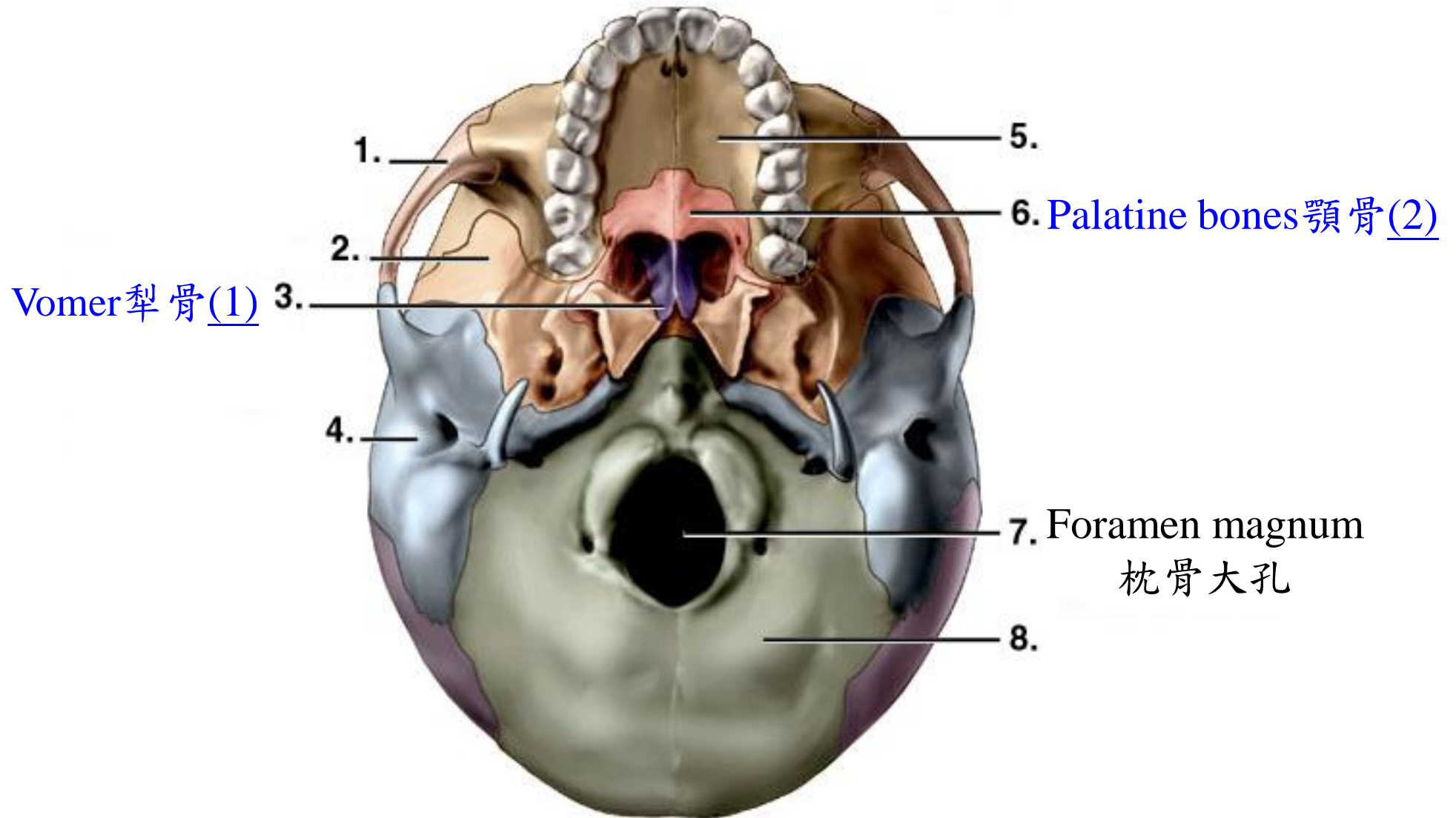


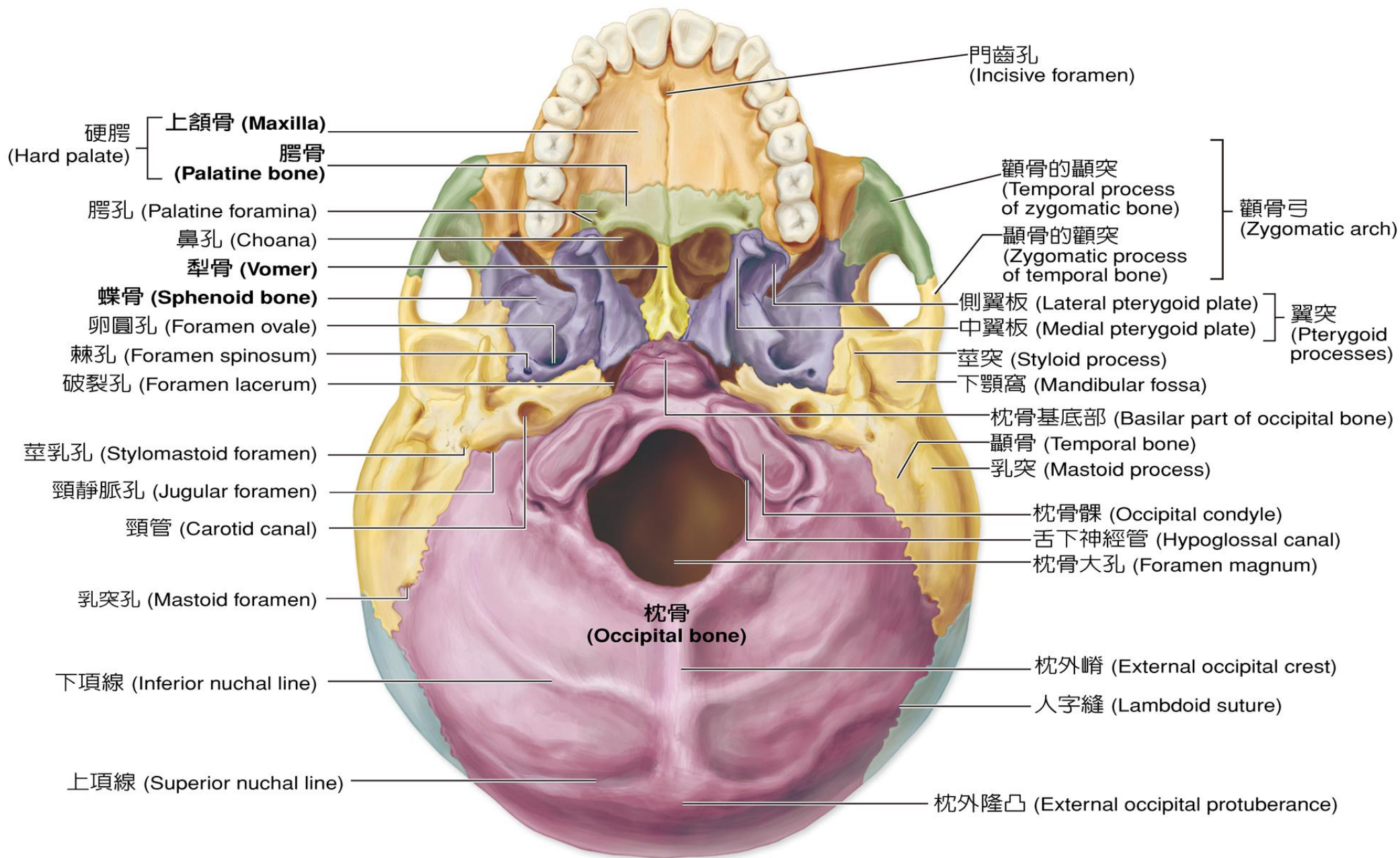


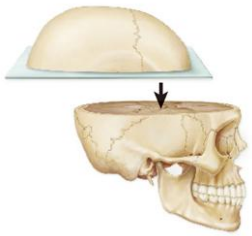
Anterior view



Skull







額竇 (Frontal sinus)

額骨 (Frontal bone)

頂嵴 (Frontal crest)

雞冠 (Crista galli)

篩板 (Cribriform plate)

篩骨

(Ethmoid bone)

視神經管 (Optic canal)

蝶骨小翼 (Lesser wing of sphenoid)

前床突 (Anterior clinoid process)

圓孔 (Foramen rotundum)

蝶骨 (Sphenoid bone)

蝶骨大翼 (Greater wing of sphenoid)

顳骨 (Temporal bone)

後床突 (Posterior clinoid process)

顳骨的岩部
(Petrous part of temporal bone)

枕骨大孔 (Foramen magnum)

頂骨 (Parietal bone)

枕骨 (Occipital bone)

枕內隆凸
(Internal occipital protuberance)

蝶鞍 (Sella turcica)

卵圓孔 (Foramen ovale)

棘孔 (Foramen spinosum)

破裂孔 (Foramen lacerum)

內耳道 (Internal acoustic meatus)

頸靜脈孔 (Jugular foramen)

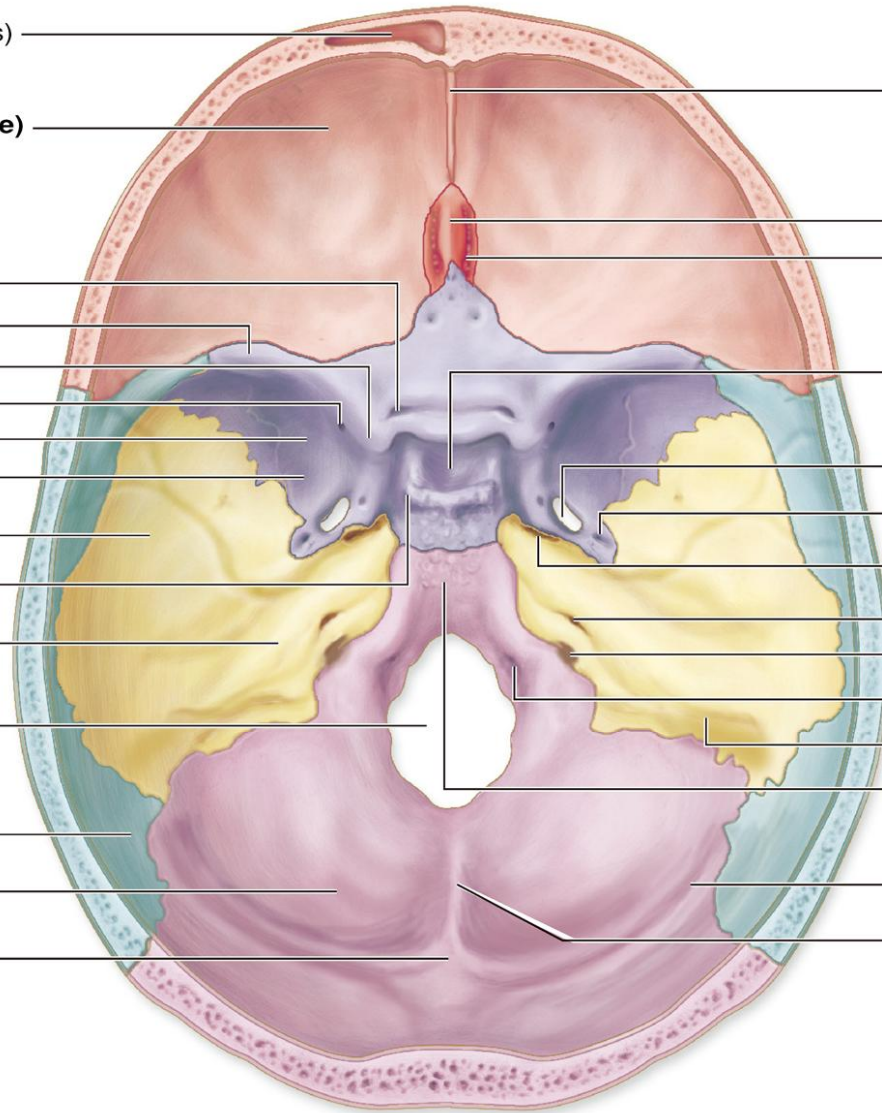
舌下神經管 (Hypoglossal canal)

乙狀竇溝 (Groove for sigmoid sinus)

枕骨基部 (Basilar part of occipital bone)

橫竇溝 (Groove for transverse sinus)

枕內嵴 (Internal occipital crest)

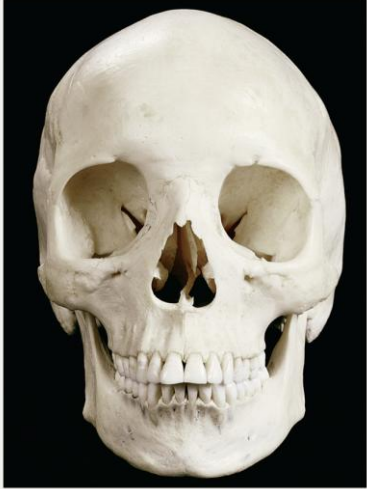





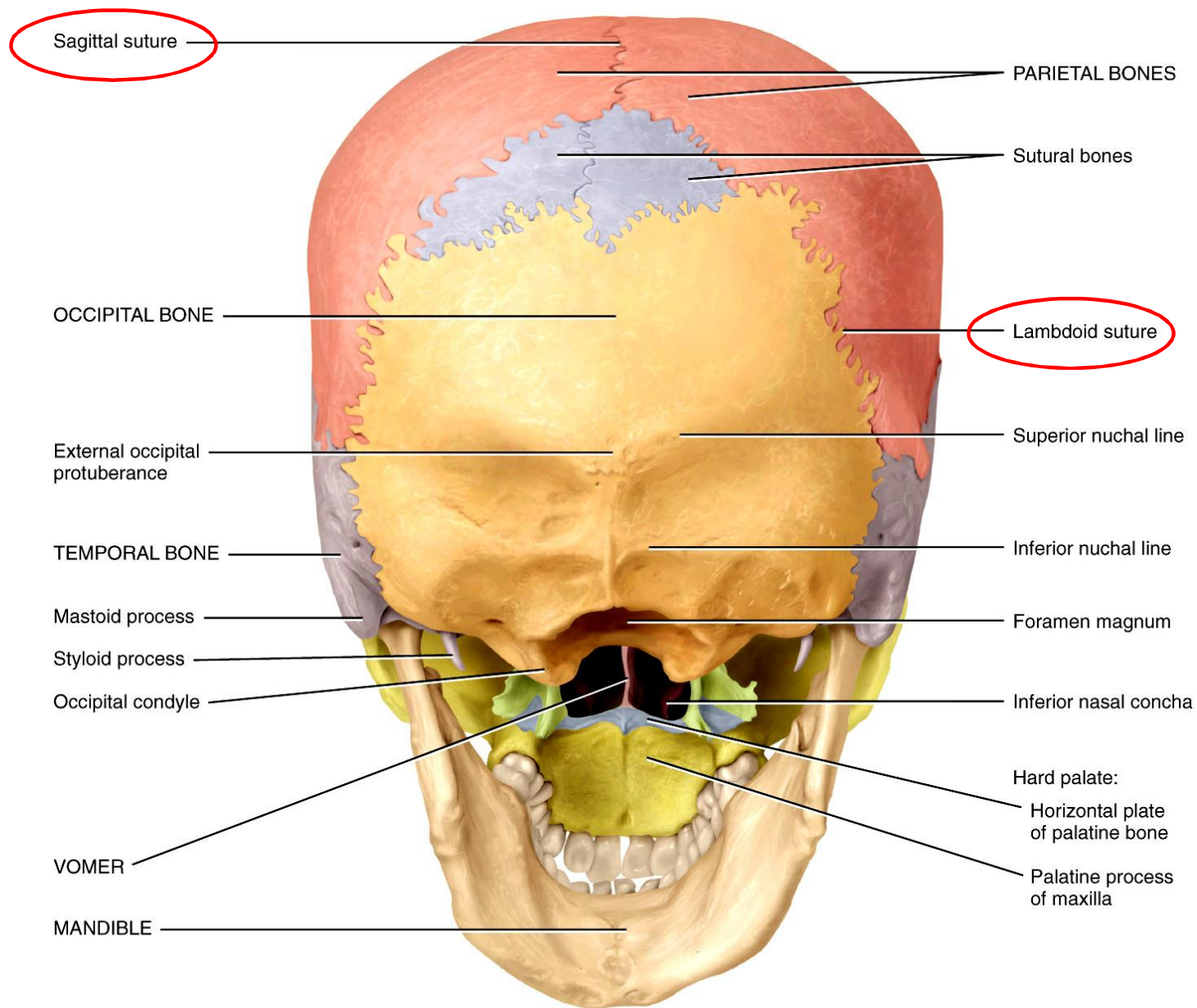
十二對腦神經通過頭顱骨的部位

1. 嗅神經：篩骨水平板之篩孔。
2. 視神經：蝶骨之視神經孔。
3. 動眼神經、滑車神經、三叉神經眼支、外旋神經：蝶骨之眶上裂。
4. 三叉神經上頷支：蝶骨之圓孔。
5. 三叉神經下頷支：蝶骨之卵圓孔。
6. 顏面神經的感覺神經與副交感神經：顛骨岩部的內耳道。
7. 顏面神經的運動神經：顛骨的莖乳突孔。
8. 前庭耳蝸神經：顛骨岩部的內耳道。
9. 舌咽神經、迷走神經、副神經：介於顛骨岩部與枕骨之間的頸靜脈孔。
10. 舌下神經：枕髁的基部上方之舌下神經孔。

Skull

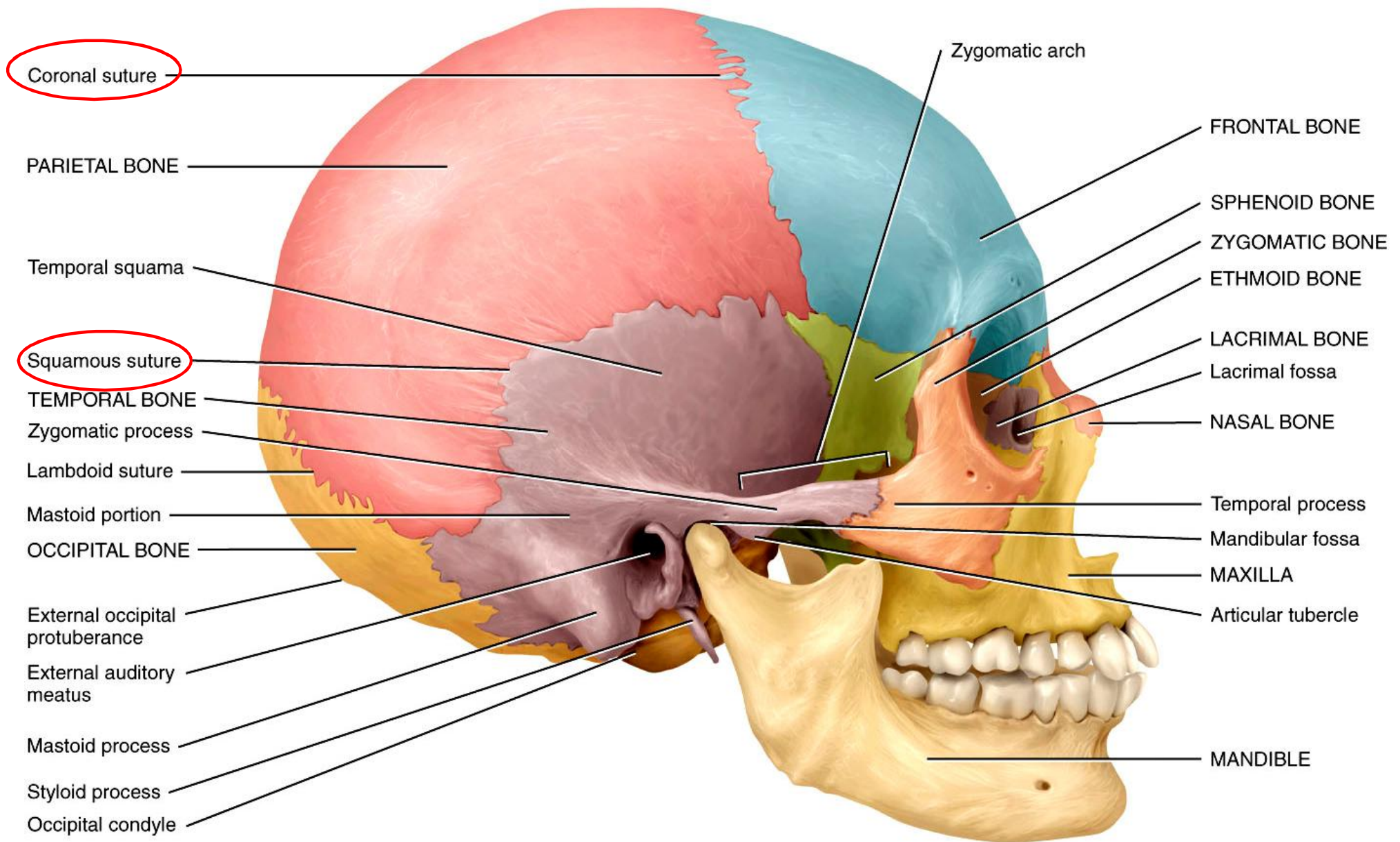
名稱	數目	描述
顱骨		
額骨	1	➢ 構成顱腔的前底部、眼眶的頂版：內有空腔位於眼眶上緣，稱為 額竇 (frontal sinus)，額竇內襯著黏膜。
頂骨	2	➢ 構成頭顱的頂部。
顳骨	2	➢ 構成顱腔的左、右下側壁，內有中耳及內耳，此外以下構成也位於顳骨：位於外耳後方的 乳突 (mastoid process)、 外耳道 (external auditory canal)以及讓肌肉附著的 莖突 (styloid process)。乳突內有許多襯著黏膜的乳突小房(mastoid cells)。
枕骨	1	➢ 構成顱腔的後壁，它有個大的洞讓脊髓能與顱腔的腦連通，稱為 枕骨大孔 (foramen magnum)。
蝶骨	1	➢ 構成顱腔底部的中央部位。以下構造位於蝶骨：一個稱為 蝶鞍 (sella turcica)的小凹陷，是腦下腺所在位置：讓肌肉附著的 翼突 (pterygoid process)。
篩骨	1	➢ 是塊形狀特殊的骨骼，它參與形成顱腔的前底部、鼻腔側壁與頂部、鼻中膈，整塊鼻中膈由 犁骨 (vomer)、篩骨的 垂直板 (perpendicular plate)與軟骨所組成，以及部分的眼眶。內有許多蜂巢狀的小空腔，稱為 篩竇 (ethmoid sinuses)。此外， 上、中鼻甲 (superior and middle concha)也是篩骨的一部分，二者都是位於鼻腔。
顏面骨		
鼻骨	2	➢ 構成鼻梁的兩小塊骨骼。
上頷骨	2	➢ 構成上顎，此外也參與形成口腔頂板、鼻腔底板和側壁、眼眶底板。內有大空腔，稱為 上頷竇 (maxillary sinus)。
顴骨	2	➢ 構成臉頰，也參與形成眼眶。
下頷骨	1	➢ 構成下顎。以下構造位於下頷骨：與顳骨形成關節的 髁突 (condyloid process)：位於下巴前方的 顏孔 (mental foramen)，神經與血管經由此小洞延伸至體表。
淚骨	2	➢ 構成眼眶內側壁與鼻側壁的小骨頭。
顎骨	2	➢ 參與形成口腔頂板的後部、鼻腔底板和側壁、眼眶底板。
下鼻甲	2	➢ 卡在鼻腔側壁的捲取樣突出物，位於中鼻甲的下方
犁骨	1	➢ 形成鼻中膈的下後部。
聽小骨		
錘骨	2	➢ 位於顳骨鼓室(中耳)的小骨頭，狀似錘子。
砧骨	2	➢ 位於顳骨鼓室的小骨頭，狀似打鐵時墊在底下的砧鑽。
鐙骨	2	➢ 位於顳骨鼓室的小骨頭，狀似騎馬的人踏腳用的馬鐙。

不同方向的觀測圖	女性頭顱	男性頭顱
前視圖		
側視圖		
頭顱特徵	女性頭顱特徵	男性頭顱特徵
一般大小與外貌	纖細優美	較強壯結實（較大、重）
頸線及枕骨外粗隆	枕骨外表面比較平順，沒有較大的骨骼突起	與頸線明顯區分，有凸起或鉤狀枕外粗隆
乳突	比較小	大，可能向下凸出至外耳道
額骨的鱗部	通常較為水平方向，比男性圓	較為傾斜的角度
眶上緣	薄、陡峭的邊緣	厚、圓、鈍狀邊緣
眉弓	小，少凸出	較凸出，有較大的邊緣
下頷骨（一般特徵）	小且輕	大、重且結實
頰粗隆（下巴）	較尖與三角形，少凸出	方形，較凸出
下頷角	一般大於125度	外傾，小鈍角，小於125度（一般大約90度）
竇	總體積較小	總體積較大
牙齒	相對較小	相對較大



Posteroinferior view

- **Lamboid suture** unites parietal and occipital
- **Sagittal suture** unites 2 parietal bones

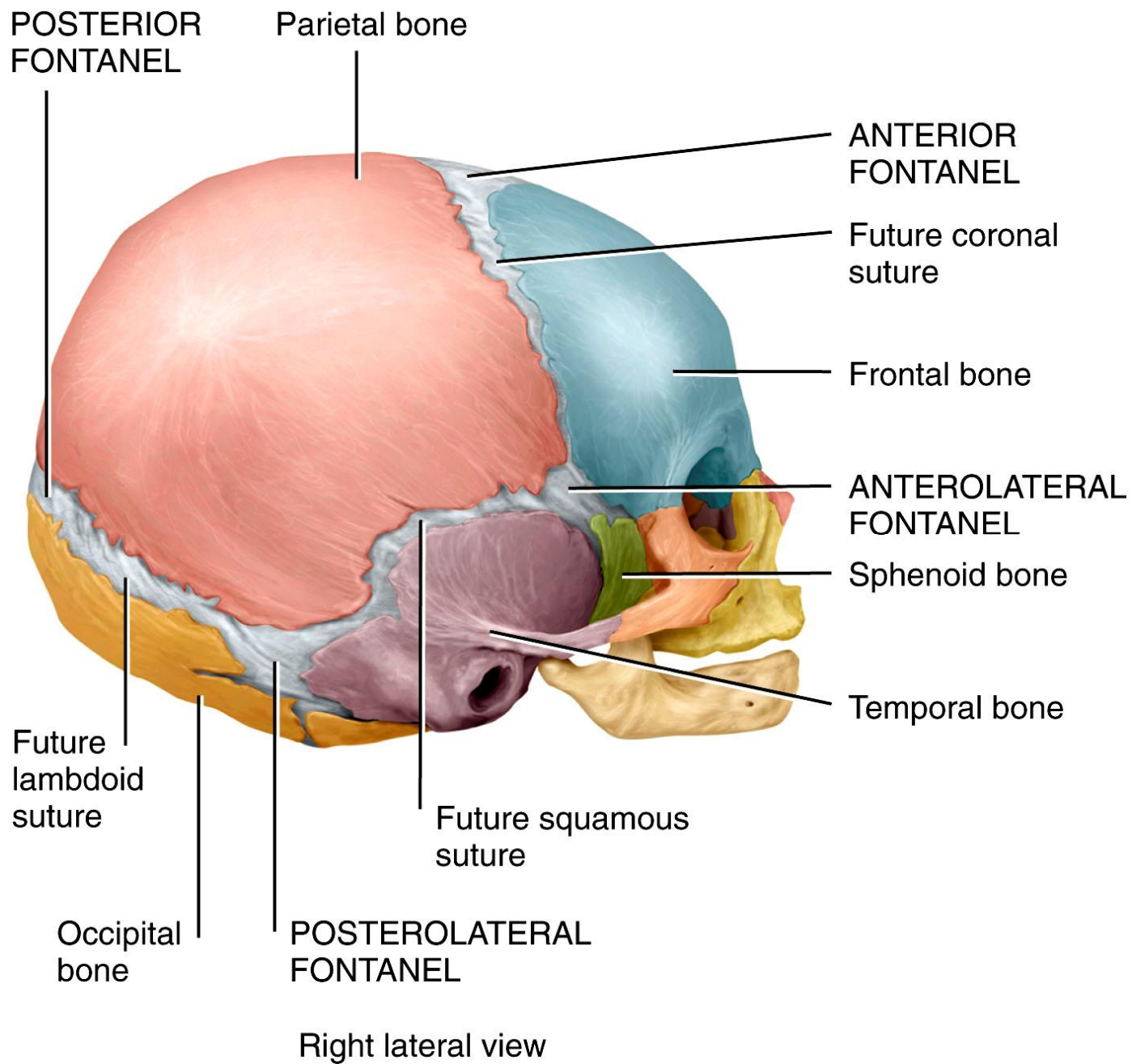


Right lateral view

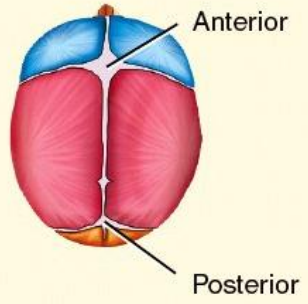
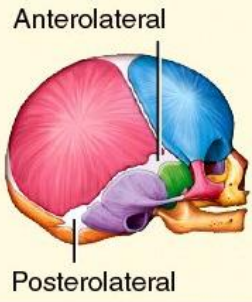
- **Coronal suture** unites frontal and both parietal bones
- **Squamous suture** unites parietal and temporal bones

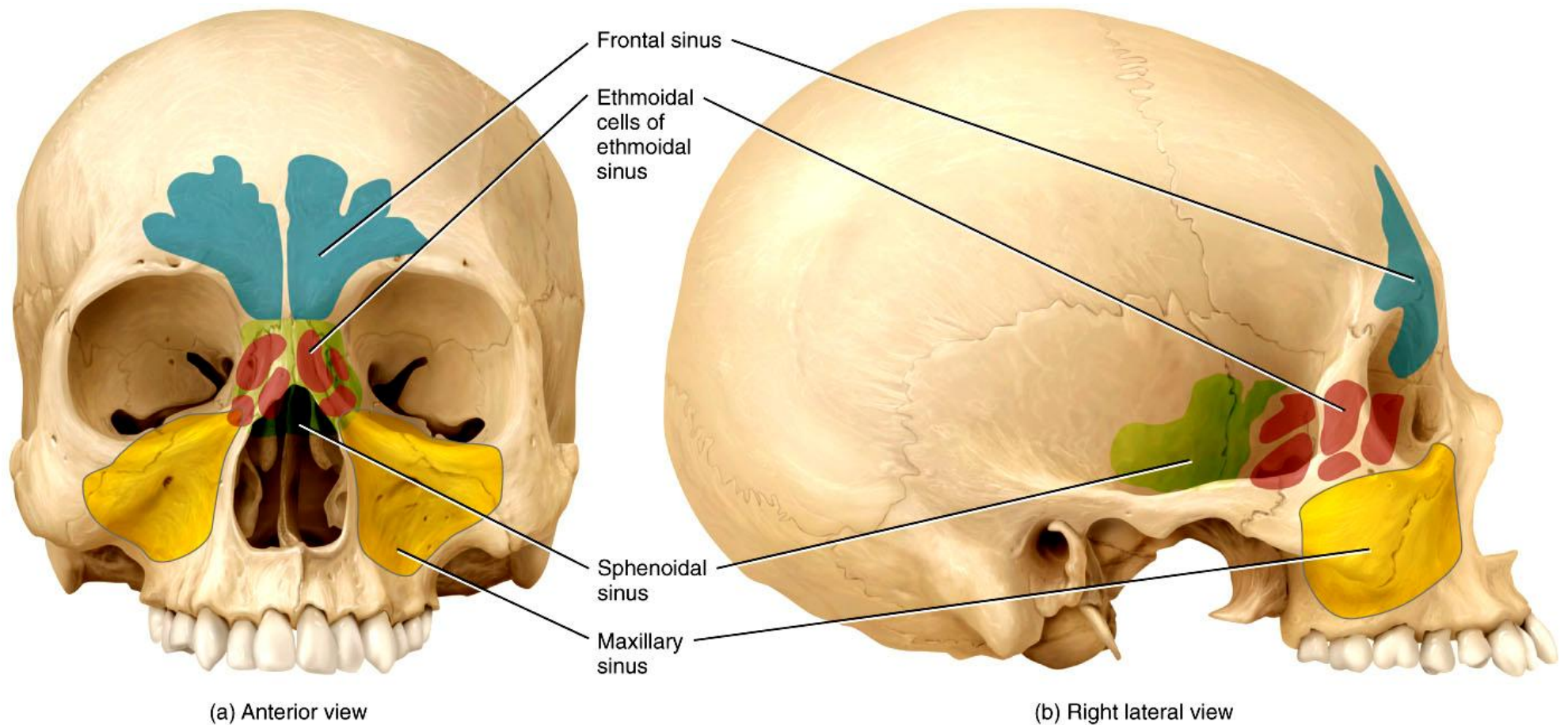
Fontanelles (囟、丁一ㄣ、'門)

- *Fontanelles* are dense connective tissue membrane-filled spaces between the cranial bones of fetuses and infants. They remain unossified at birth but close early in a child's life
 - The major fontanelles (6) are the *anterior, posterior, anterolaterals, and posterolaterals*
- Fontanelles have two major functions.
 - They enable the fetal skull to modify its size and shape as it passes through the birth canal
 - They permit rapid growth of the brain during infancy



Fontanels (囟、丁一ㄣ、'門)

Fontanel	Location	Description
Anterior	Between the two parietal bones and the frontal bone.	Roughly diamond-shaped, the largest of the fontanel; usually closes 18–24 months after birth.
Posterior	Between the two parietal bones and the occipital bone.	Diamond-shaped, considerably smaller than the anterior fontanel; generally closes about 2 months after birth.
		
Anterolateral	One on each side of the skull between the frontal, parietal, temporal, and sphenoid bones.	Small and irregular in shape; normally close about 3 months after birth.
Posterolateral	One on each side of the skull between the parietal, occipital, and temporal bones.	Irregularly shaped; begin to close 1 or 2 months after birth, but closure is generally not complete until 12 months.
		

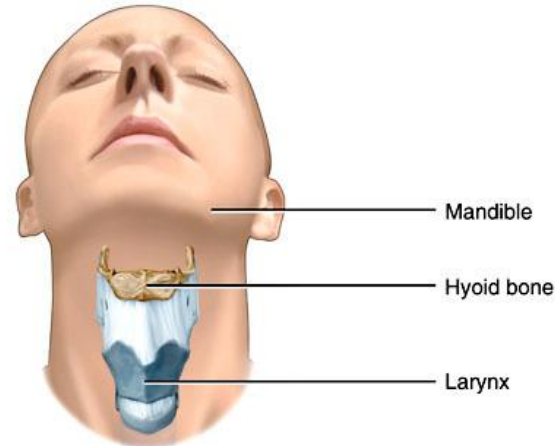


● Paranasal Sinuses

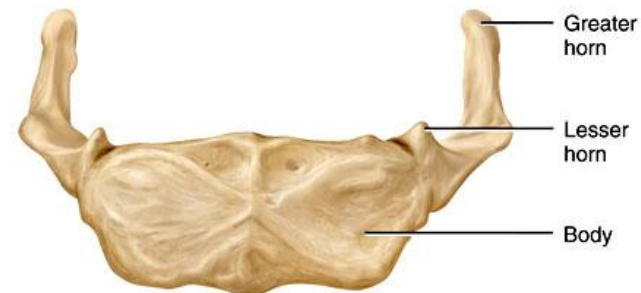
- Cavities within cranial and facial bones near the nasal cavity
- Secretions produced by the mucous membranes which line the sinuses, drain into the nasal cavity
- Serve as resonating chambers that intensify and prolong sounds

Hyoid Bone

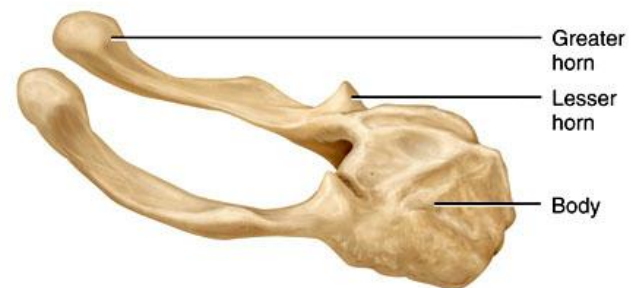
- U-shaped single bone
- Articulates with **no** other bone of the body
- Suspended by **ligament and muscle** from skull
- Supports the **tongue** & provides attachment for **tongue, neck and pharyngeal muscles**



(a) Position of hyoid



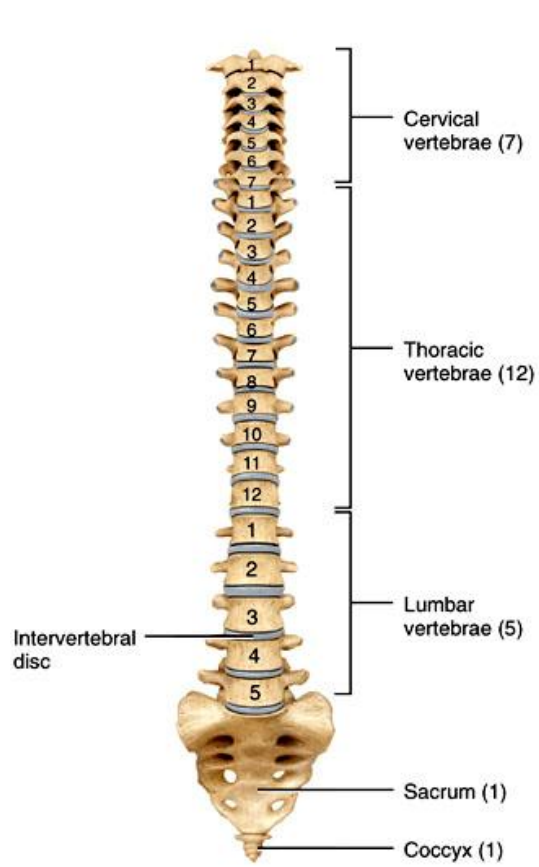
(b) Anterior view



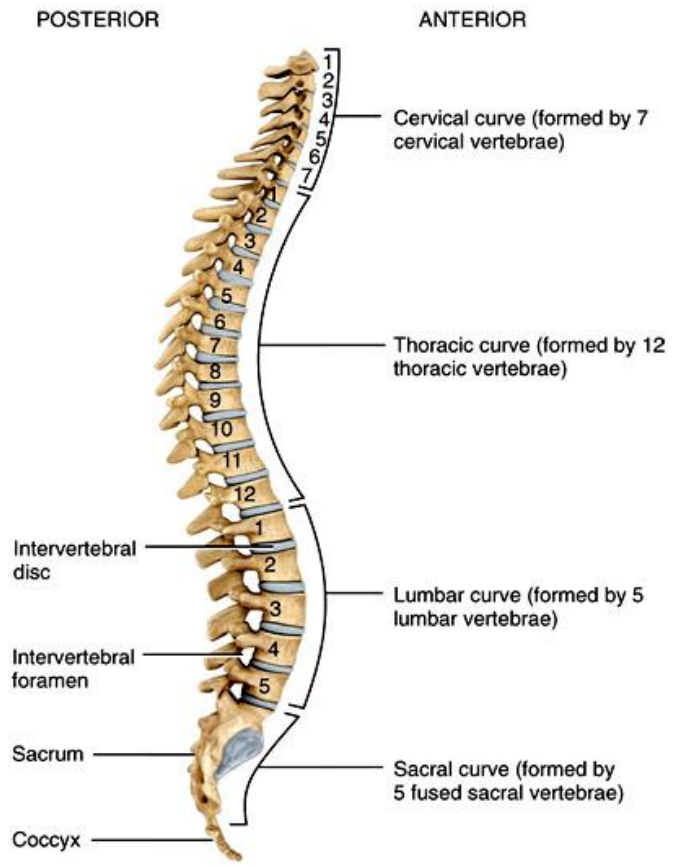
(c) Right lateral view

Spine (26)

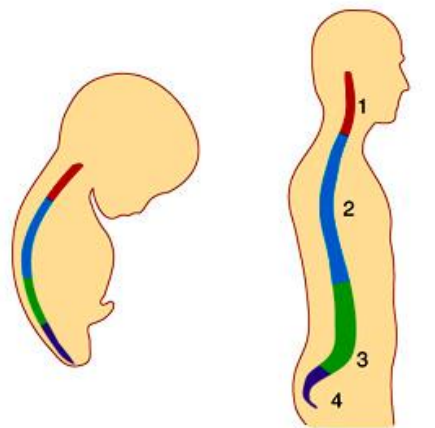
名稱	數量	特性
頸椎 (Cervical vertebrae)	7	簡稱C，最上方的7節脊椎，在頸部；第一頸椎稱寰椎(C1)，功能是可點頭；第二頸椎是軸椎(C2)，和第一頸椎寰椎(C1)形成寰軸關節，功能是可使頭部轉動
胸椎 (Thoracic vertebrae)	12	簡稱T，利用肋骨直接附在胸椎上，T4代表胸椎的第四塊
腰椎 (Lumbar vertebrae)	5	簡稱L，在腰部，L3代表腰椎第三塊
薦椎 (Sacral vertebrae)	1	簡稱S，在孩童期有五節，成年癒合成一塊
尾椎 (Coccygeal vertebrae)	1	孩童期有三~五節，成年癒合成一塊



(a) Anterior view showing regions of the vertebral column

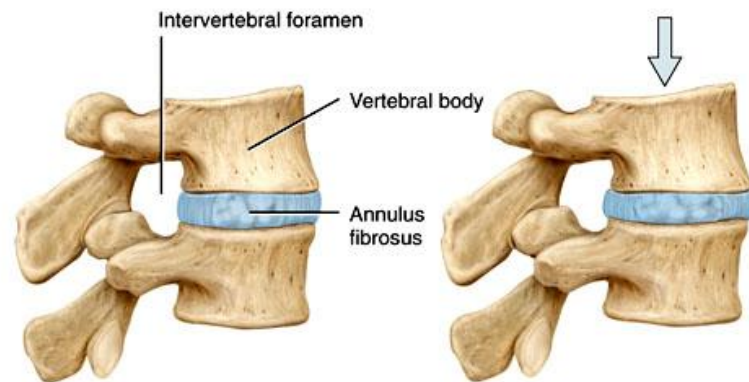


(b) Right lateral view showing four normal curves



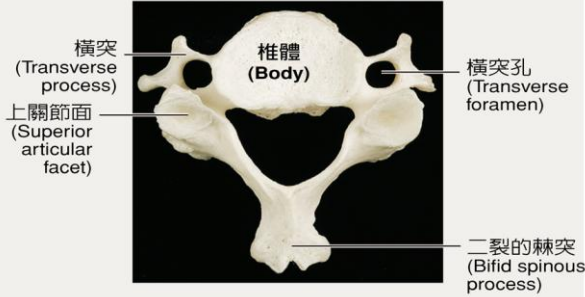
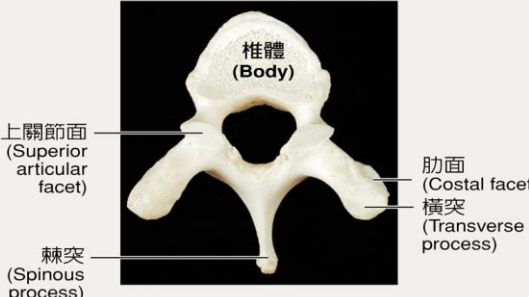
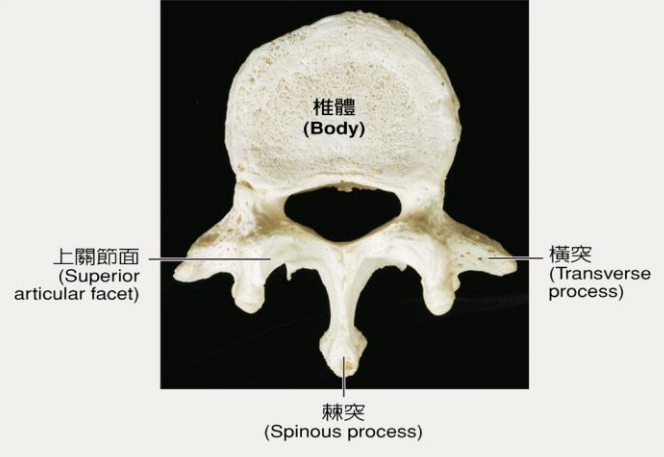
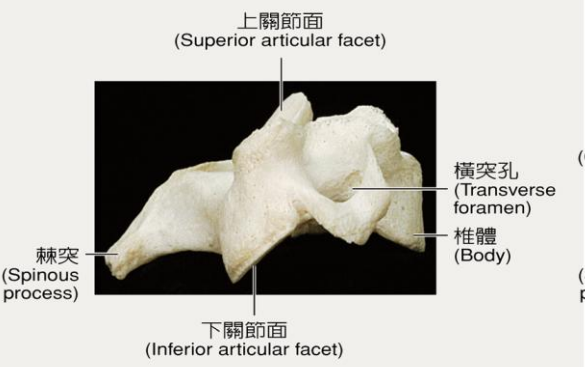
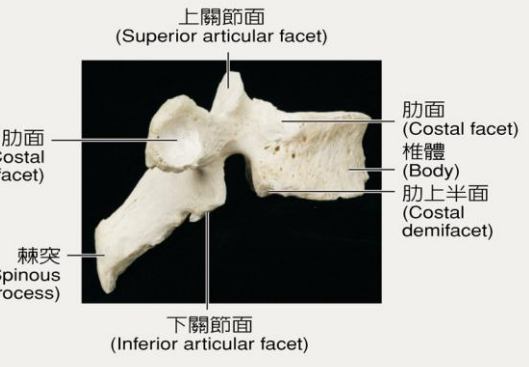
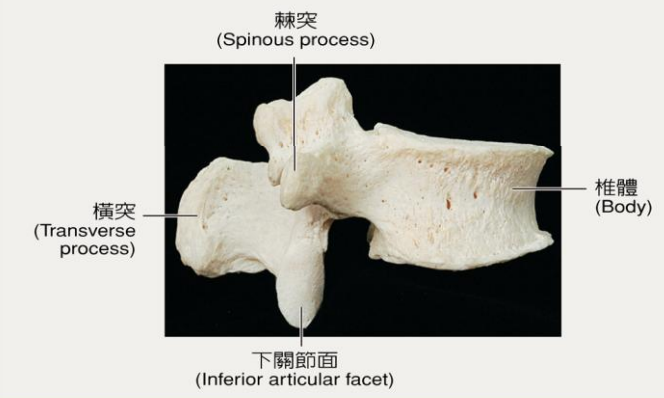
Single curve in fetus Four curves in adult

(c) Fetal and adult curves



Normal intervertebral disc Compressed intervertebral disc in a weight-bearing situation

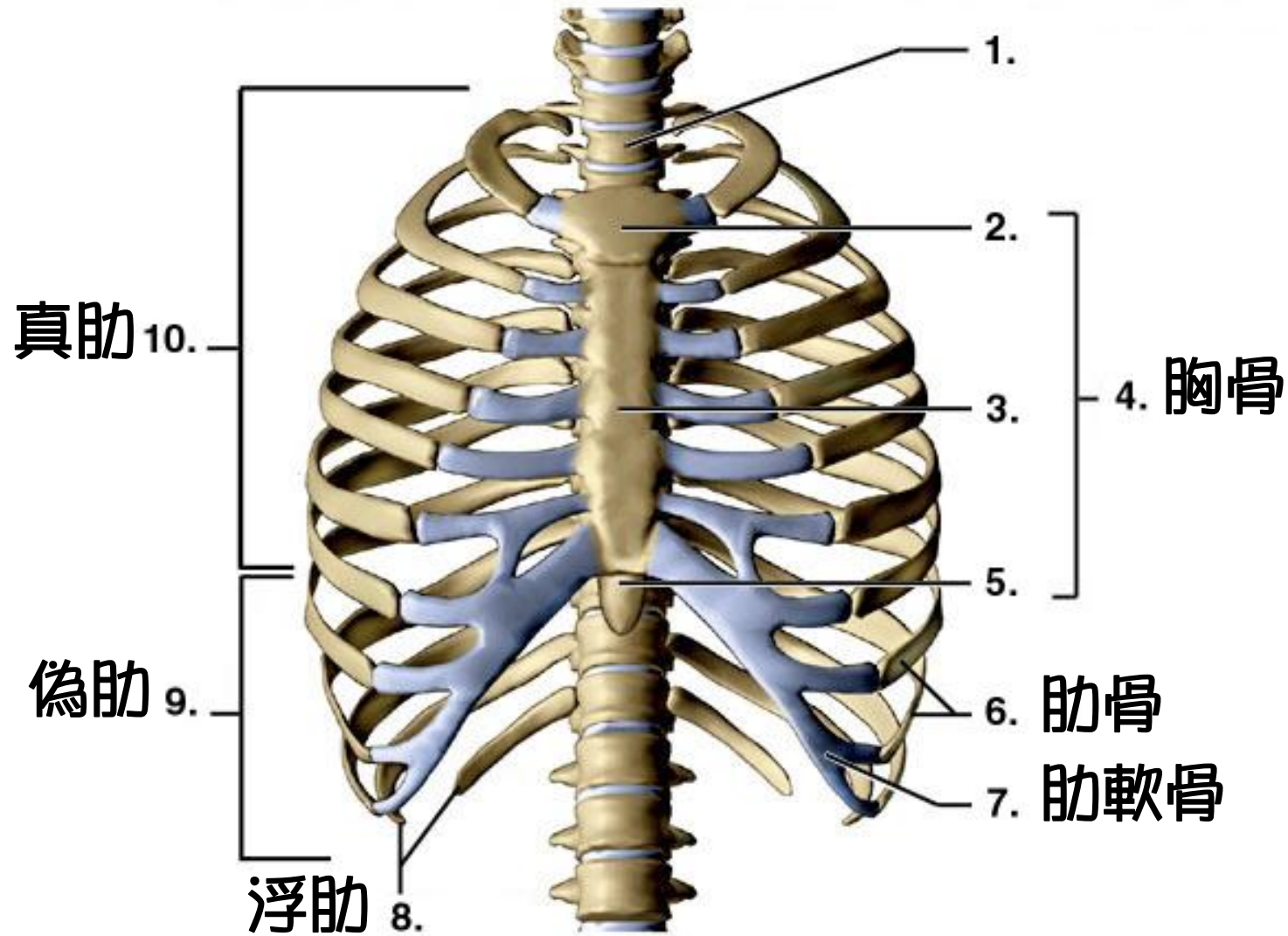
(d) Intervertebral disc

圖示	(a) 頸椎	(b) 胸椎	(c) 腰椎
上視圖	 <p>橫突 (Transverse process) 椎體 (Body) 橫突孔 (Transverse foramen) 上關節面 (Superior articular facet) 二裂的棘突 (Bifid spinous process)</p>	 <p>上關節面 (Superior articular facet) 椎體 (Body) 肋面 (Costal facet) 橫突 (Transverse process) 棘突 (Spinous process)</p>	 <p>上關節面 (Superior articular facet) 椎體 (Body) 棘突 (Spinous process) 橫突 (Transverse process)</p>
側視圖	 <p>上關節面 (Superior articular facet) 棘突 (Spinous process) 下關節面 (Inferior articular facet) 橫突孔 (Transverse foramen) 椎體 (Body)</p>	 <p>上關節面 (Superior articular facet) 肋面 (Costal facet) 棘突 (Spinous process) 下關節面 (Inferior articular facet) 肋面 (Costal facet) 椎體 (Body) 肋上半面 (Costal demifacet)</p>	 <p>棘突 (Spinous process) 椎體 (Body) 下關節面 (Inferior articular facet) 橫突 (Transverse process)</p>
特徵	頸椎	胸椎	腰椎
大小	較小	中等大小 (比頸椎大)	最大
體型	較小、腎豆形	心形	大，圓形到卵圓形
與肋骨接合面	不存在	在椎體上，有橫突	不存在
橫孔	有	無	無
棘突	較苗條，C ₁ 到C ₆ 通常是二裂狀的	較長，通常為下方突出	短 (粗厚且鈍)，下方突出
關節面的角度	<ol style="list-style-type: none"> 1. 朝前下方 2. 朝後上方 	<ol style="list-style-type: none"> 1. 朝前中邊 2. 朝後側邊 	<ol style="list-style-type: none"> 1. 朝側邊 2. 朝中間
橫突	較小 (包含橫突孔)	中等大小	大，粗厚且鈍

Thoracic Cage (25)

名稱	數量	特性
真肋	14	R1~R7透過肋軟骨接在胸骨上
偽肋	10	下方之五對肋骨 (R8~R12)，好像接在胸骨上，又好像沒有。R8~R10沒直接接在胸骨，而是接到第七對肋骨上面，稱偽肋。最下方的兩對 (R11~R12) 沒有附在胸骨上面，直接從胸椎接出來，稱浮肋
胸骨	1	由三部分組成: 1. 胸骨柄(像菜刀的手把) 2. 胸骨體(CPR壓的地方) 3. 胸骨劍突(像劍的末端)

Thoracic Cage (25)



Upper Limb (64)

名稱	數量	特性
鎖骨	2	胸帶與中軸骨骼之間唯一的關節，介於兩邊的胸骨及鎖骨，稱為胸鎖骨關節
肩胛骨	2	肩胛骨與鎖骨共同形成了肩帶。在肩胛骨處有一關節稱為肩關節，肩關節位於肩胛骨與手臂上肱骨交接處為全身活動範圍最大的關節
肱骨	2	為上肢最長最大的骨頭。外科頸通常為肱骨骨折時最容易斷裂的地方
橈骨	2	前臂靠大姆指側的骨頭，即為手臂的外側
尺骨	2	前臂靠小姆指側的骨頭，即為手臂的內側；鷹嘴突為尺骨的突起，與肱骨下方的鷹嘴窩形成肘關節，所謂的手肘，為運動程度最小的關節
腕骨	16	左右手各8塊，屬於不規則骨，骨頭排列方式為上下排列
掌骨	10	左右手各5塊
指骨	28	左右手各14塊，大姆指為2塊，其餘的四指皆為3塊 ²

Upper Limb

(64)

鎖骨

肩胛骨

肱骨

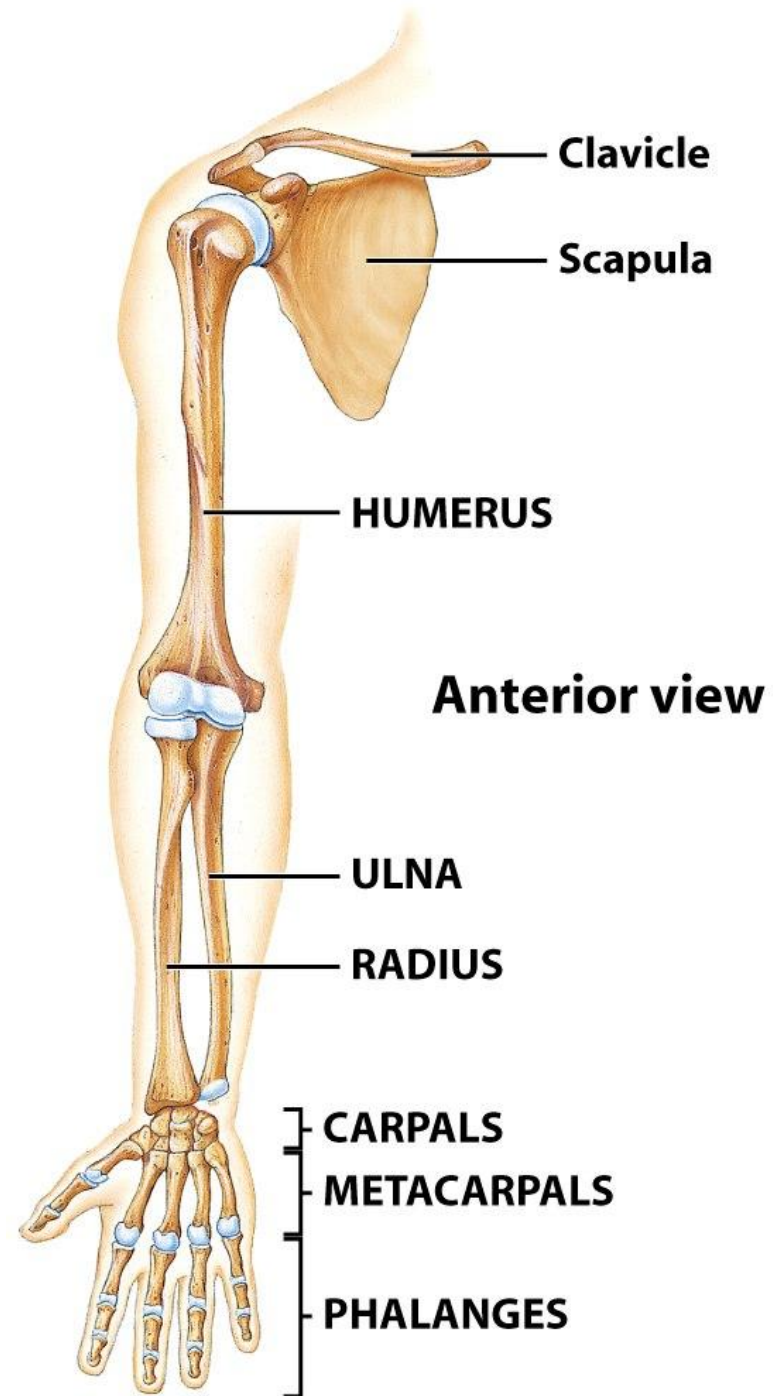
橈骨

尺骨

腕骨

掌骨

指骨



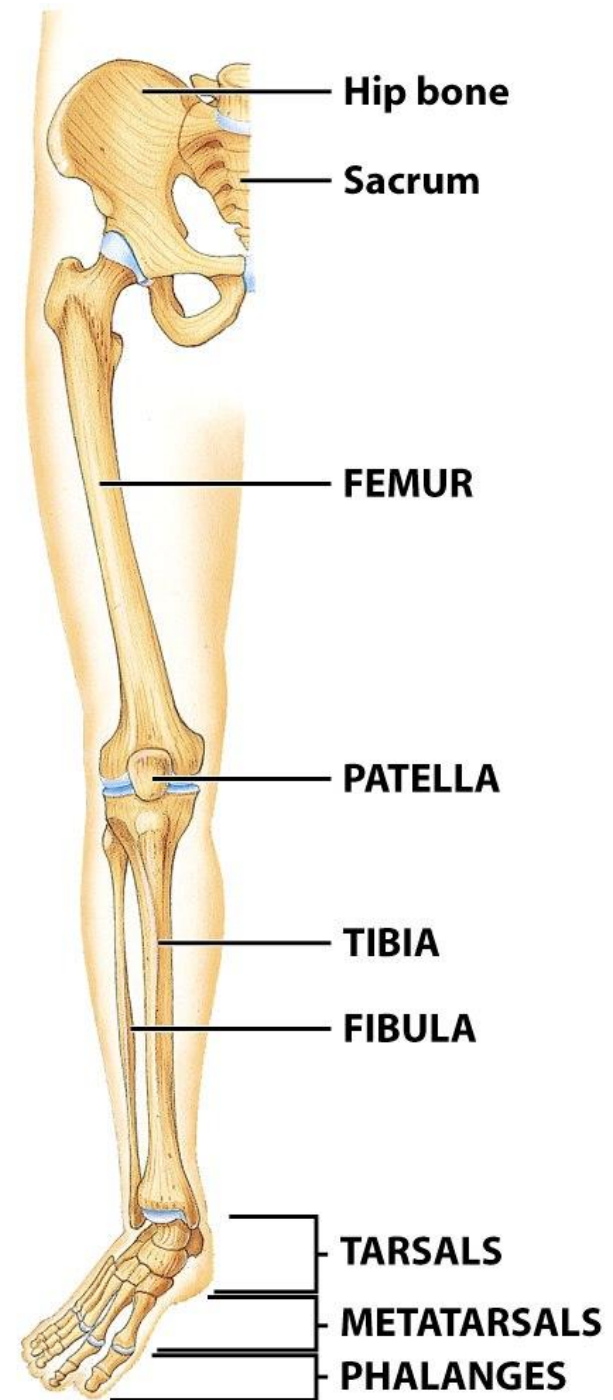
Lower Limb (62)

名稱	數量	特性
髖骨	2	1. 髌骨又稱『腸骨』位於一骨盆骨上部 2. 坐骨位於一骨盆骨下背部 3. 恥骨位於一骨盆骨之前下部。『髌白』會跟大腿骨的骨頭最上端形成一個重要的關節稱為『髌關節』
股骨	2	稱『大腿骨』為身體中最長、最大、最重的骨頭。骨頭之上端成球狀，與髌骨的髌白相嵌合形成髌關節
髌骨	2	屬『種子骨』，身體最大的種子骨為「膝蓋骨」。髌骨(膝蓋骨)與股骨(大腿骨)及脛骨形成『膝關節』
脛骨	2	『小腿骨』，緊貼在皮膚的骨頭，身體內第二長的骨頭
腓骨	2	『小腿骨』，位在小腿外側，為瘦長的骨頭
跗骨	14	『距骨』或『踝骨』，形成腳跟及腳的後部，俗稱為『腳踝』 跗骨裡最大的骨頭稱為『跟骨』，是平時赤腳走路或穿平底鞋承受最大重量、最吃重的骨頭
跖骨	10	穿高跟鞋時最吃重的骨頭，腳與腳趾連接的部分。跗骨與跖骨的排列方式在足部形成三個『足弓』
趾骨	28	腳趾頭和手指頭一樣

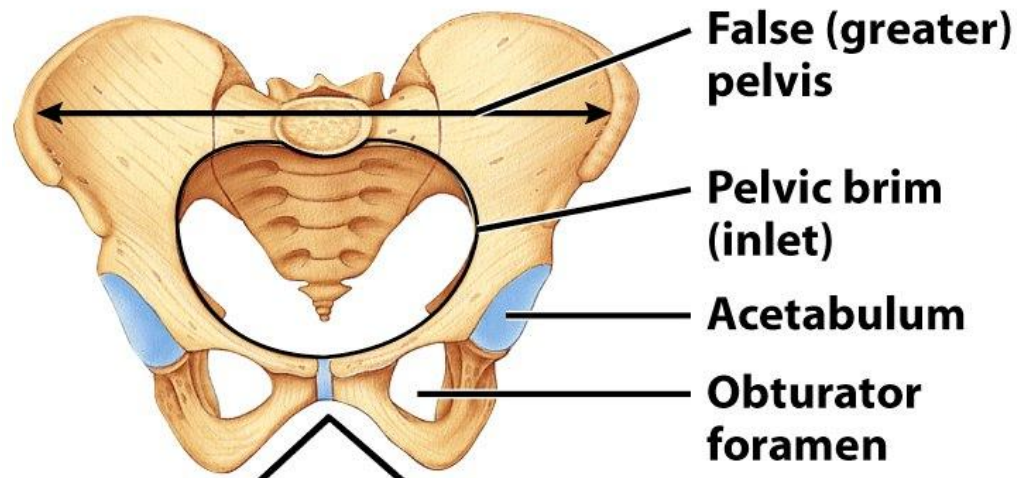
Lower Limb

(62)

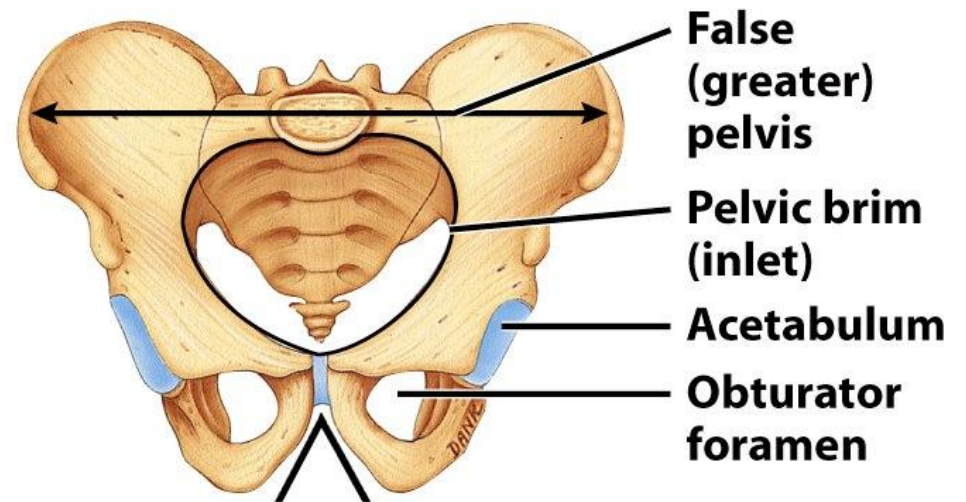
髌骨
股骨
髌骨
胫骨
腓骨
跗骨
蹠骨
趾骨



Sex Differences of Pelvises



Pubic arch (greater than 90°)



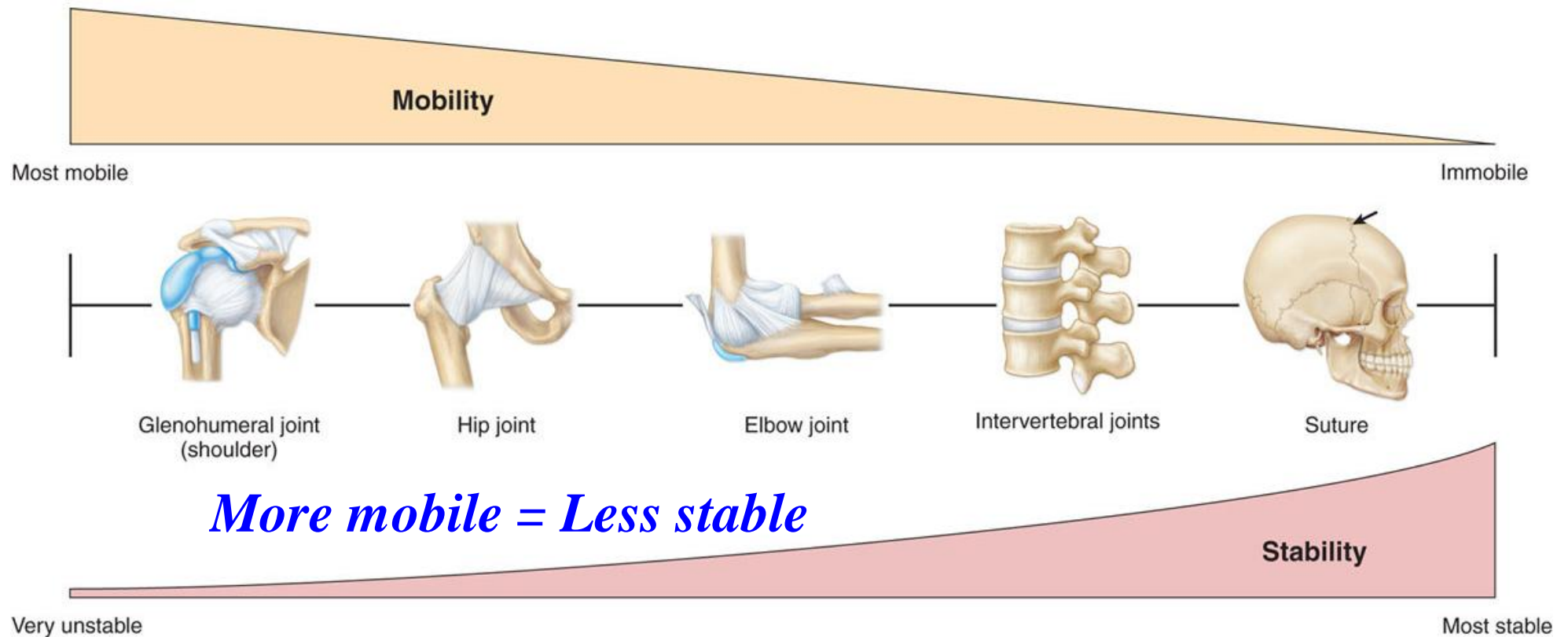
Pubic arch (less than 90°)

Anterior views

比較	男性	女性
一般的構造	重而厚	輕而薄
關節面	大	小
肌肉的附著處	很明顯	不明顯
大骨盆	深	淺
骨盆上口	心臟形	較大且接近卵形
骨盆下口	較小（呈漏斗形）	較大（呈圓形）
恥骨弓	小於90°	大於90°
恥骨的下枝	有強韌的外翻面，以作為陰莖角的附著處	外翻面不存在
恥骨聯合	較長	較短
坐骨棘	朝內	較不朝內
坐骨粗隆	朝內	朝外
髌骨	較垂直	朝不垂直
髌骨窩	深	淺
髌骨嵴	較彎曲	較不彎曲
髌白	大	小
閉孔	圓形	卵圓形

Joint= *articulation* = *arthrosis*

- Joints hold **bones together** but permit **movement**
- Point of contact--Between 2 bones; Between cartilage and bone; Between teeth and bones
- Arthrology = study of joints
- Kinesiology = study of motion



Classification of Joints

- Structural classification is based on the presence or absence of a *synovial (joint) cavity* and *type of connecting tissue*

--Structurally, joints are classified as *fibrous, cartilaginous, or synovial*

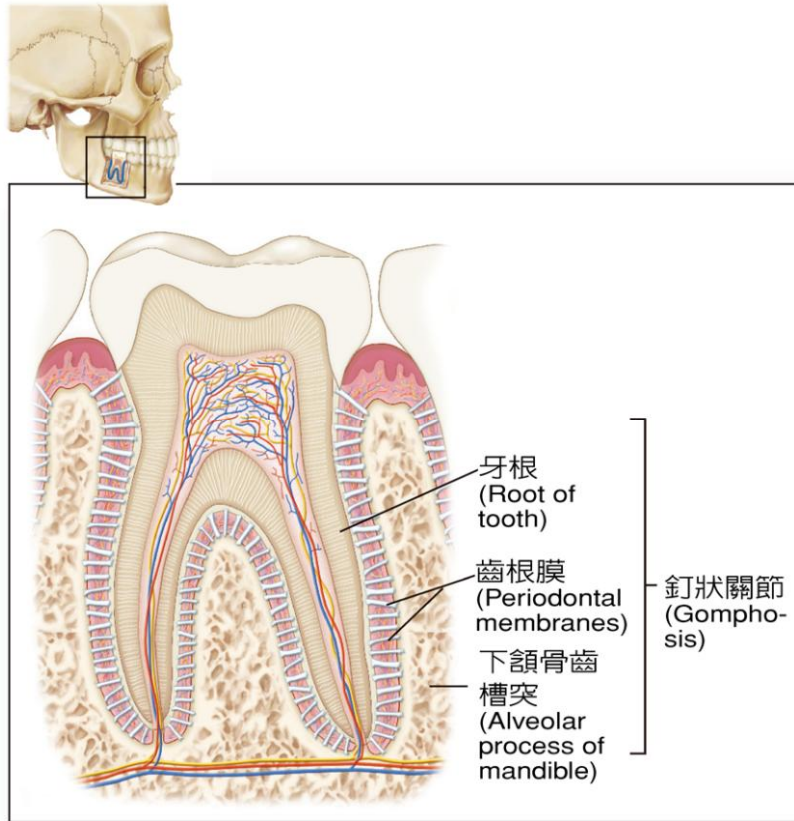
- Functional classification based upon movement:

--*Immovable* = synarthrosis

--*Slightly movable* = amphiarthrosis

--*Freely movable* = diarthrosis

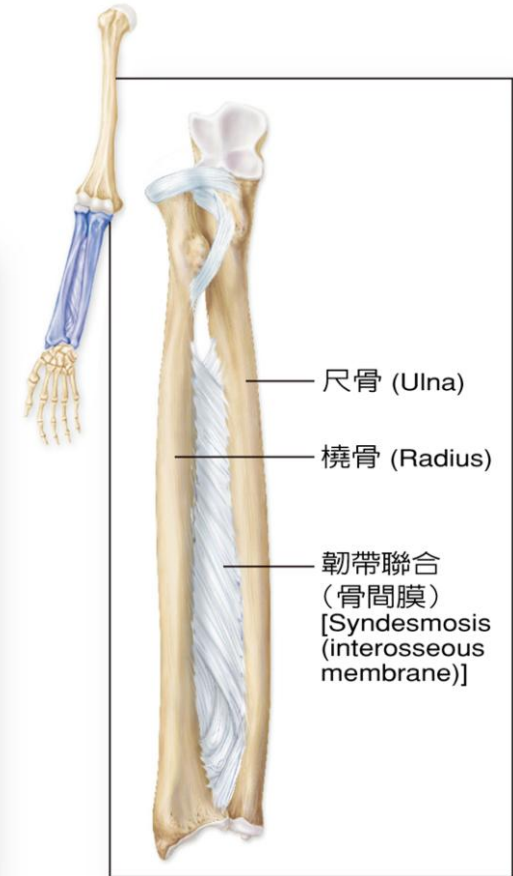
Fibrous Joints



(a) 釘狀關節 (Gomphosis)

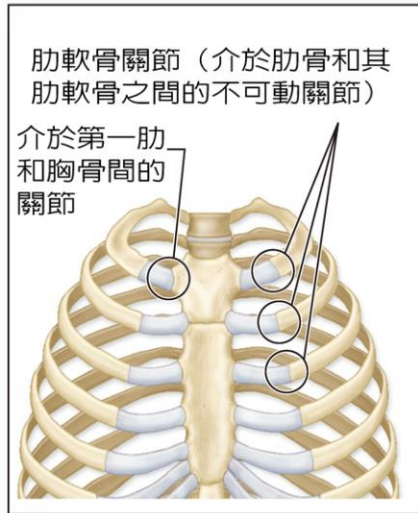
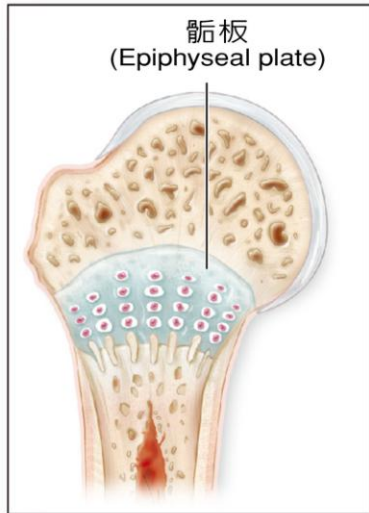


(b) 縫合 (Suture)

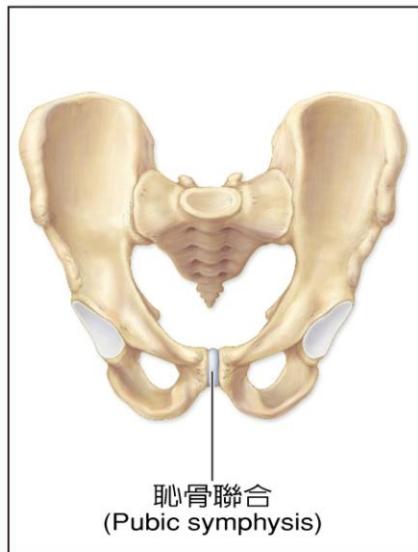
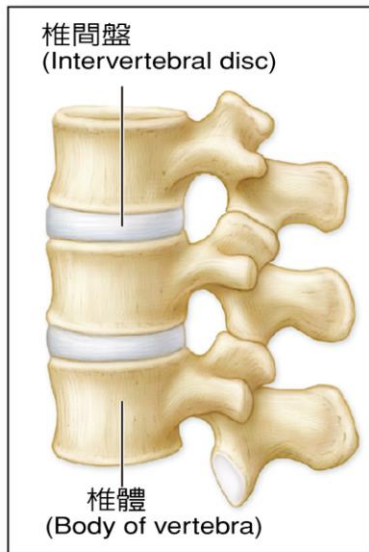


(c) 韌帶聯合 (Syndesmosis)

Cartilaginous Joint

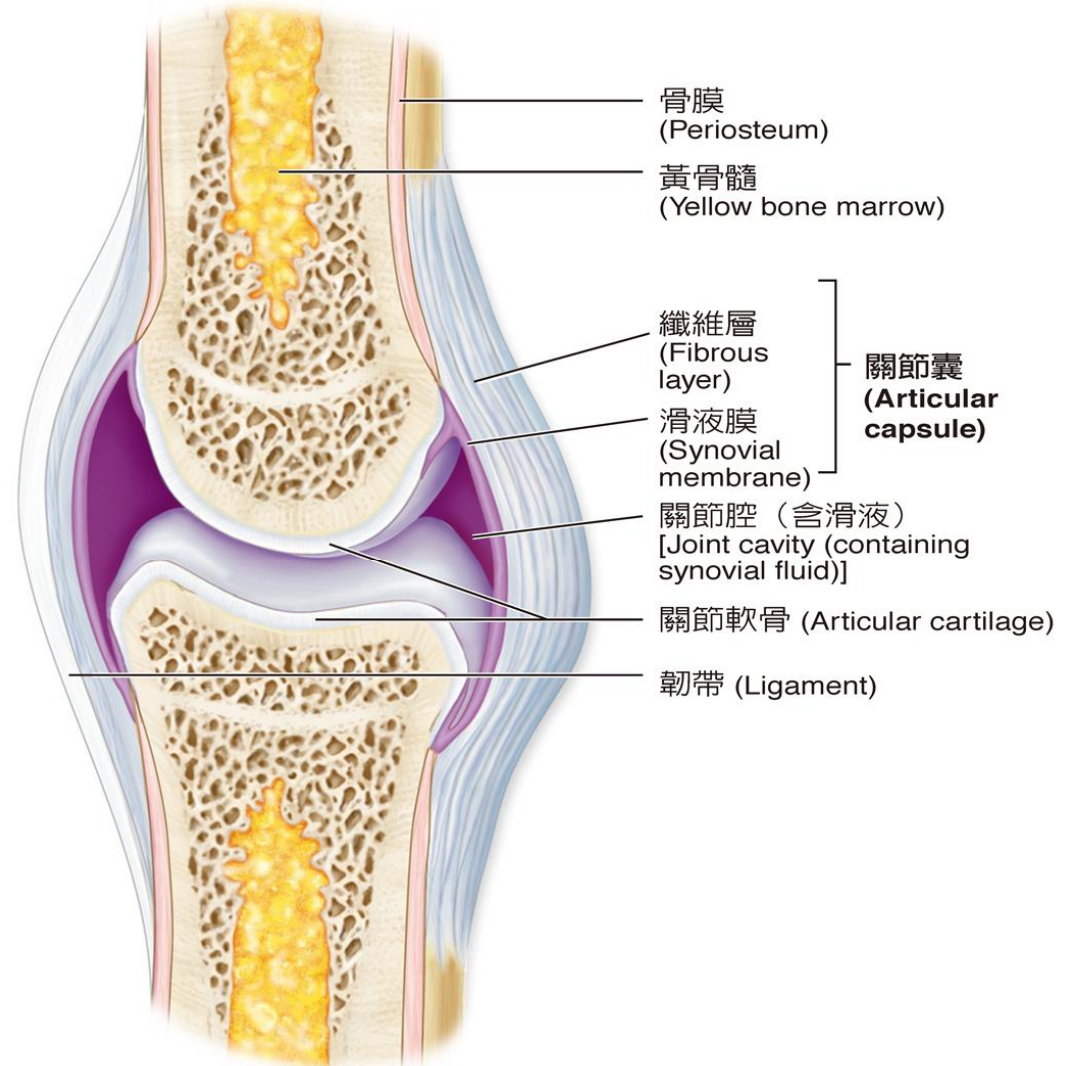


(a) 軟骨聯合 (含透明軟骨)
[Synchondroses (contain hyaline cartilage)]



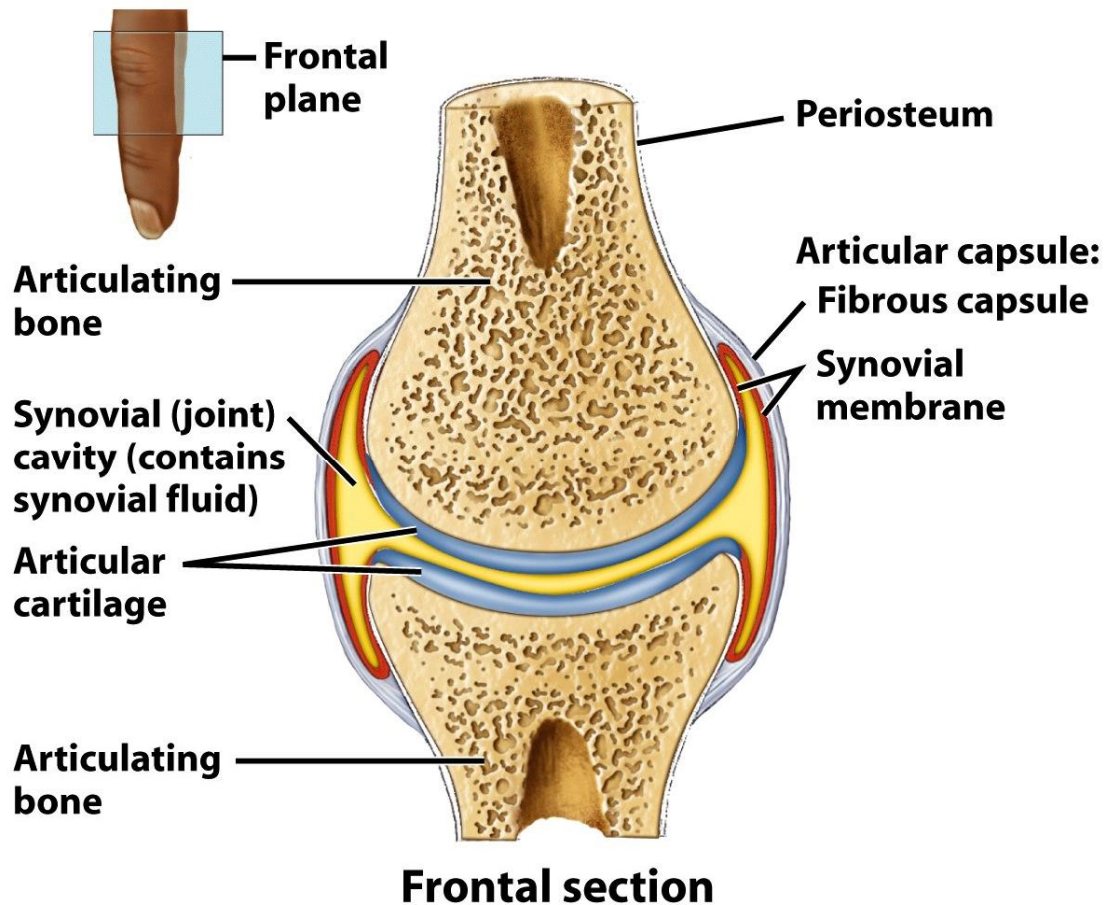
(b) 聯合 (含纖維軟骨) [Symphyses (contain fibrocartilage)]

Synovial Joint



典型滑液關節 (Typical synovial joint)

可動關節 = 滑液關節



➤ *Thickenings in fibrous capsule called **ligaments***

❖ 關節囊(articular capsule) :

A. Synovial mem滑液膜(關節膜)

位於關節囊內層，關節囊內有關節腔，而關節腔內有關節液(潤滑液)可使關節減少磨損。

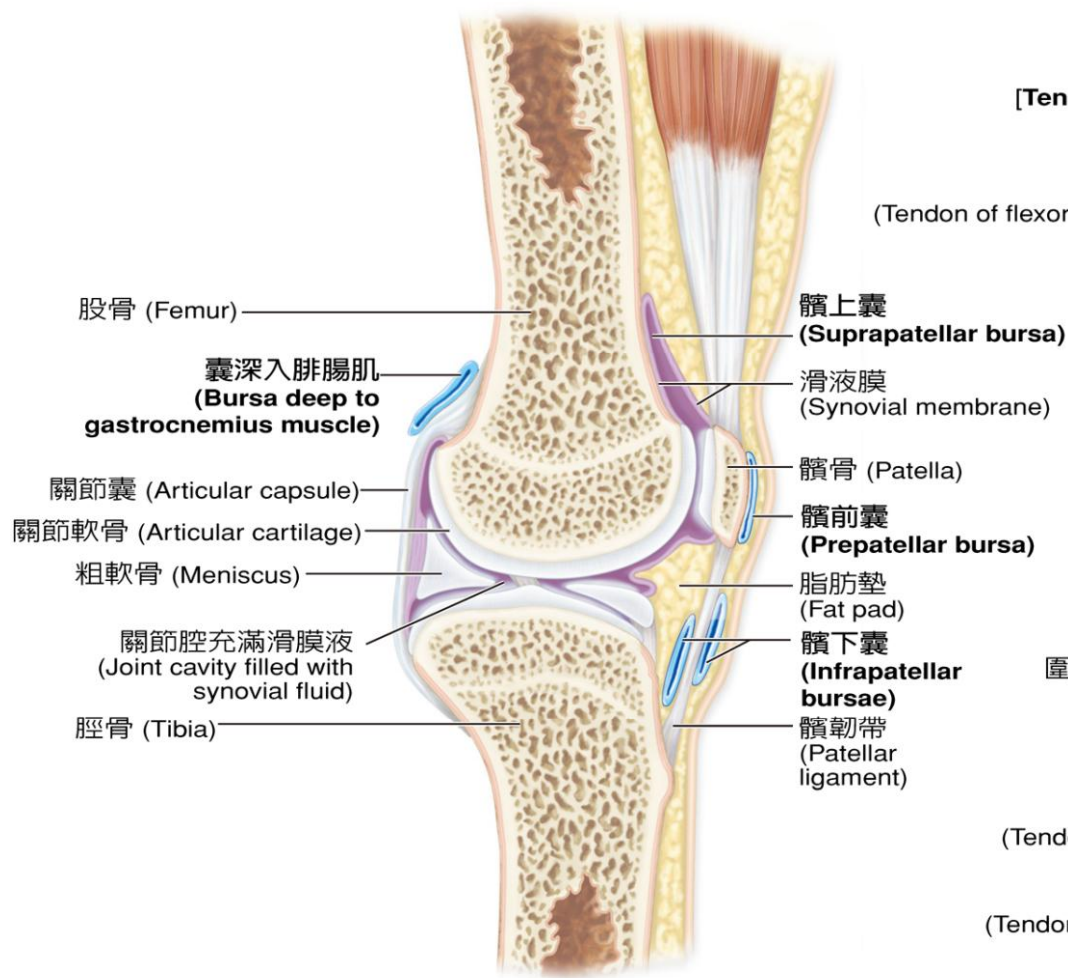
功能： --Lubricating the joint
--Absorbing shocks
--Supplying oxygen and nutrients to the cartilage
--Removing carbon dioxide and metabolic wastes from the cartilage

B. Fibrous capsule纖維囊

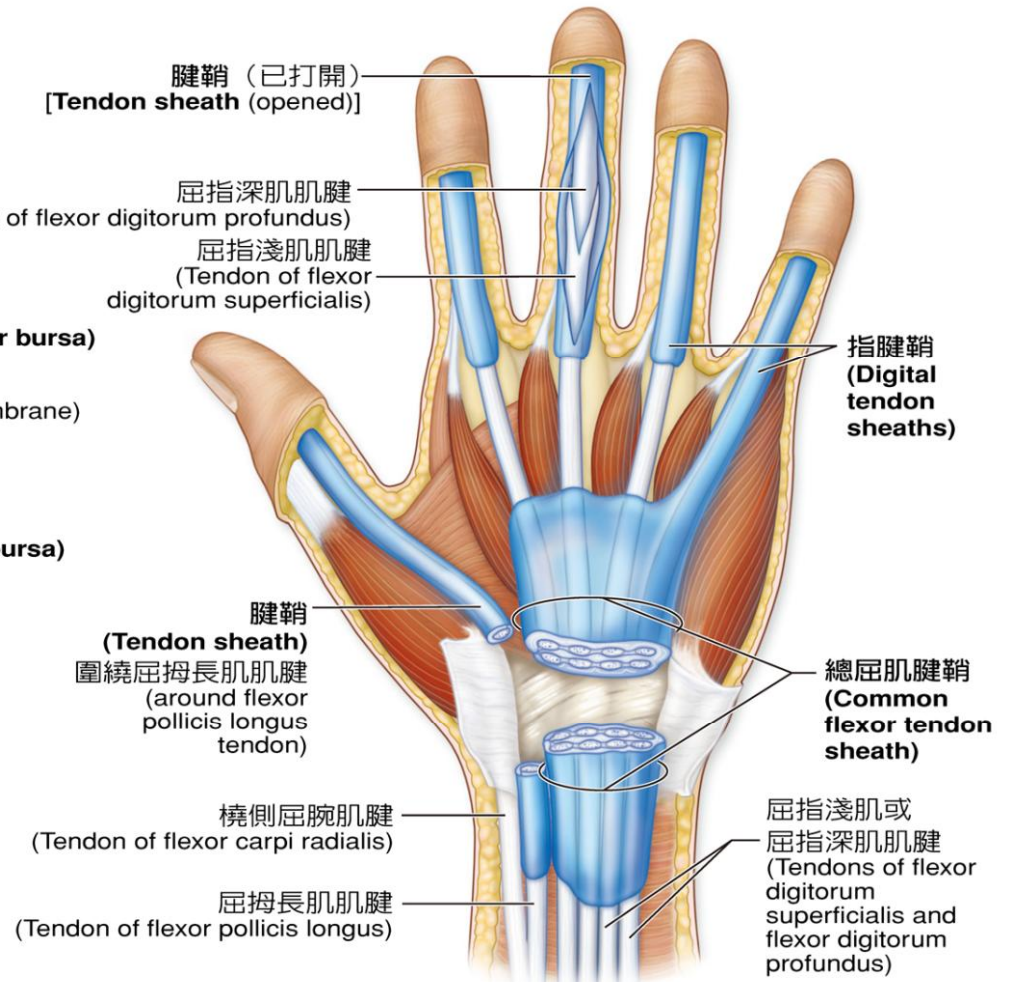
位於關節囊外層。

功能：防止關節脫臼(可協助承受重覆性的扭曲變形，所以不易脫臼)及降低肌腱與韌帶間磨擦

Bursae and Tendon Sheaths



(a) 膝關節黏液囊，矢狀切面
(Bursae of the knee joint, sagittal section)



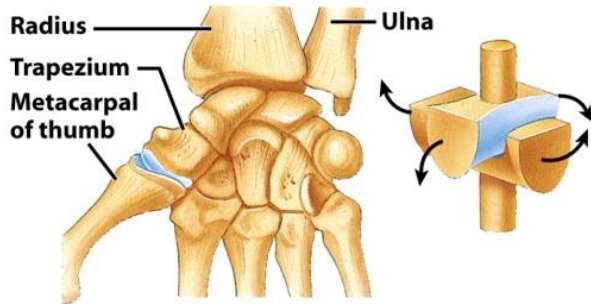
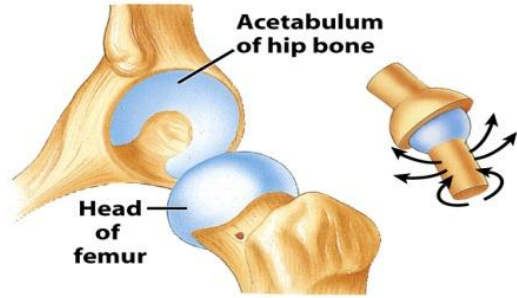
(b) 腕和手的腱鞘，前面觀
(Tendon sheaths of wrist and hand, anterior view)

滑液關節

球窩(杵臼)關節:

主要運動: 運動類型或活動範圍很大的關節

舉例: 肩關節、髖關節

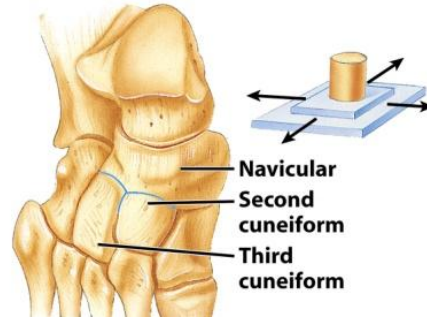
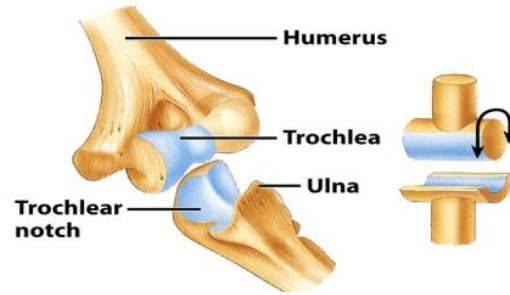


鞍狀關節:

主要運動: 外展、內收、屈曲、對掌和開掌
舉例: 拇指的腕掌關節, 大拇指掌骨之間

屈戌關節: 「樞扭」關節

主要運動: 屈曲或伸直
舉例: 肘關節、膝關節、踝關節、指關節

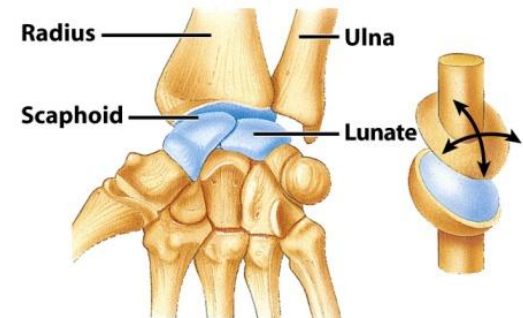
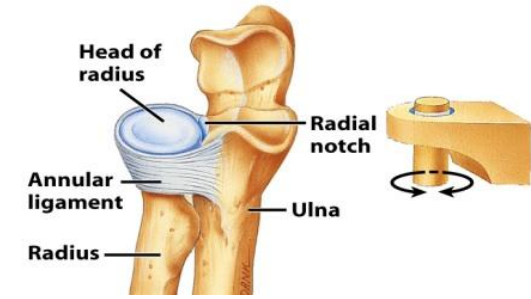


滑動(平面)關節:

主要運動: 活動範圍最小的關節
舉例: 腕骨之間、跗骨之間、肩峰與鎖骨之間、胸鎖骨關節、肋骨與脊椎骨間

車軸(軸狀)關節:

主要運動: 旋前、旋後和旋轉、屈曲或伸直
舉例: 寰軸關節、橈尺關節

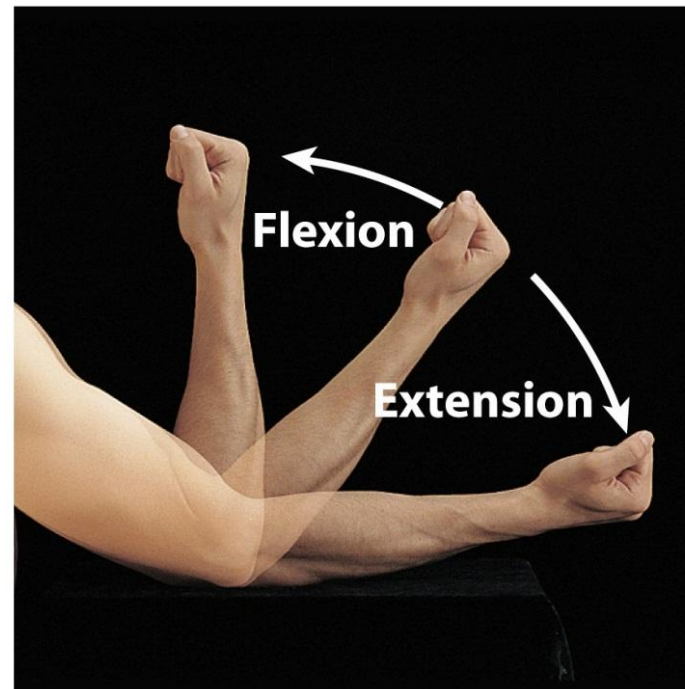
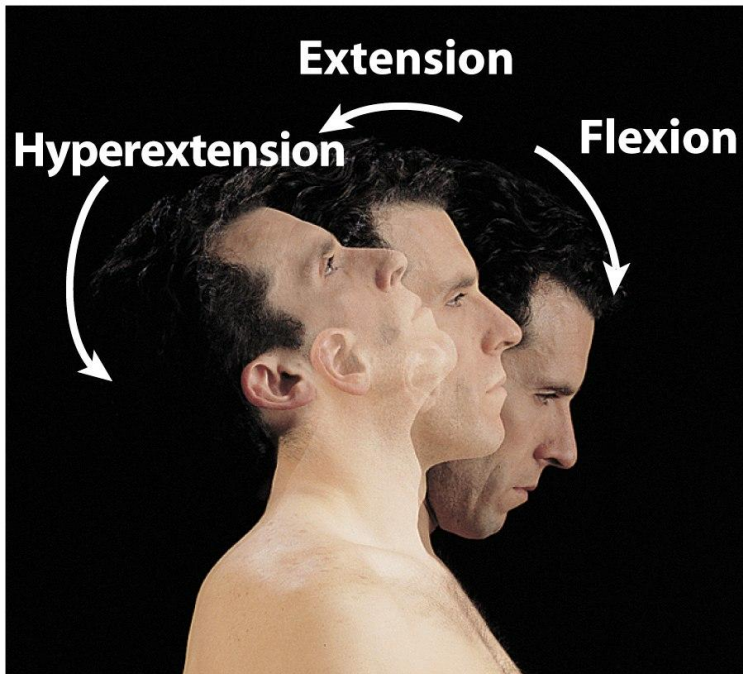
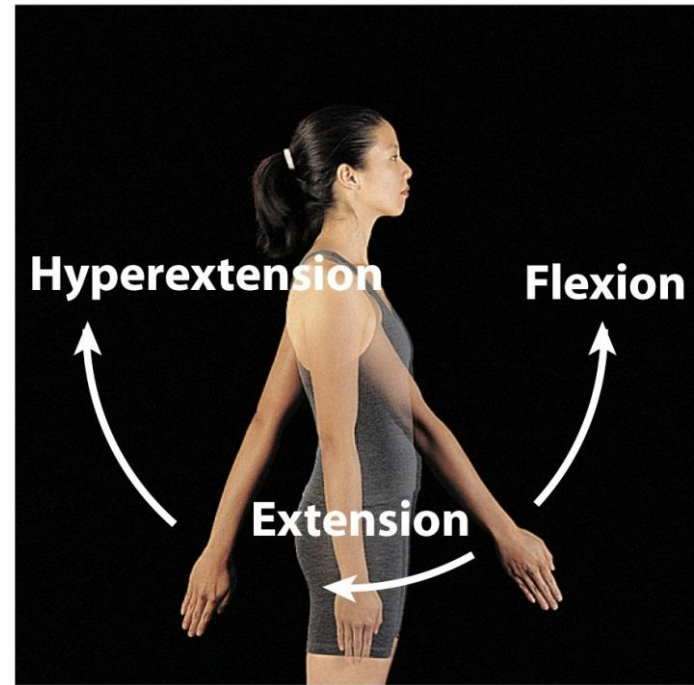
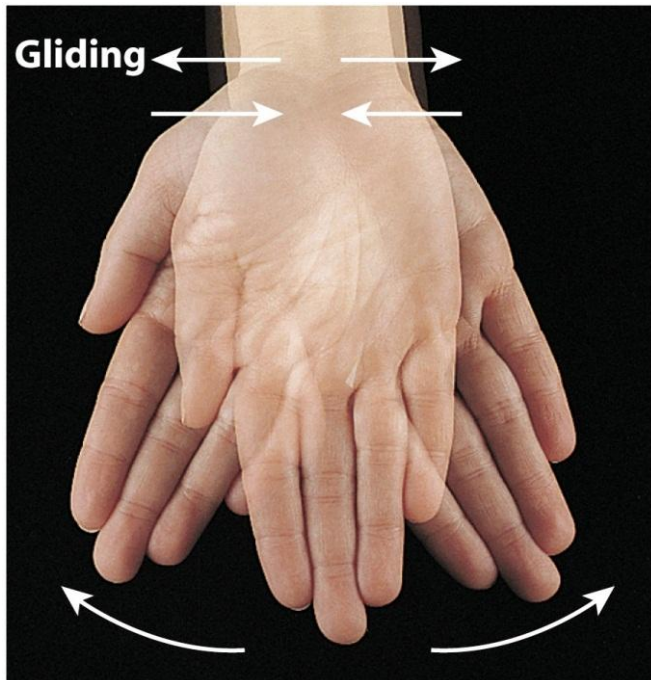


髁狀關節:

主要運動: 屈曲、伸直、外展、內收和迴旋
舉例: 掌指關節、腕骨與橈骨間、蹠趾關節

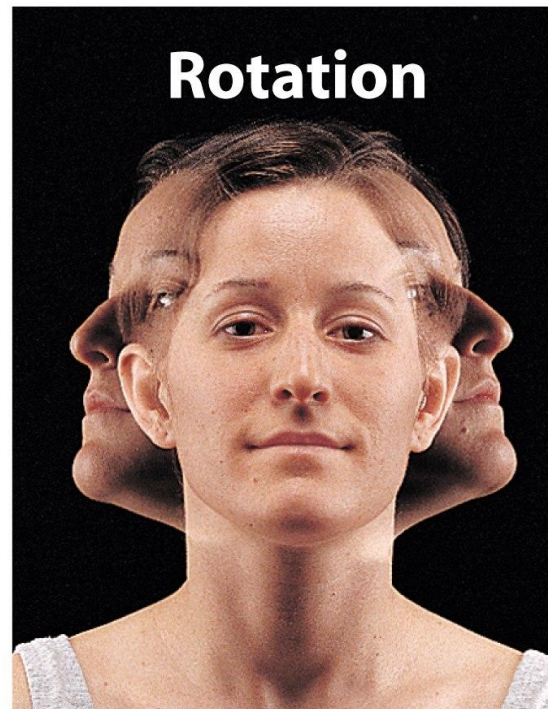
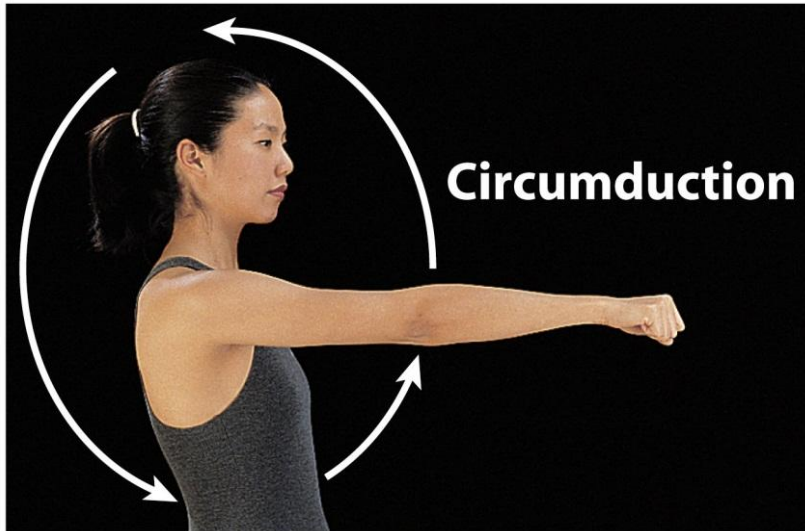
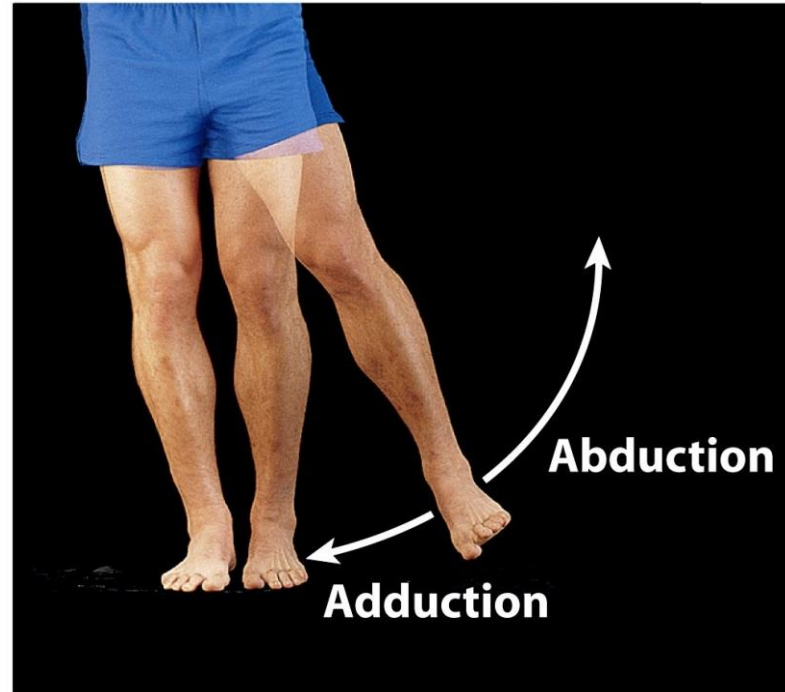
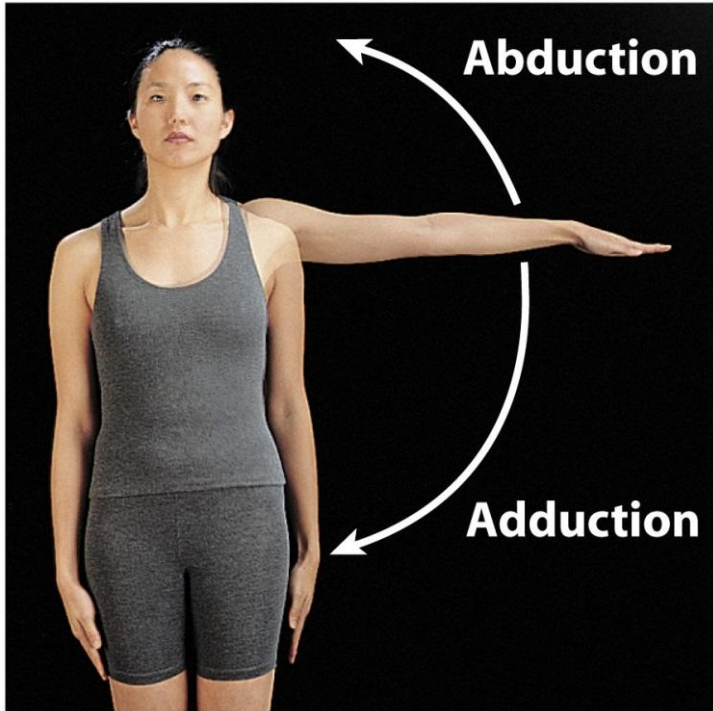
滑液關節運動種類

- 滑動(**Gliding**)扁平骨的表面互相移動
- 彎曲(**Flexion**)相關節骨頭的前後平面上減少角度
- 伸直(**Extension**)相關節骨頭的前後平面上增加角度
 - 伸直是彎曲的相反動作，將身體回復為解剖位置
 - 過度伸直(**Hyperextension**)當伸直超過解剖位置時(超過180度)



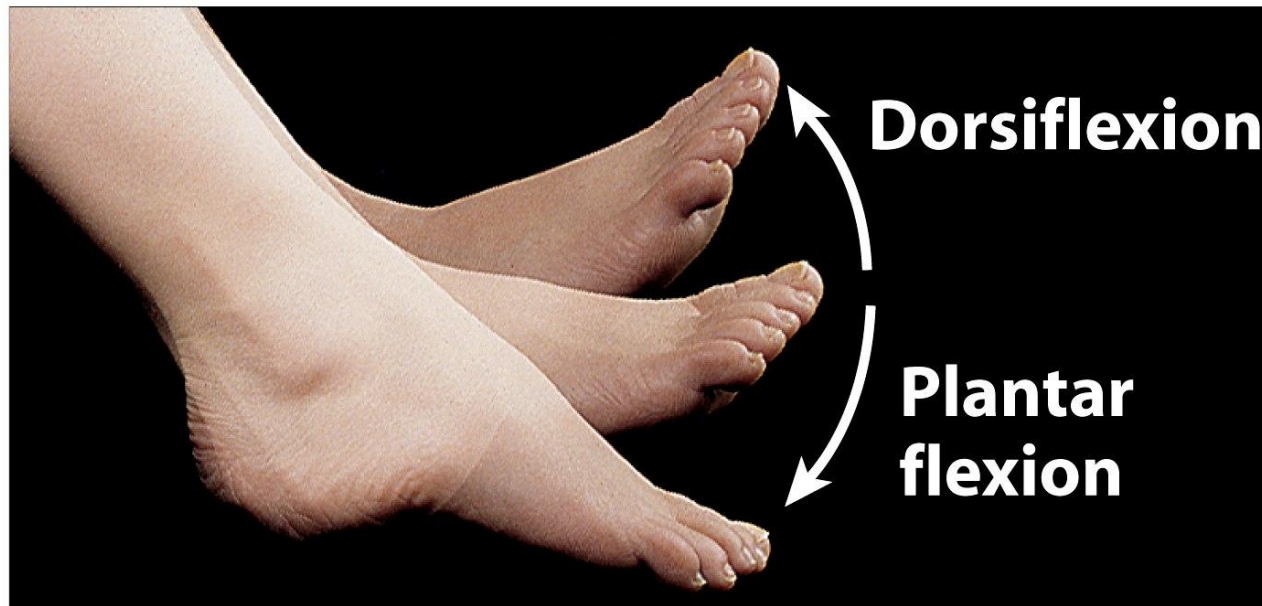
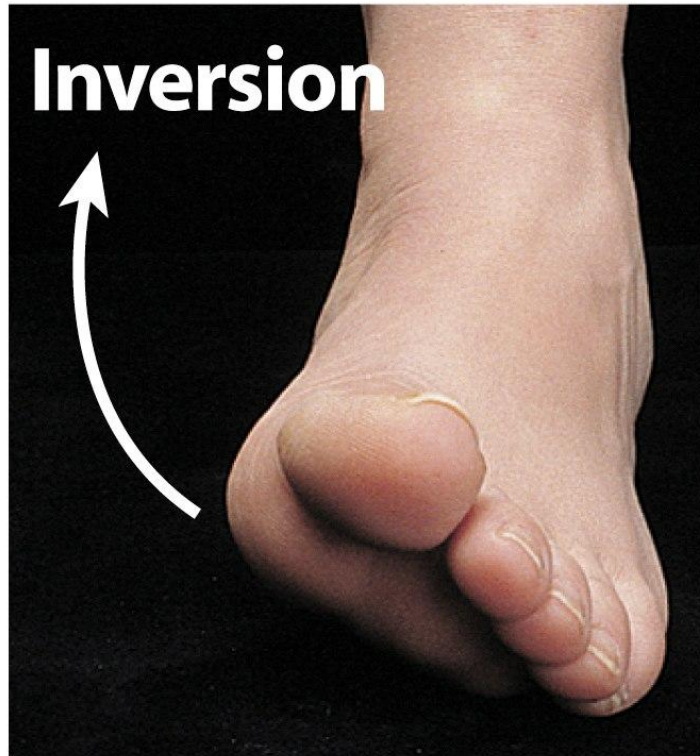
滑液關節運動種類

- 外展(**Abduction**)將骨頭遠離中線
- 內收(**Adduction**)內收則在相同平面下回到解剖位置
- 迴旋(**Circumduction**)近端固定，遠端沿著圓周做運動
- 旋轉(**Rotation**)在身體的縱軸上做運動



滑液關節運動種類

- **內翻(Inversion)**足部腳底向內側扭轉，提高足底內側邊緣
- **外翻(Eversion)**內翻的相反動作，將腳掌面朝外
- **足背彎曲或背屈(Dorsiflexion)**踝關節向上彎曲，足底提高，腳跟碰地
- **足底彎曲或蹠屈(Plantar flexion)**踝關節向下伸直，提高足跟，墊腳尖站立



滑液關節運動種類

- 旋後(Supination)前臂(forearm)的運動，將掌面轉回解剖位置
- 旋前(Pronation)將手腕和手掌轉到掌面朝後

