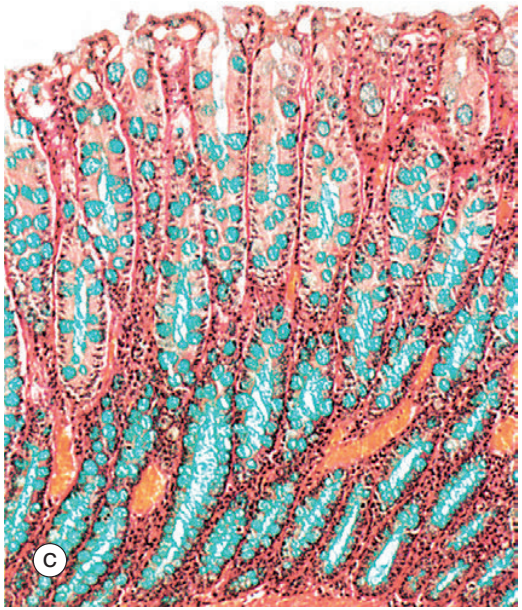
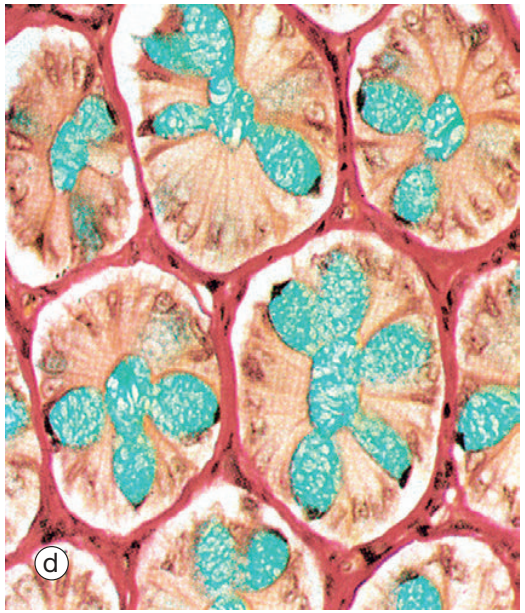
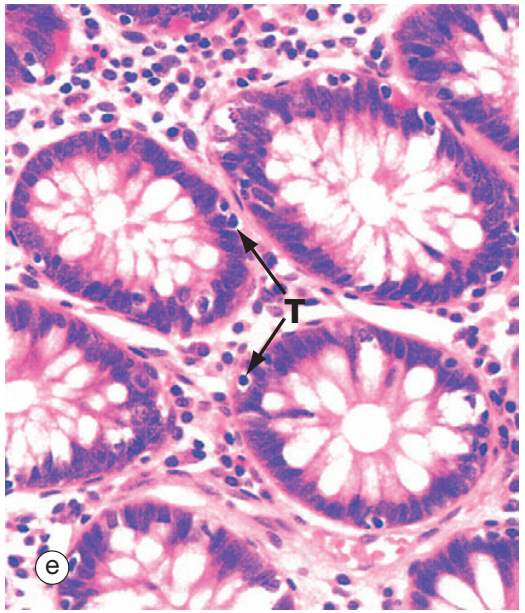
組織學介紹







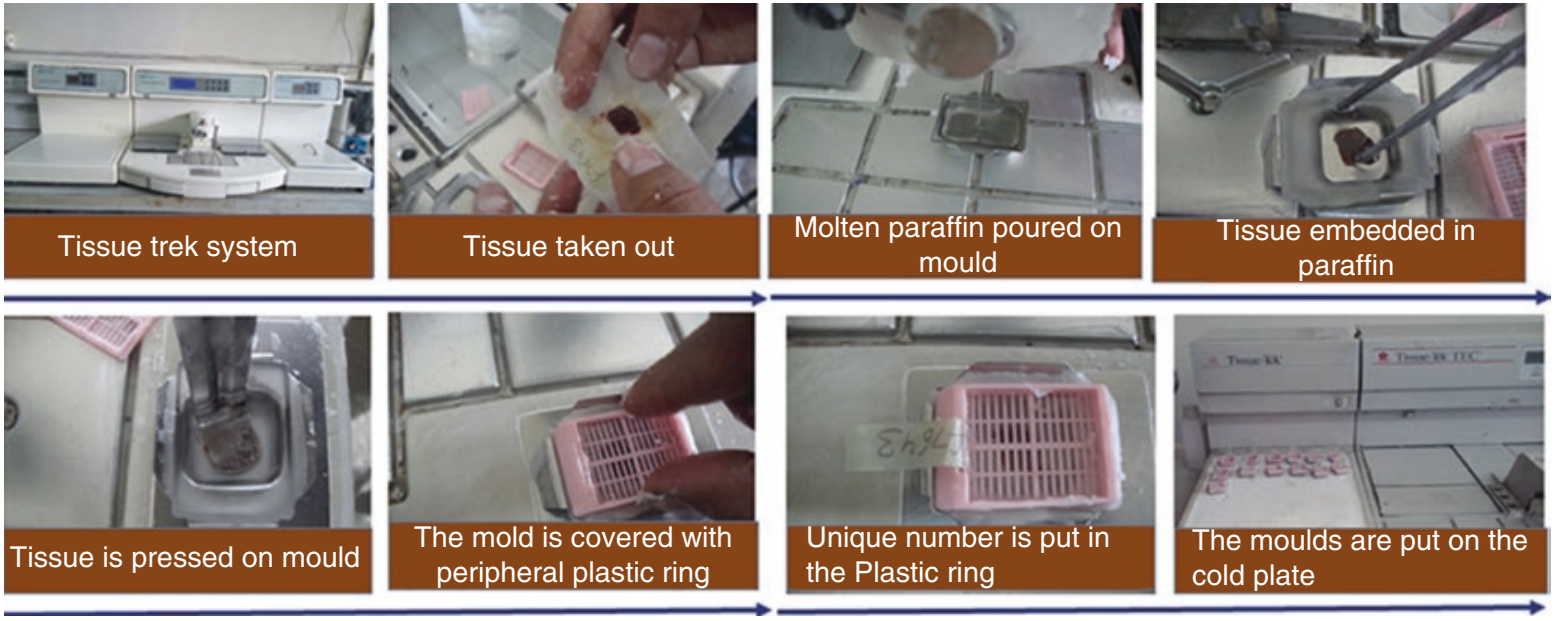
解剖學科
林含貞
hanchen@kmu.edu.tw

顯微解剖學/組織學 (Microscopic Anatomy)

- 主要探討人體和實驗動物器官的正常組織與細胞結構、組織功能和細胞種類
- 組織學是病理組織學 (Histopathology) 的基礎
- 如何取得器官的組織塊 (tissue blocks)?
  (1) 人體: 外科手術、穿刺、抽血...等等
  (2) 實驗動物: 以動物實驗取得
- 顯微研究技術:
  1. 光學顯微鏡檢術 (Light Microscopy)
  2. 電子顯微鏡檢術(Electron Microscopy)

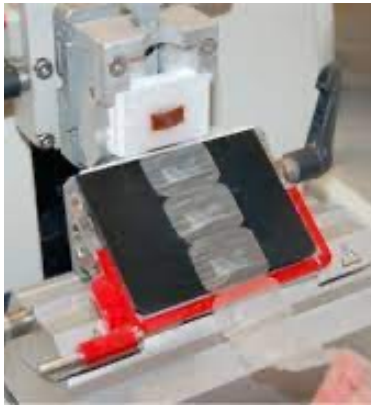
  其中包含處理組織塊、用組織切片機做石蠟/樹脂包埋切片、 切片染色和顯微照相

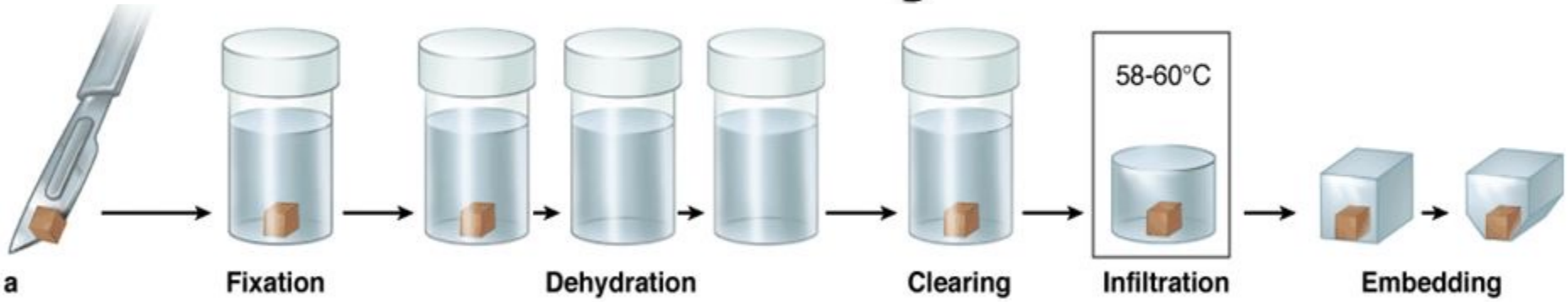
https://link.springer.com/chapter/10.1007/978-981-10-8252-8_3



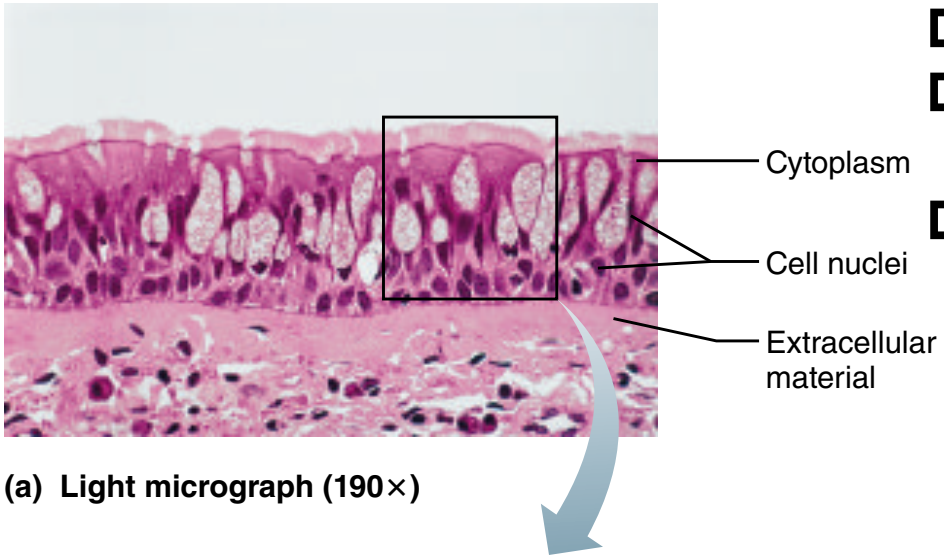
Tissue preparation

- **Fixation**
  - Function→
    - Terminate cell metabolism
    - Prevent enzymatic degradation of cells and tissues by autolysis (self-digestion)
    - Kill pathogenic microorganisms such as bacteria, fungi, and viruses, and
    - Harden the tissue as a result of either cross-linking or denaturing protein molecules
  - Formalin
    - 37% aqueous solution of formaldehyde
- **Embedding** in paraffin
- **Staining**

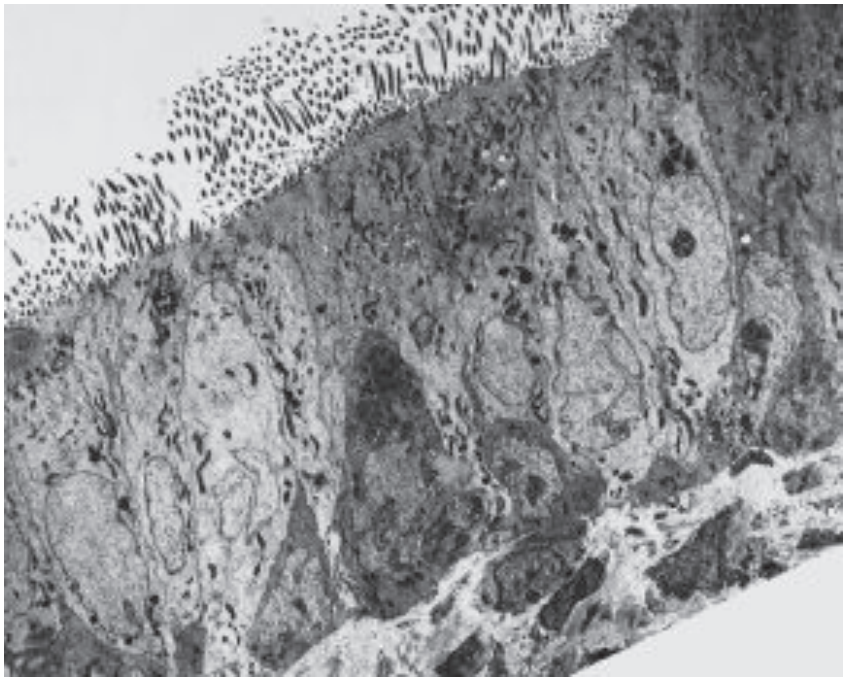




顯微解剖學/組織學 (Microscopic Anatomy)研究方法

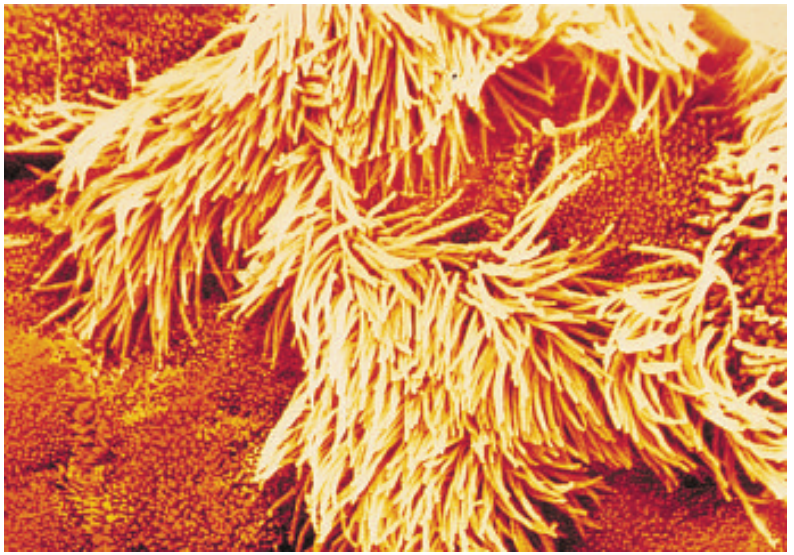


(a) Light micrograph (190×)



(b) Transmission electron micrograph (2250×)

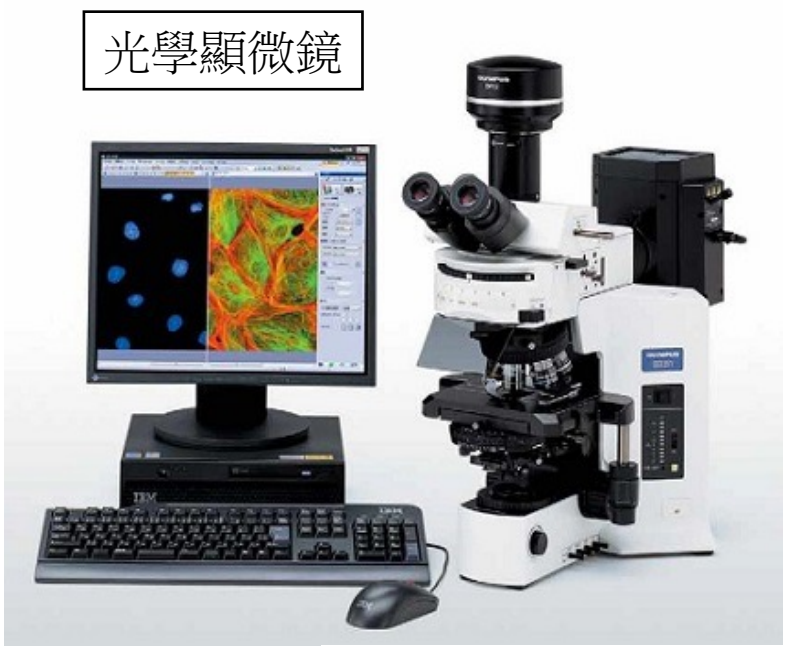
- **Light microscope (LM)**
- **Transmission electron microscope (TEM)**
- **Dyes**
  - Acidic stain (negatively charged molecules): stain positively charged structures
  - Basic stain (positively charged dyes): stain negatively charged structures
- **H&E stain**



(c) Scanning electron micrograph, artificially colored (2500×)

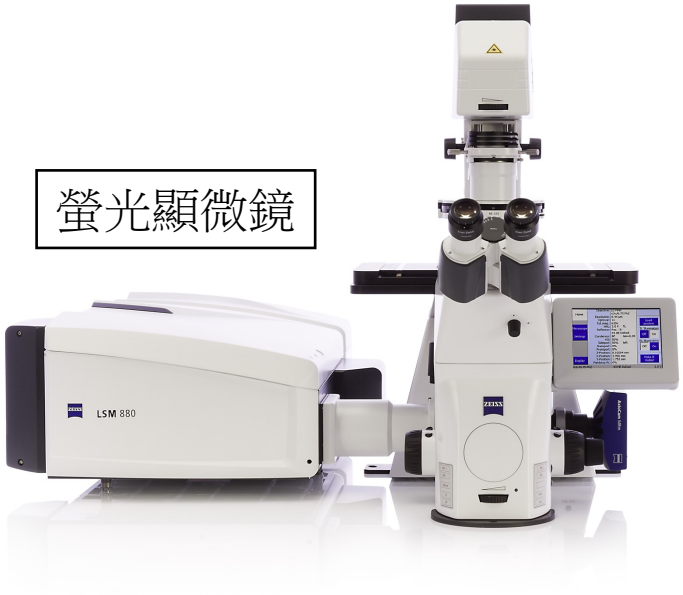
Microscope

光學顯微鏡

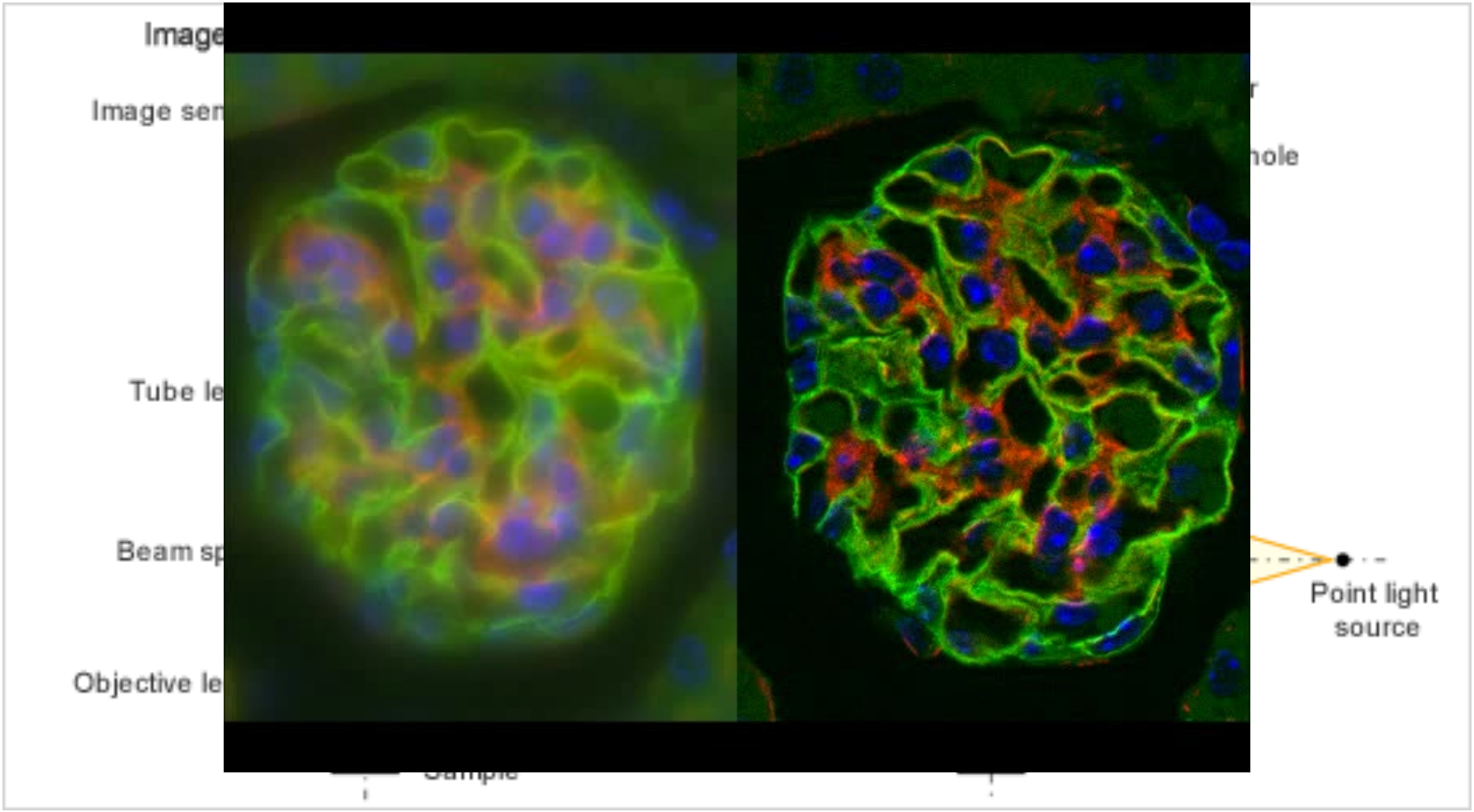


解剖顯微鏡

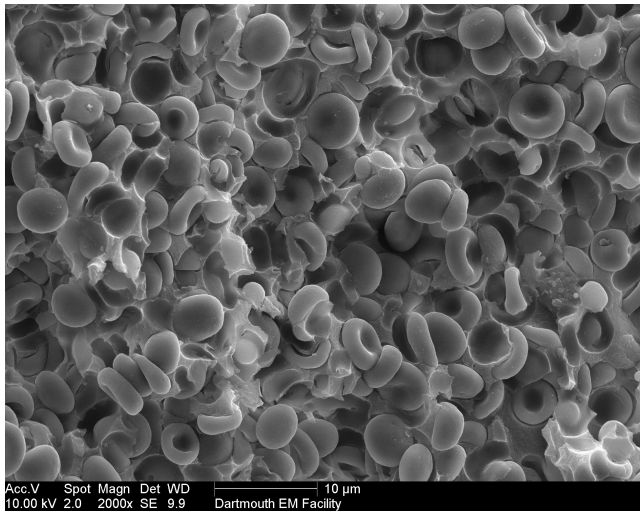
螢光顯微鏡



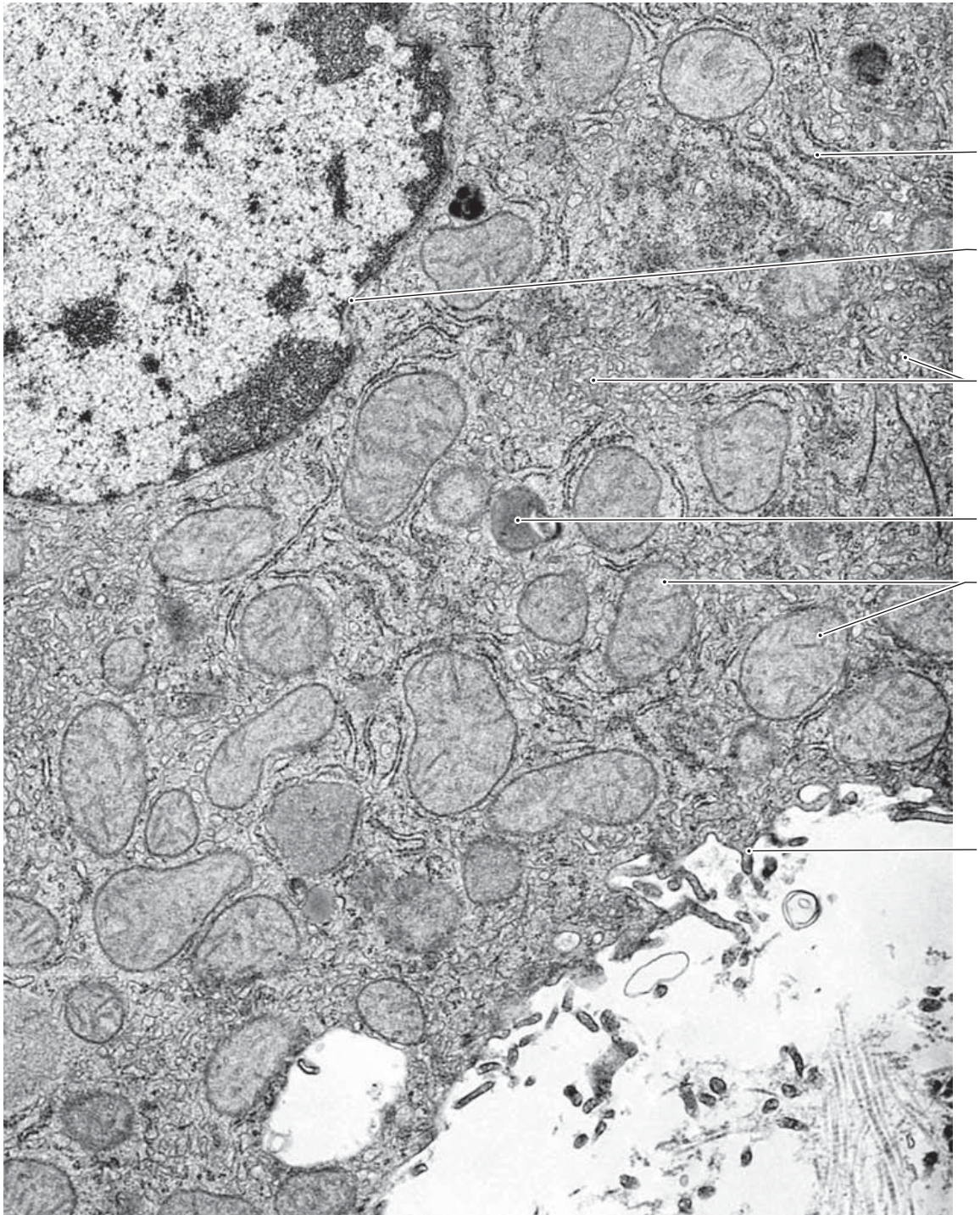
共軛焦顯微鏡 (Confocal microscope)
vs.
螢光顯微鏡 (Fluorescence Microscope)



Scanning Electron Microscopy (SEM)

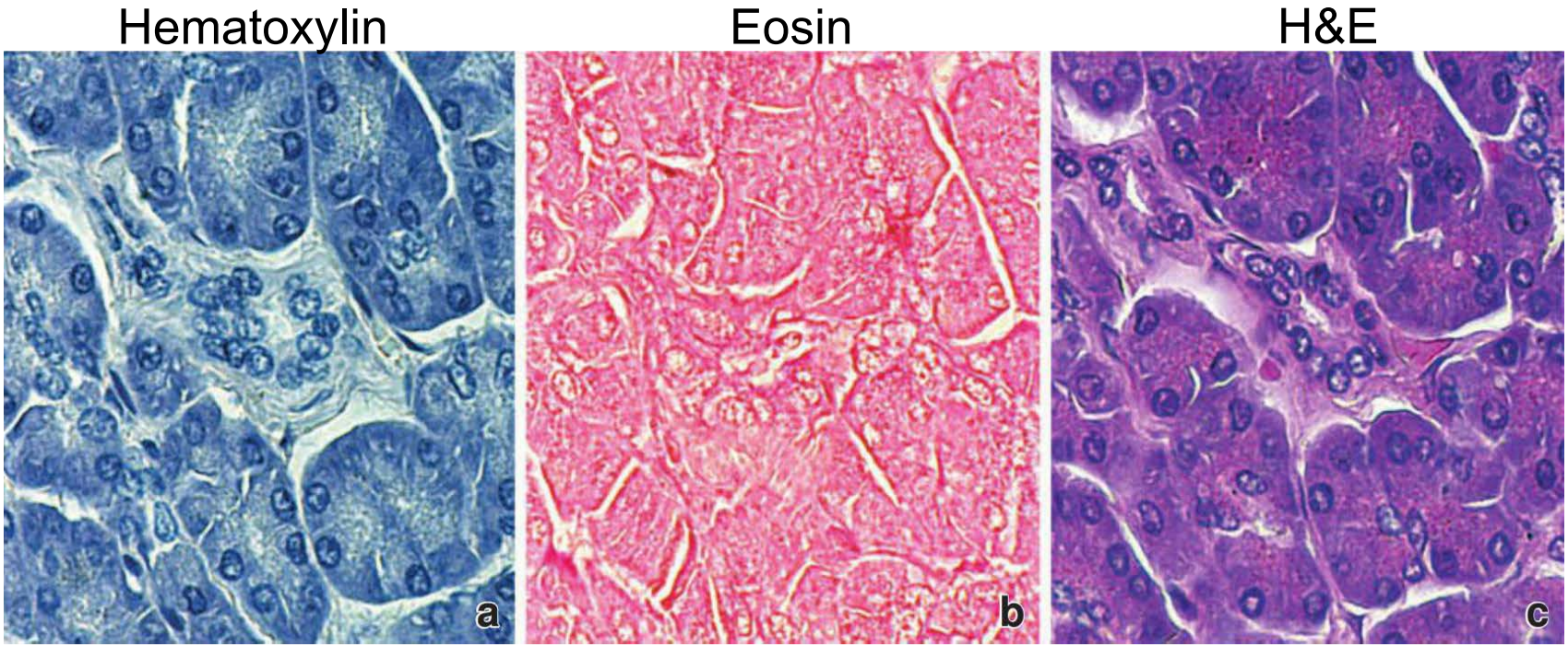


穿透式電子顯微鏡
Transmission Electron Microscopy (TEM)



染色方法簡介

☐ Hematoxylin & Eosin staining



HE stain 是組織染色最常使用的染色方法之一，這種染色方法的基礎是組織結構對不同染料的結合程度不同。可以將嗜鹼性結構染成藍紫色，鹼性結構通常包括含有核酸的部分，如核糖體、細胞核及細胞質中富含核糖核酸（**RNA**）的區域等，而伊紅可以將嗜酸性結構染成粉紅色

優點:

1、組織及細胞結構清晰，為最廣泛應用於組織切片形態觀察的染色法

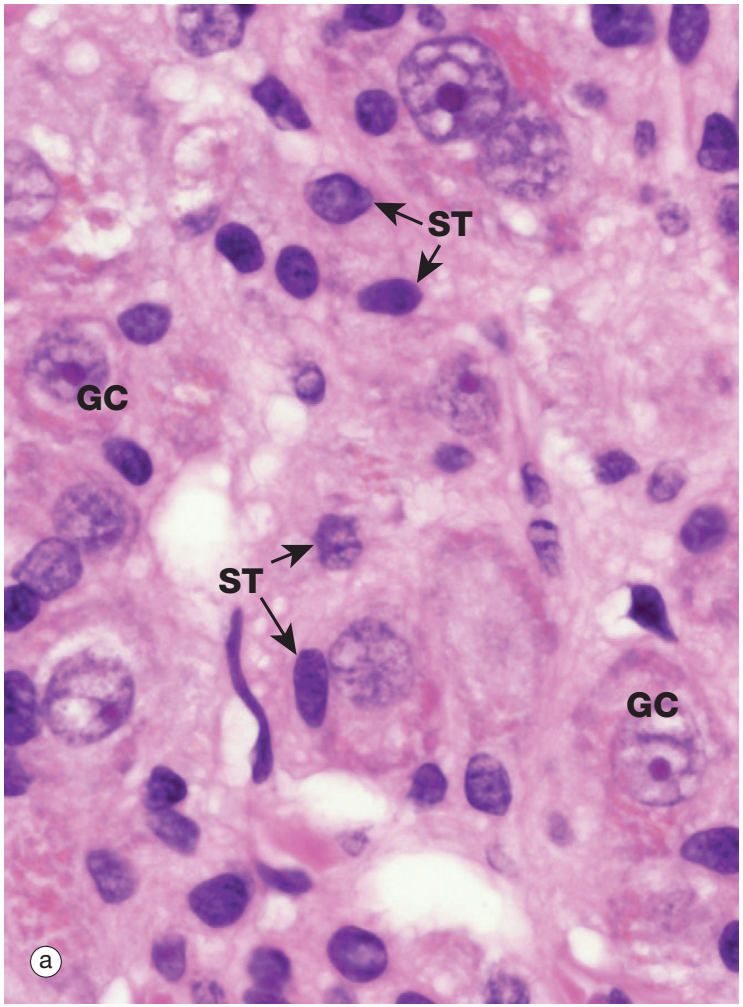
缺點:

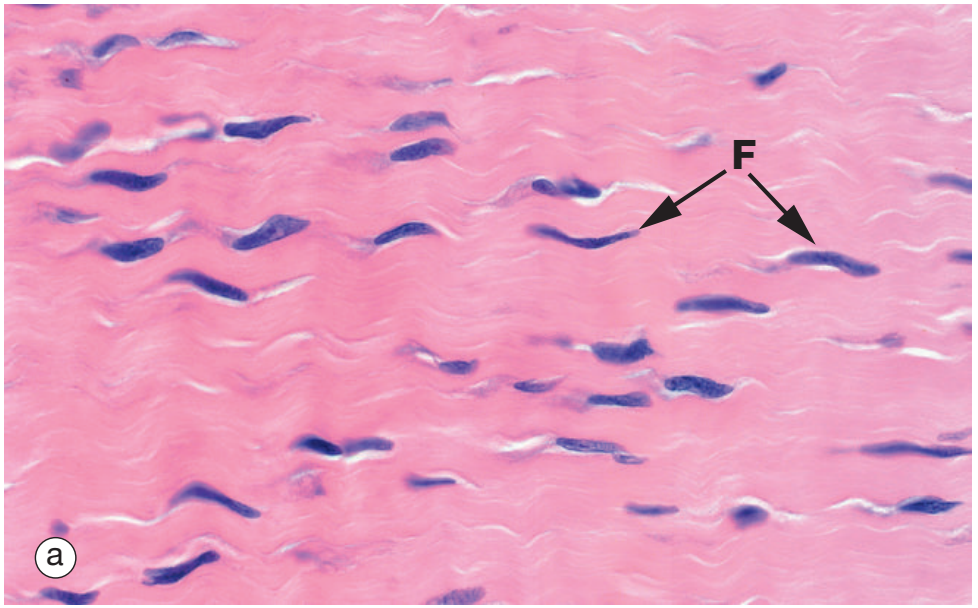
1、部份形態相近細胞難以區別

2. 僅用於形態觀察，無法分辨組織細胞不同的生化特性

https://www.toson.com.tw/product/he-stain

Basophilia	Acidophilia
• Heterochromatin and nucleoli • Ergastoplasm (rRNA) • Complex carbohydrate of the matrix of cartilage	• Cytoplasmic filaments • Intracellular membranous components • Extracellular fibers





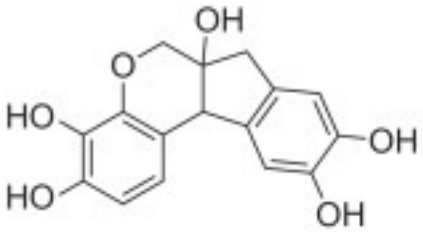
☐ **Extracellular fiber**: collagen fibers

GC: ganglion cells
ST: sustentacular cell

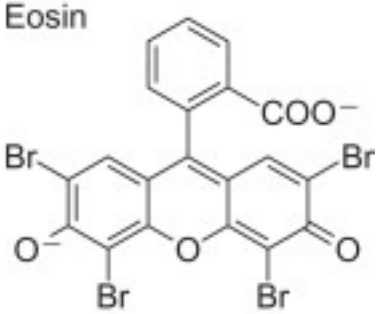
H&E染色步驟(protocol)

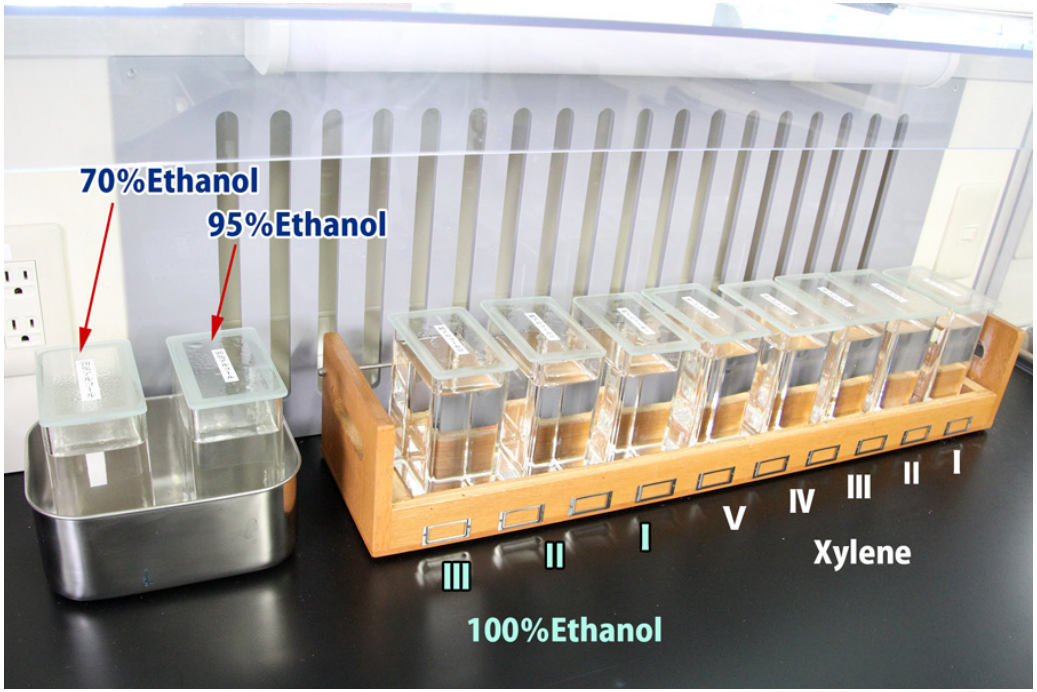
1. 脫蠟: Xylene (二甲苯)
2. 覆水: 100%酒精→95%酒精→85%酒精 →75%酒精
3. 自來水浸泡
4. Hematoxylin染色
5. 自來水沖洗(避免直沖組織)
6. Eosin染色
7. 脫水： 75%酒精→85%酒精 →95%酒精→ 100%酒精
8. Xylene
9. 封片 膠封片

Hematoxylin



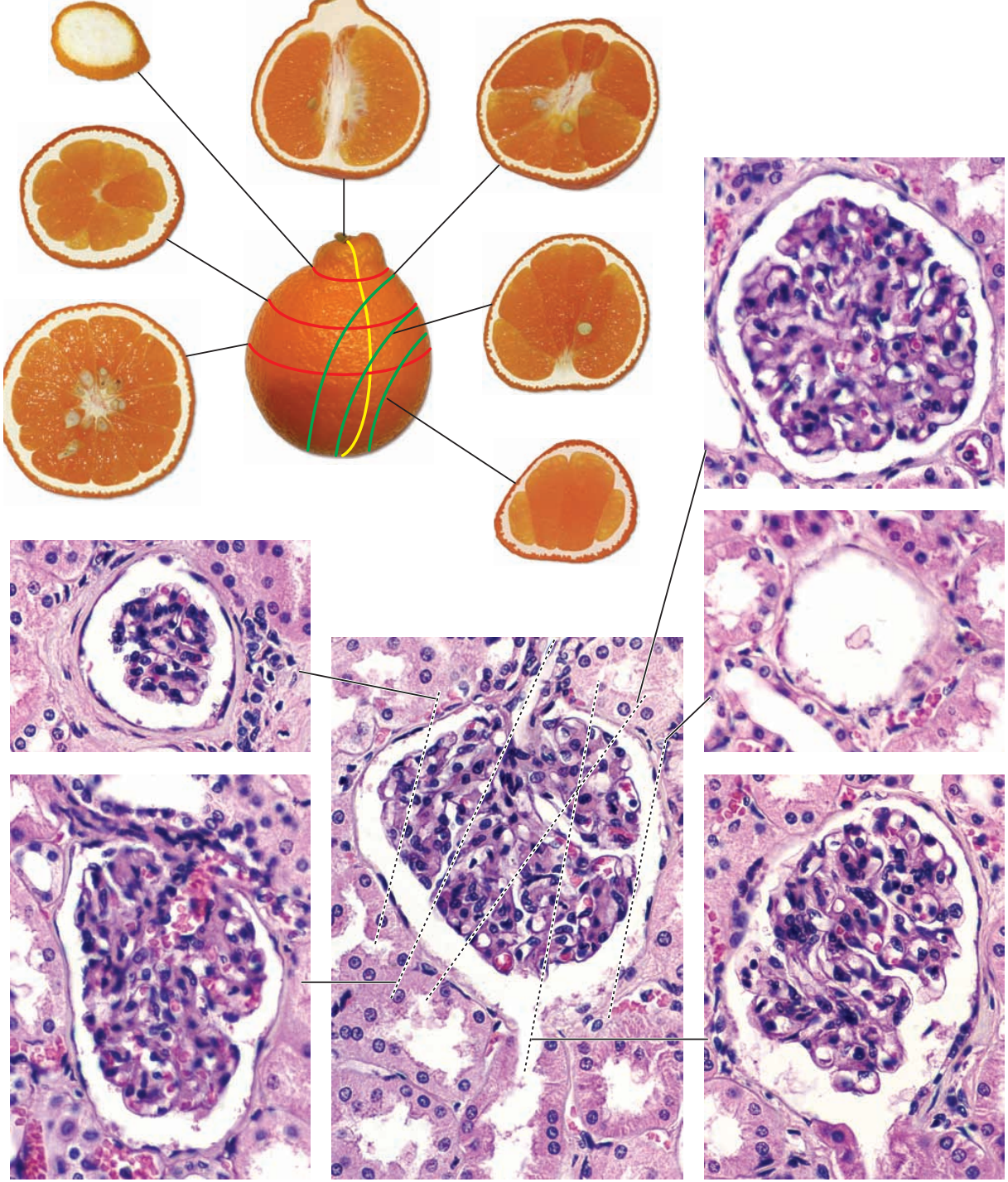
Eosin





https://pathologycenter.jp/method-e/method11.html

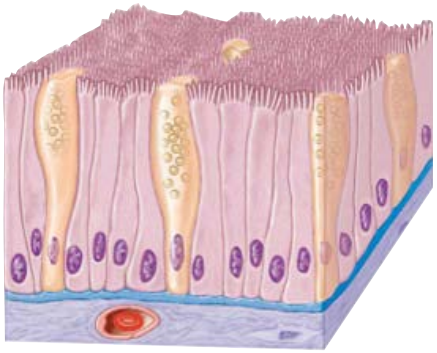
https://www.sciencedirect.com/science/article/pii/B9780128206539000043



組織 (tissues)

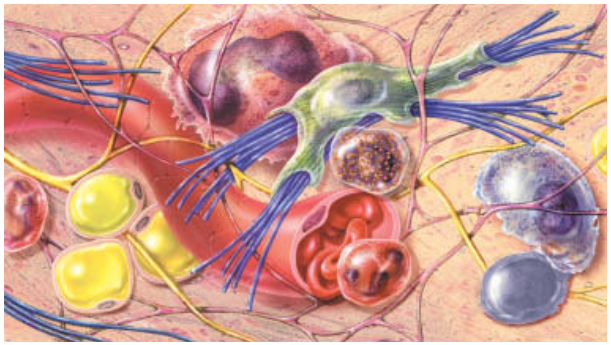
- 一群有類似構造的細胞在一起執行同樣的功能
- Tissue→ Old French word means “to weave (編織)”
- 4 Basic types of tissues:
  - Epithelial tissue (covering): lines hollow organs, body cavities, ducts; forms glands
  - Connective tissue (support): store energy, immunity
  - Muscle tissue (movement): generate force and heat
  - Nervous tissue (control): generate action potential to activate muscular contractions and glandular secretions

上皮組職



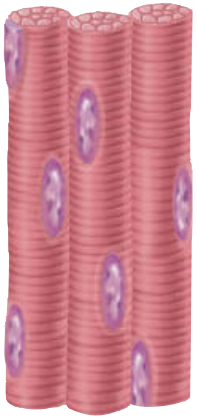
(a) Epithelial tissue

結締組職



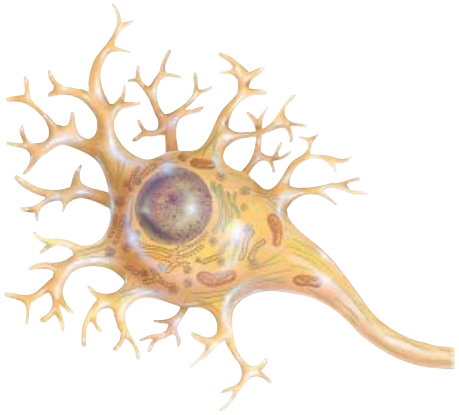
(b) Connective tissue

肌肉組職



(c) Muscular tissue

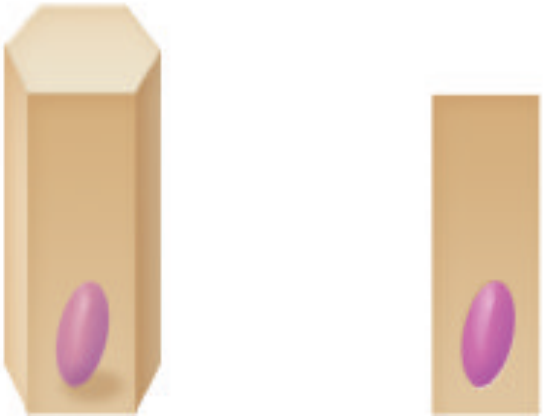
神經組職

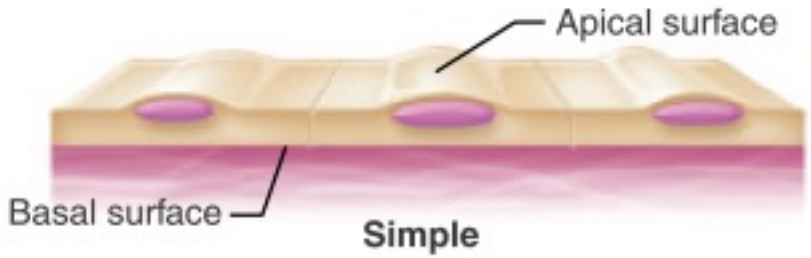


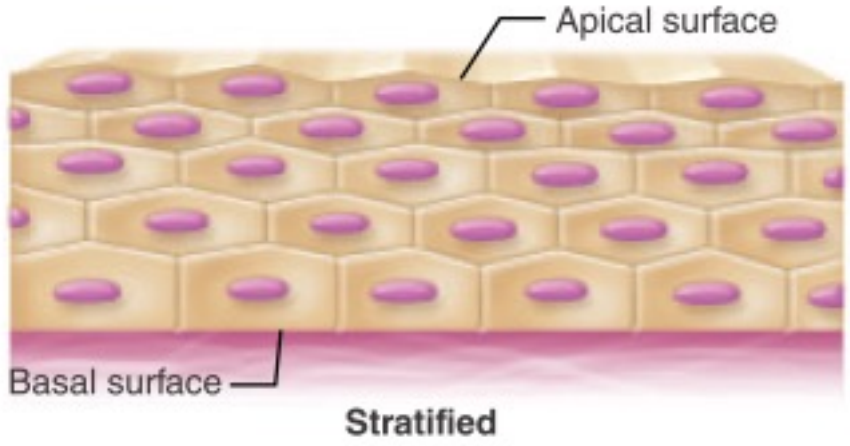
(d) Nervous tissue

上皮組織的分類

- The number of cell layers and the shape of the cells are used to classify and name epithelia
  - **Simple epithelia**: single layer and cell attached to the basement membrane
  - **Stratified epithelia**: more than one layer of cells
  - **Squamous cells**: disc-shaped nuclei
  - **Cuboidal cells**: cube-shaped cells with spherical, centrally located nuclei
  - **Columnar cells**: taller than wide, nuclei located near the basal surface and oval in shape







Simple Epithelium

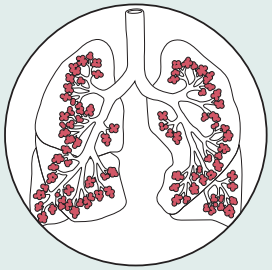
- Simple squamous epithelium- thin and often permeable
  單層鱗狀上皮
  - walls of capillary, the air sacs in the lungs
    微血管管壁 肺臟的肺泡

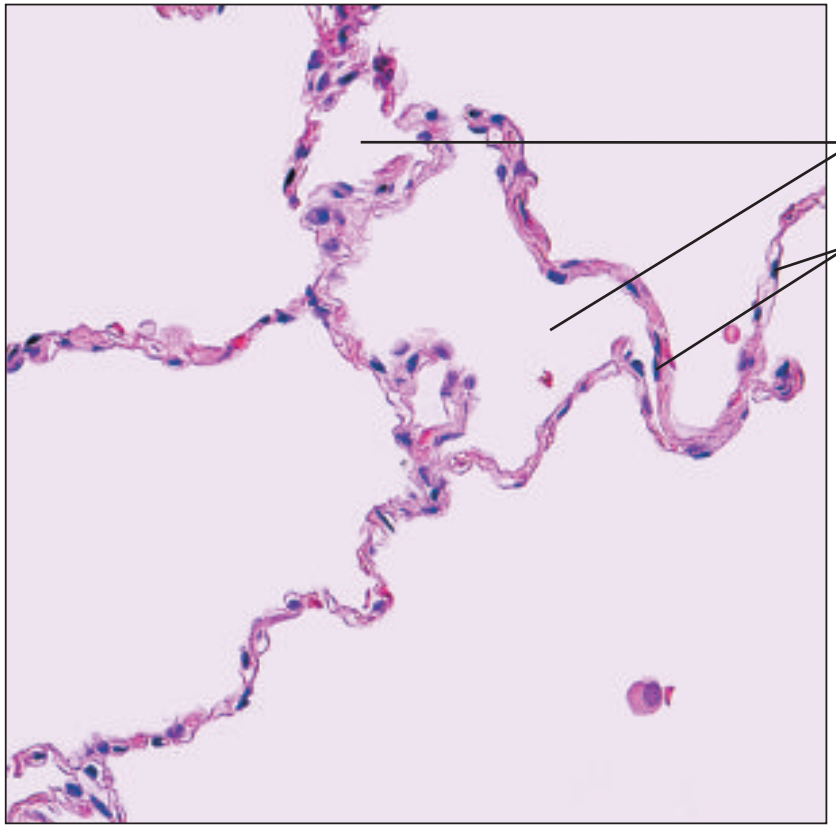
(a) Simple squamous epithelium

Description: Single layer of flattened cells with disc-shaped central nuclei and sparse cytoplasm; the simplest of the epithelia.

Function: Allows passage of materials by diffusion and filtration in sites where protection is not important; produces lubricating fluid in serosae.

Location: Kidney glomeruli; air sacs of lungs; lining of heart, blood vessels, and lymphatic vessels; lining of ventral body cavity (serosae).





Photomicrograph: Simple squamous epithelium forming part of the alveolar (air sac) walls (140×).

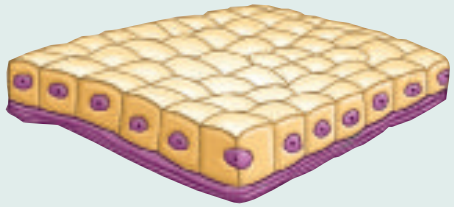
Simple Epithelium

- Simple cuboidal epithelium- secretory cells and smallest duct of glands

單層立方上皮

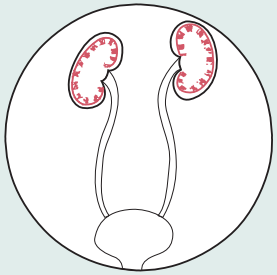
(b) Simple cuboidal epithelium

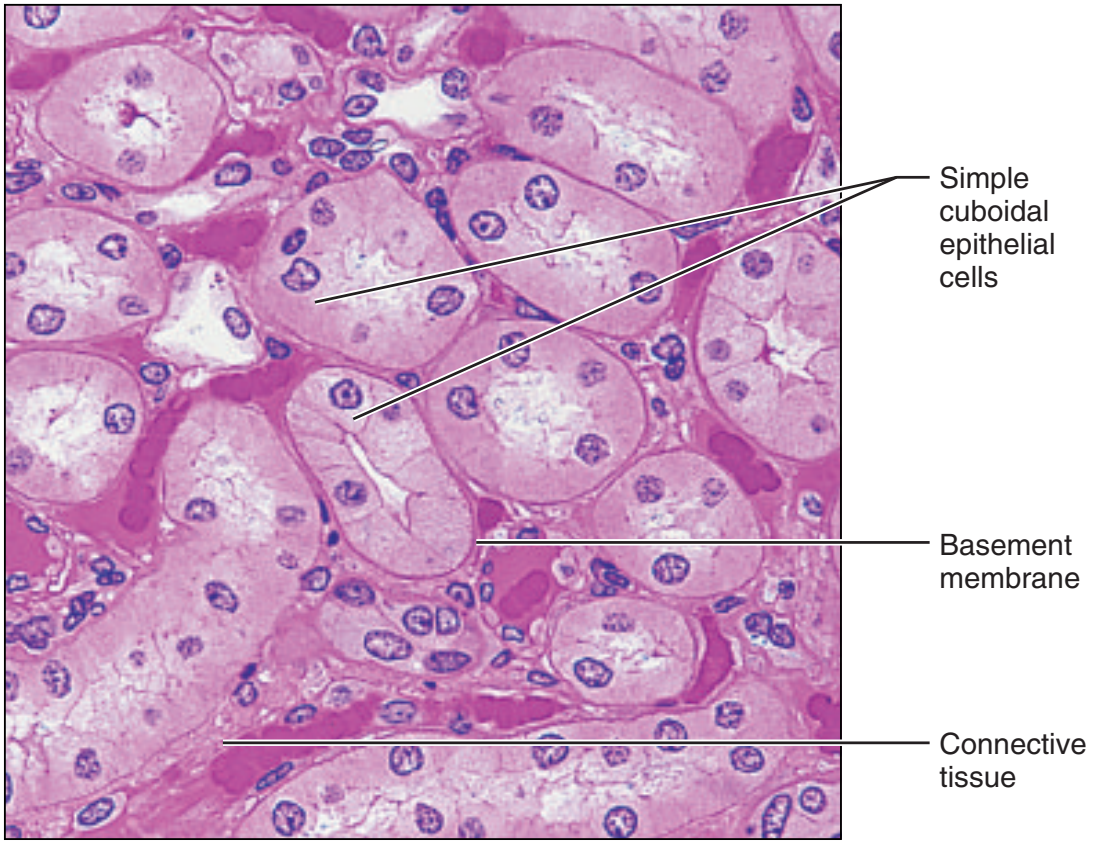
Description: Single layer of cubelike cells with large, spherical central nuclei.



Function: Secretion and absorption.

Location: Kidney tubules; ducts and secretory portions of small glands; ovary surface.





Photomicrograph: Simple cuboidal epithelium in kidney tubules (430×).

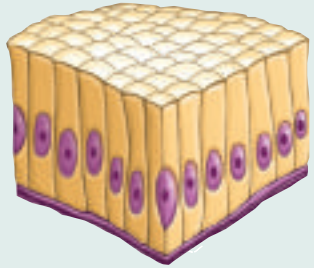
腎臟的管道 (近曲小管，遠曲小管)

Simple Epithelium

- Simple columnar epithelium- lines the digestive tube
  單層柱狀上皮
  - function in absorption and secretion
  - some bear “cilia”(纖毛)

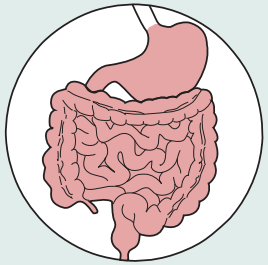
(c) Simple columnar epithelium

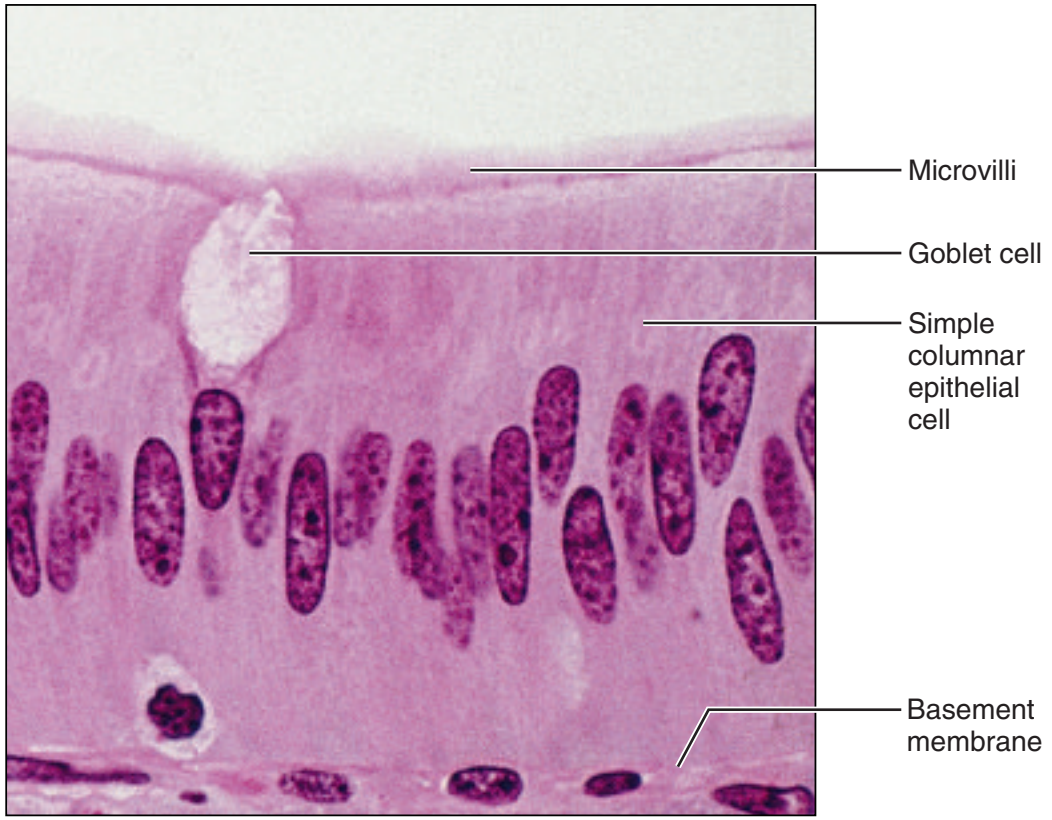
Description: Single layer of tall cells with *round* to *oval* nuclei; some cells bear cilia; layer may contain mucus-secreting unicellular glands (goblet cells).



Function: Absorption; secretion of mucus, enzymes, and other substances; ciliated type propels mucus (or reproductive cells) by ciliary action.

Location: Nonciliated type lines most of the digestive tract (stomach to rectum), gallbladder, and excretory ducts of some glands; ciliated variety lines small bronchi, uterine tubes, and some regions of the uterus.





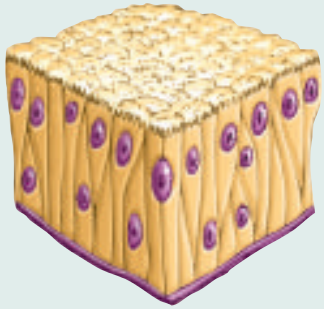
Photomicrograph: Simple columnar epithelium of the small intestine (650×).
小腸上皮

Simple Epithelium

- Pseudostratified columnar epithelium- all cells rest on the basement membrane
  偽複層柱狀上皮
  - function in secretion and absorption
  - ciliated type lines interior of the respiratory tubes

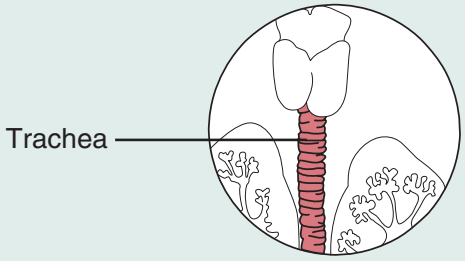
(d) Pseudostratified columnar epithelium

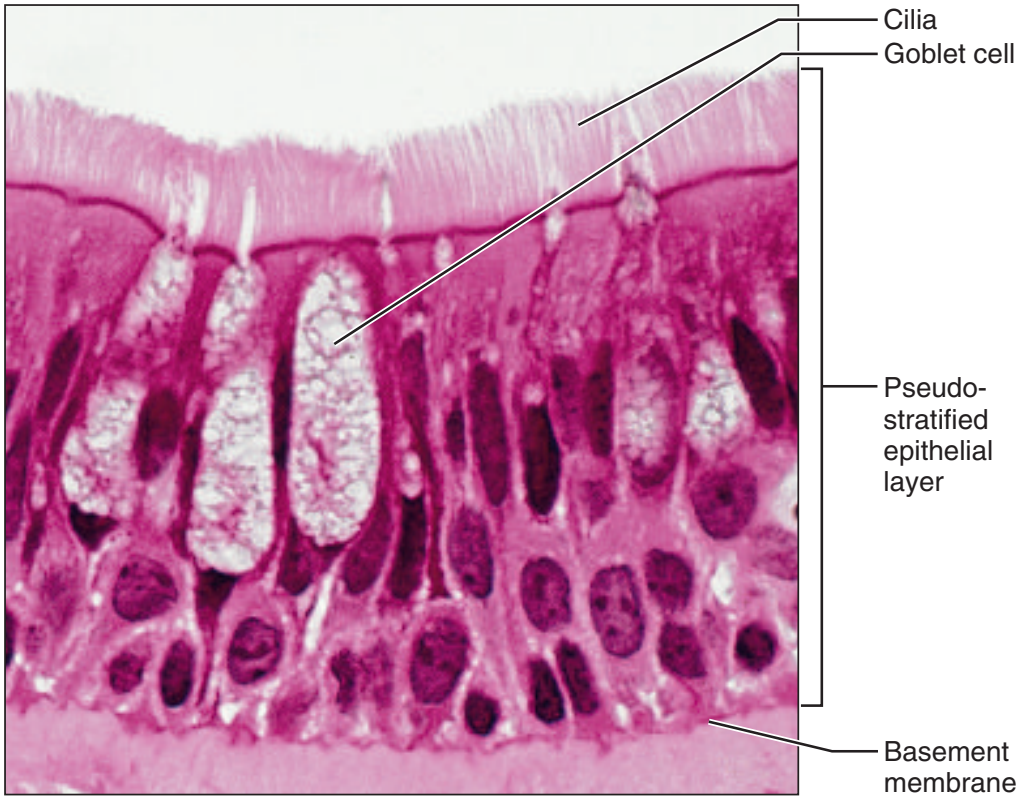
Description: Single layer of cells of differing heights, some not reaching the free surface; nuclei seen at different levels; may contain mucus-secreting goblet cells and bear cilia.



Function: Secretion, particularly of mucus; propulsion of mucus by ciliary action.

Location: Nonciliated type in male's sperm-carrying ducts and ducts of large glands; ciliated variety lines the trachea, most of the upper respiratory tract.





Photomicrograph: Pseudostratified ciliated columnar epithelium lining the human trachea (780×).

氣管

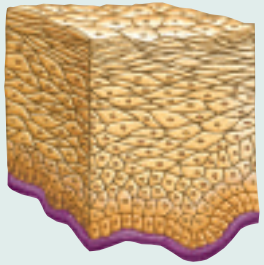
Stratified Epithelium

- Contain two or more layers
- Regenerate from below
- Protection

Stratified squamous epithelium

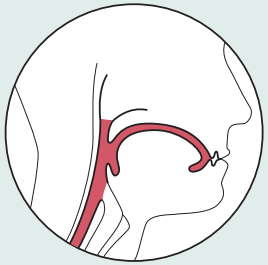
複層鱗狀上皮

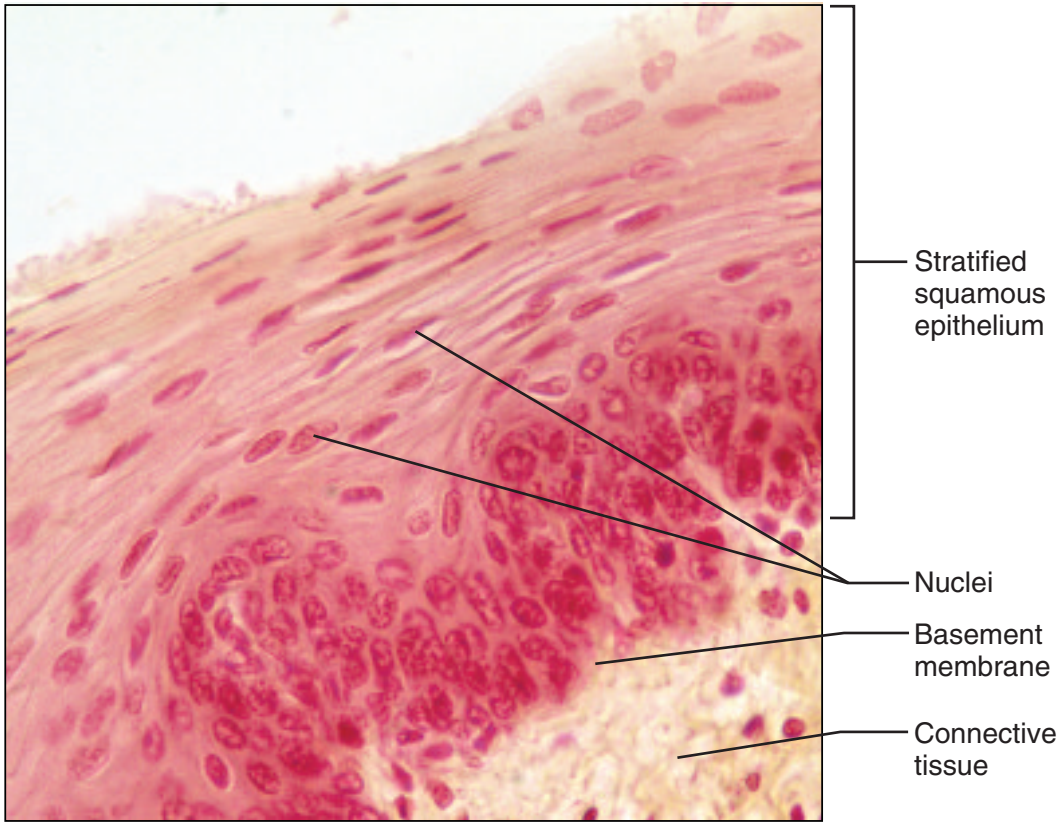
Description: Thick membrane composed of several cell layers; basal cells are cuboidal or columnar and metabolically active; surface cells are flattened (squamous); in the keratinized type, the surface cells are full of keratin and dead; basal cells are active in mitosis and produce the cells of the more superficial layers.



Function: Protects underlying tissues in areas subjected to abrasion.

Location: Nonkeratinized type forms the moist linings of the esophagus, mouth, and vagina; keratinized variety forms the epidermis of the skin, a dry membrane.





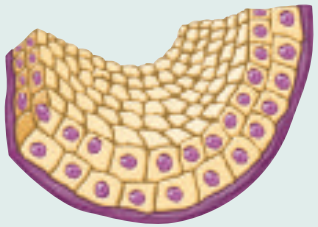
Photomicrograph: Stratified squamous epithelium lining the esophagus (280×).

Stratified Epithelium

複層立方上皮

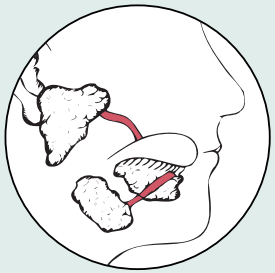
Stratified cuboidal epithelium

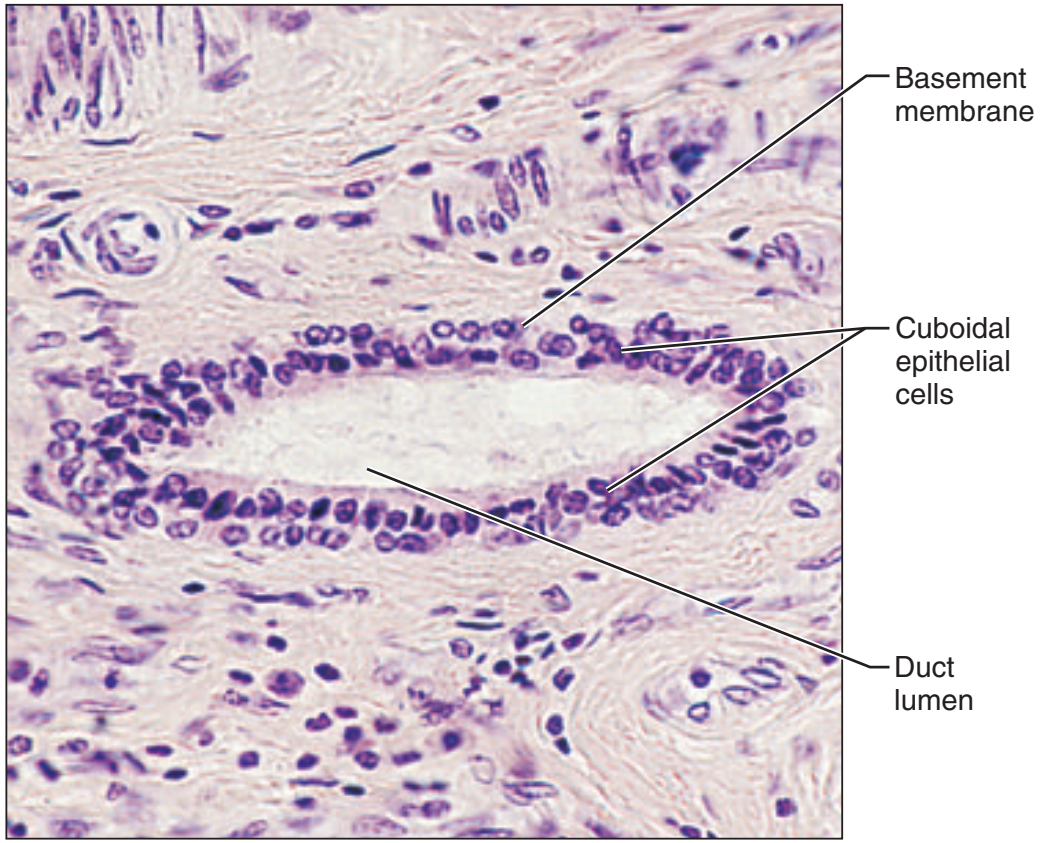
Description: Generally two layers of cubelike cells.



Function: Protection.

Location: Largest ducts of sweat glands, mammary glands, and salivary glands.





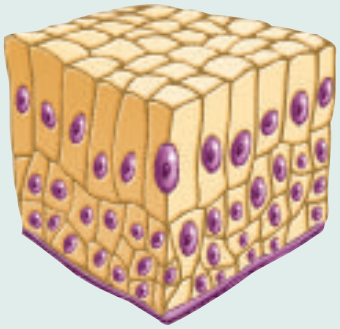
Photomicrograph: Stratified cuboidal epithelium forming a salivary gland duct (290×).

Stratified Epithelium

Stratified columnar epithelium

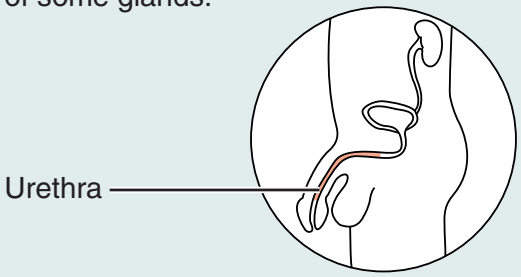
複層柱状上皮

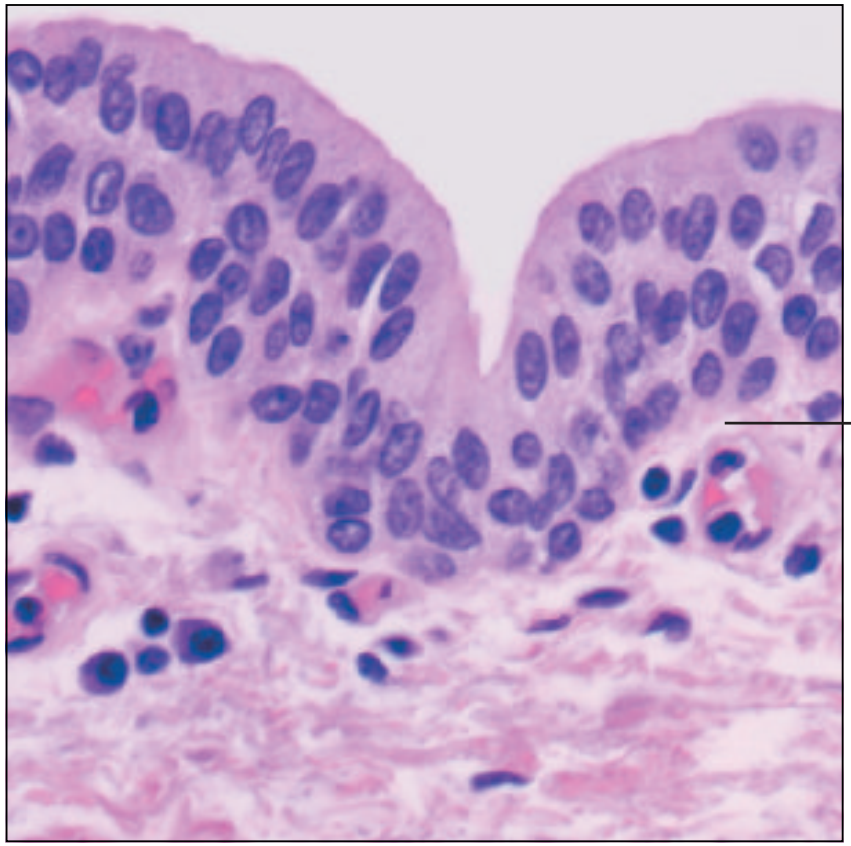
Description: Several cell layers; basal cells usually cuboidal; superficial cells elongated and columnar.



Function: Protection; secretion.

Location: Rare in the body; small amounts in male urethra and in large ducts of some glands.





Photomicrograph: Stratified columnar epithelium lining the male urethra (360×).

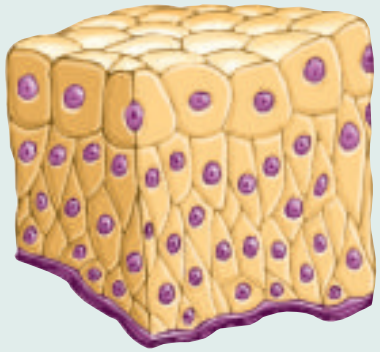
尿道

Stratified Epithelium

Transitional epithelium

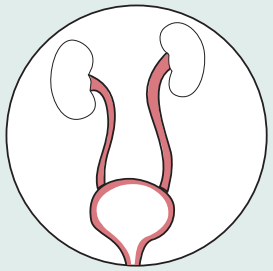
移形上皮

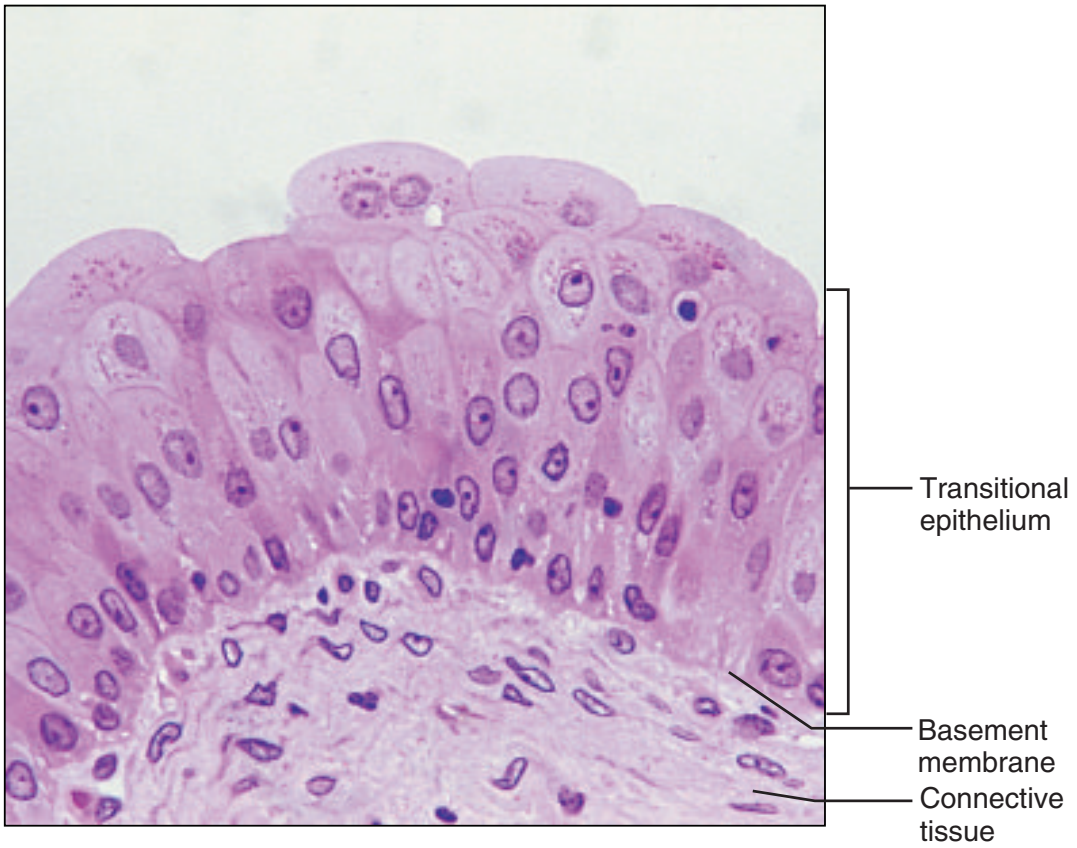
Description: Resembles both stratified squamous and stratified cuboidal; basal cells cuboidal or columnar; surface cells dome shaped or squamous-like, depending on degree of organ stretch.



Function: Stretches readily and permits distension of urinary organ by contained urine.

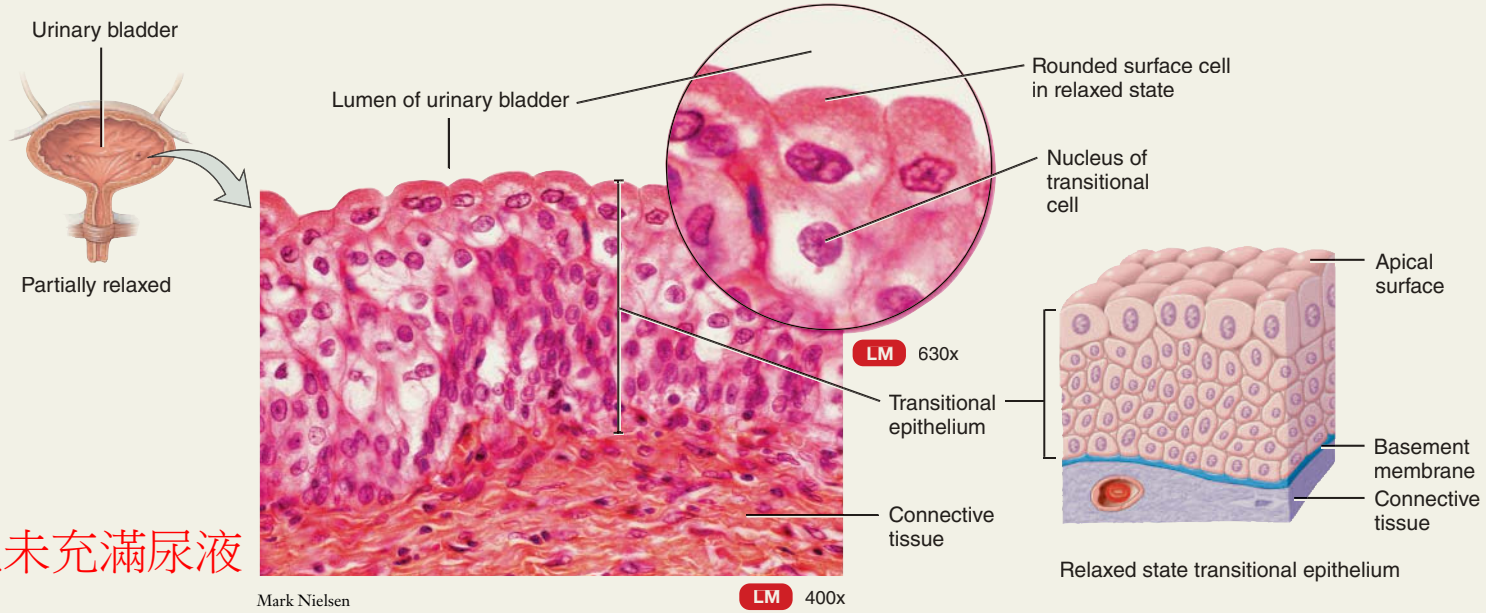
Location: Lines the ureters, bladder, and part of the urethra.

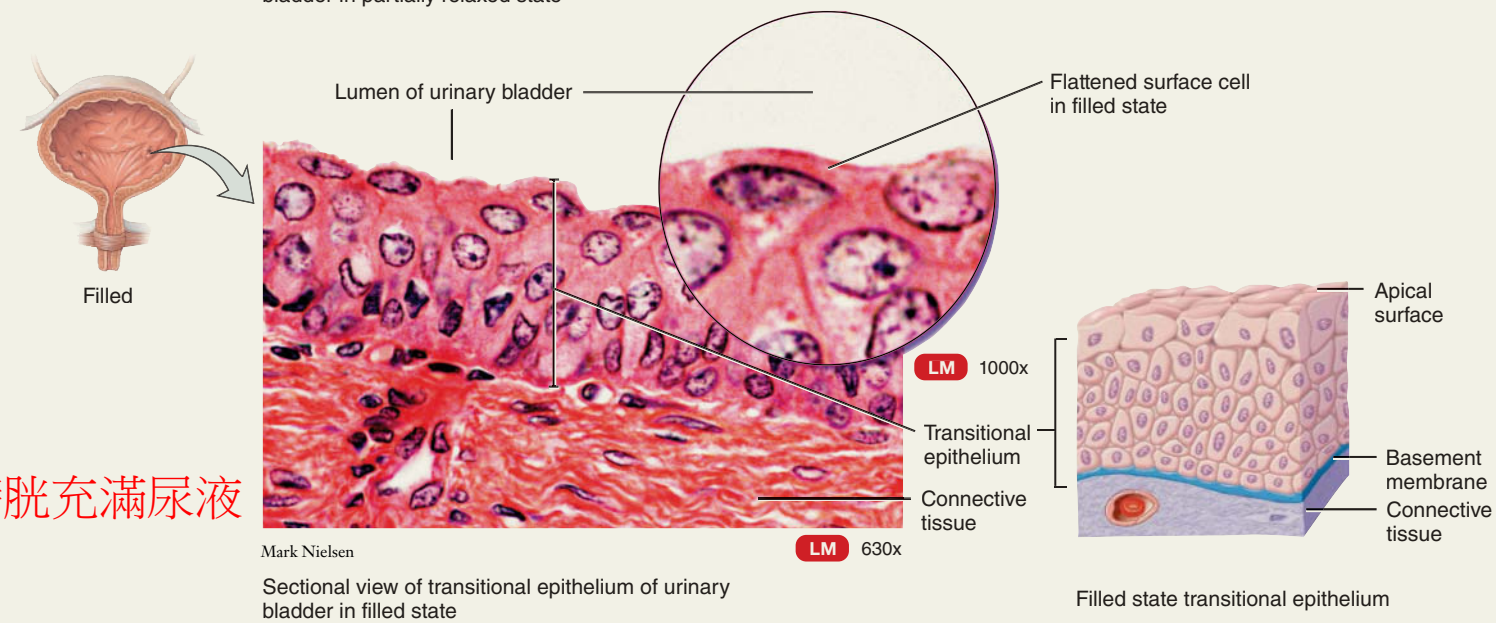




Photomicrograph: Transitional epithelium lining the bladder, relaxed state (365×); note the bulbous, or rounded, appearance of the cells at the surface; these cells flatten and become elongated when the bladder is filled with urine.

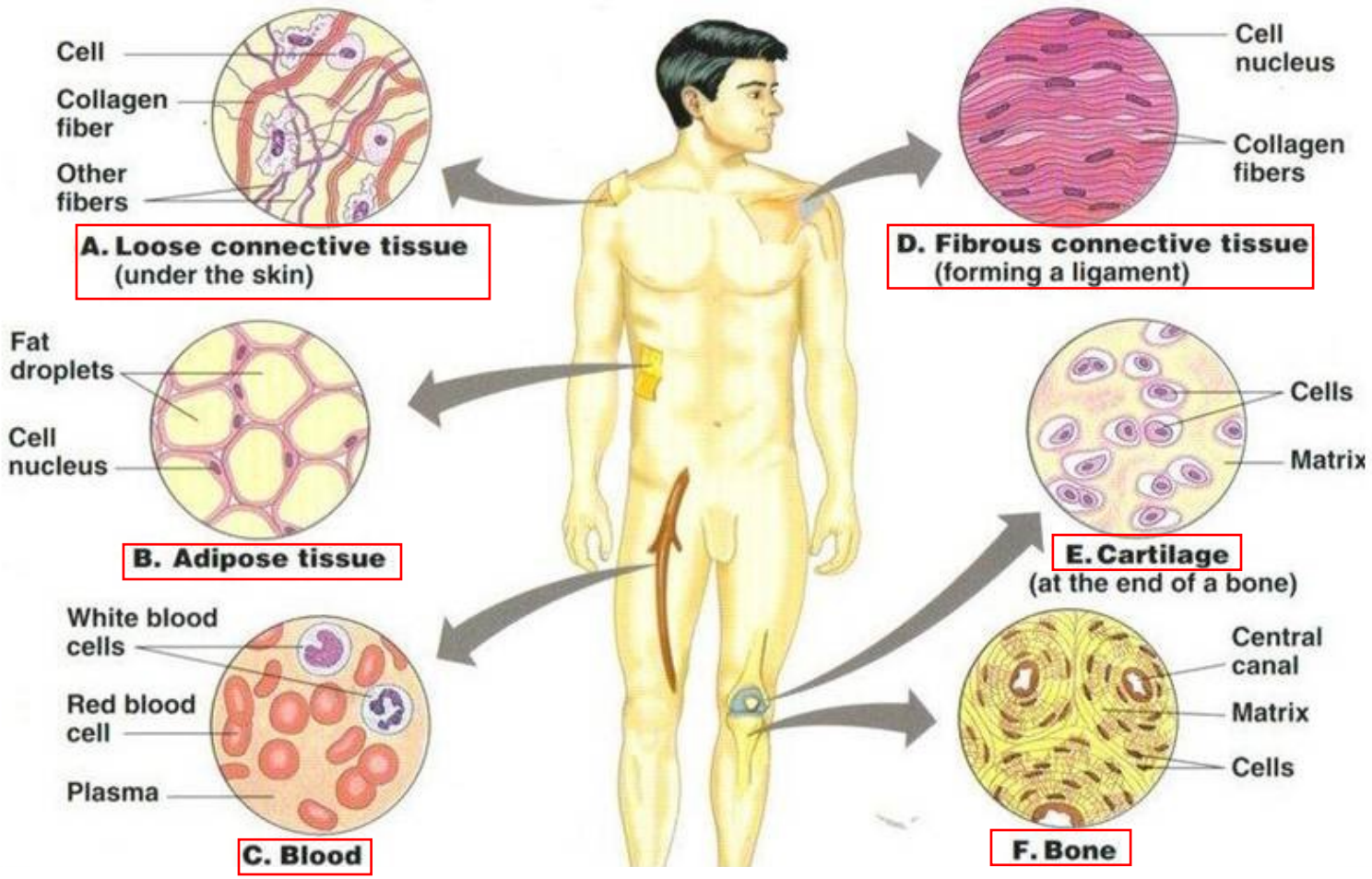
膀胱


Urinary bladder
Partially relaxed
Lumen of urinary bladder
Rounded surface cell in relaxed state
Nucleus of transitional cell
LM 630x
Transitional epithelium
Connective tissue
Apical surface
Basement membrane
Connective tissue
Relaxed state transitional epithelium
膀胱未充满尿液
Mark Nielsen
LM 400x
Sectional view of transitional epithelium of urinary bladder in partially relaxed state


Filled
Lumen of urinary bladder
Flattened surface cell in filled state
LM 1000x
Transitional epithelium
Connective tissue
Apical surface
Basement membrane
Connective tissue
Filled state transitional epithelium
膀胱充满尿液
Mark Nielsen
LM 630x
Sectional view of transitional epithelium of urinary bladder in filled state

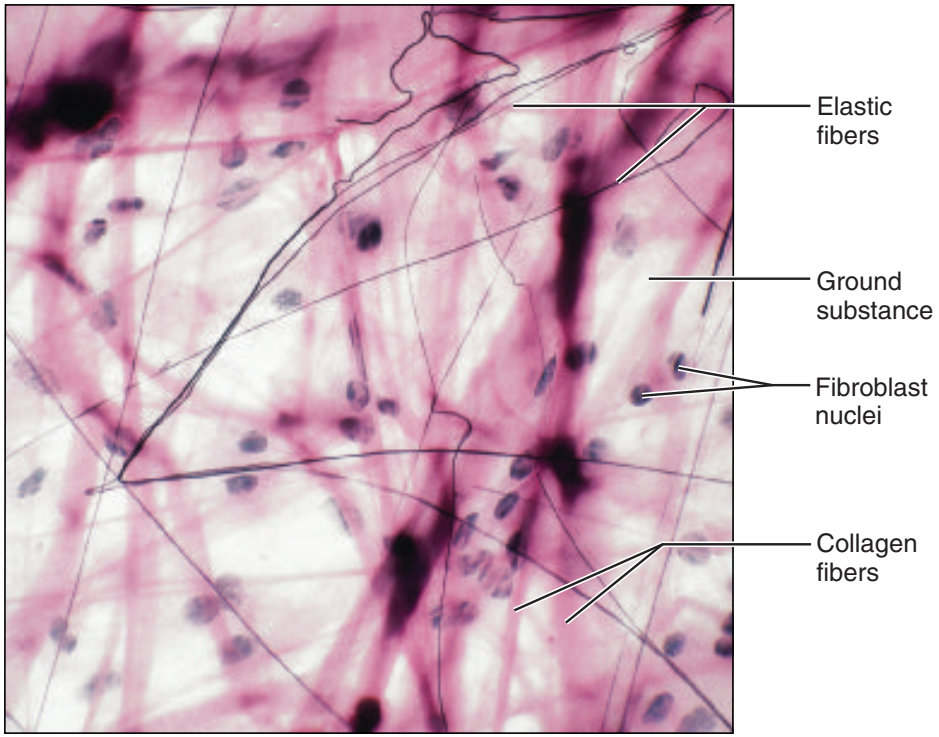
結締組織 (Connective tissue)

- Most diverse and abundant type of tissue
- Functions:
  - Connect tissues and organs
  - Form the basis of skeleton (bone and cartilage)
  - Store and carry nutrients (fat tissue and blood)
  - Surround blood vessels and nerves (connective tissue proper)
  - Against infection

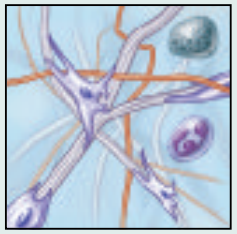


Connective Tissue Proper

- Loose connective tissue (areolar, adipose, reticular) and dense connective tissue (dense irregular, dense regular, elastic)
- **Areolar connective tissue (疏鬆結締組織)**
  - Underlying all epithelia of the body and surround the small nerves and vessels
  - Functions: 1. supporting and binding other tissues
    2. holding body fluids
    3. Defending the body against infection
    4. Storing nutrients as fat
  - Interstitial fluid

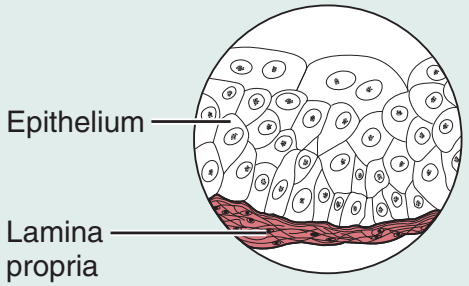


Description: Gel-like matrix with all three fiber types; cells: fibroblasts, macrophages, mast cells, and some white blood cells.



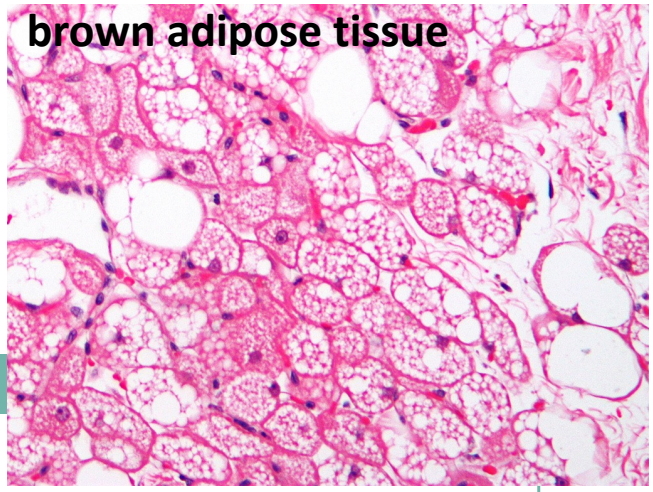
Function: Wraps and cushions organs; its macrophages phagocytize bacteria; plays important role in inflammation; holds and conveys tissue fluid.

Location: Widely distributed under epithelia of body, e.g., forms lamina propria of mucous membranes; packages organs; surrounds capillaries.



Adipose tissue

- Nutrient-storing
- Richly vascularized
- Visceral fat (in the mesenteries, serve as cushion)
- White adipose tissue and brown adipose tissue

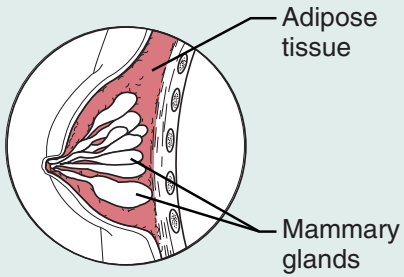


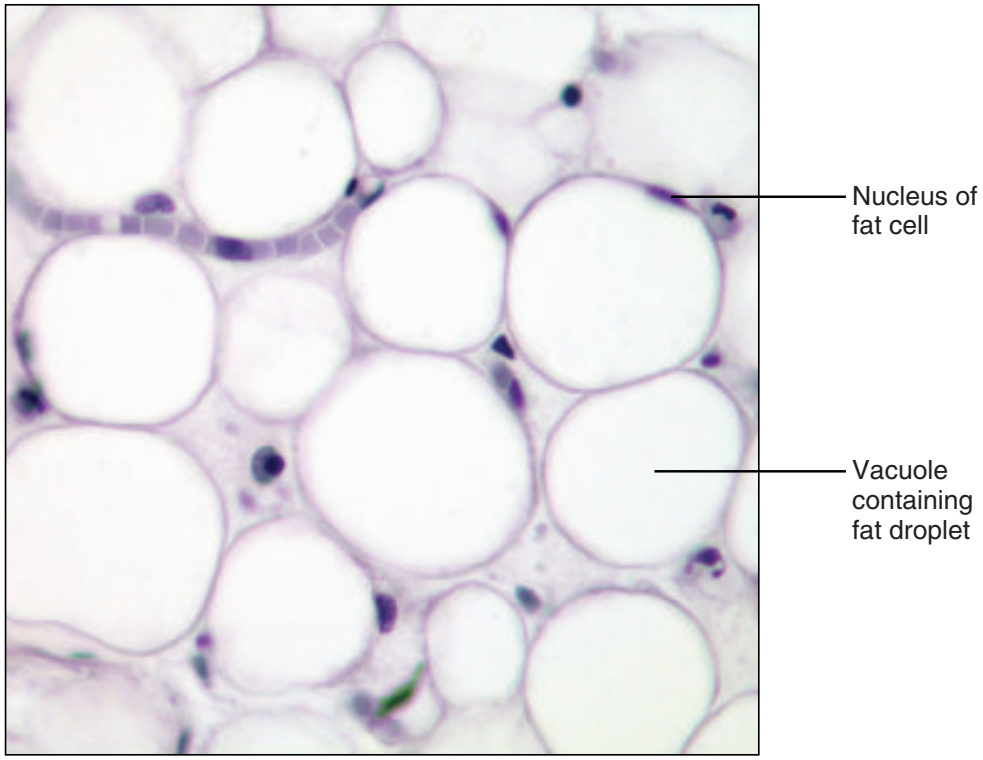
(c) Connective tissue proper: loose connective tissue, adipose

Description: Matrix as in areolar connective tissue, but very sparse; closely packed adipocytes, or fat cells, have nucleus pushed to the side by large fat droplet.

Function: Provides reserve food fuel; insulates against heat loss; supports and protects organs.

Location: Under skin in the hypodermis; around kidneys and eyeballs; within abdomen; in breasts.





Photomicrograph: Adipose tissue from the subcutaneous layer under the skin (350×).

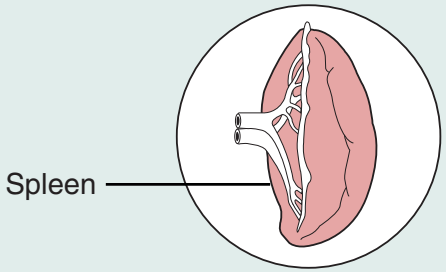
Reticular connective tissue

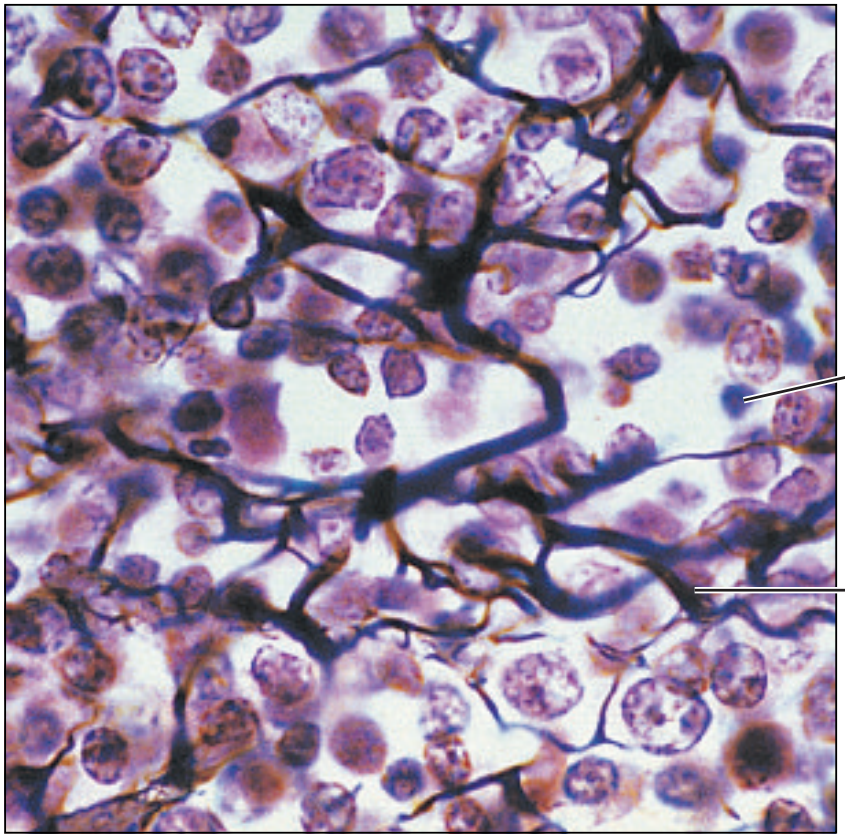
- The bone marrow, spleen, and lymph nodes, which house many free blood cells outside their capillaries, consist largely of reticular connective tissue
- Fibroblasts called **reticular cells** lie along the reticular network of this tissue

Description: Network of reticular fibers in a typical loose ground substance; reticular cells lie on the network.

Function: Fibers form a soft internal skeleton (stroma) that supports other cell types including white blood cells, mast cells, and macrophages.

Location: Lymphoid organs (lymph nodes, bone marrow, and spleen).



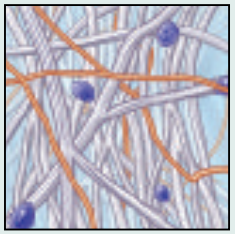


Photomicrograph: Dark-staining network of reticular connective tissue fibers forming the internal skeleton of the spleen (350×).

Dense Irregular Connective Tissue

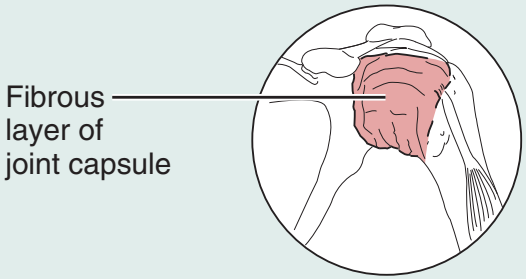
- Thicker collagens run in different planes, allow the tissue to resist strong tensions
- Dermis of skin, fibrous capsules surrounding kidney, lymph node, bone

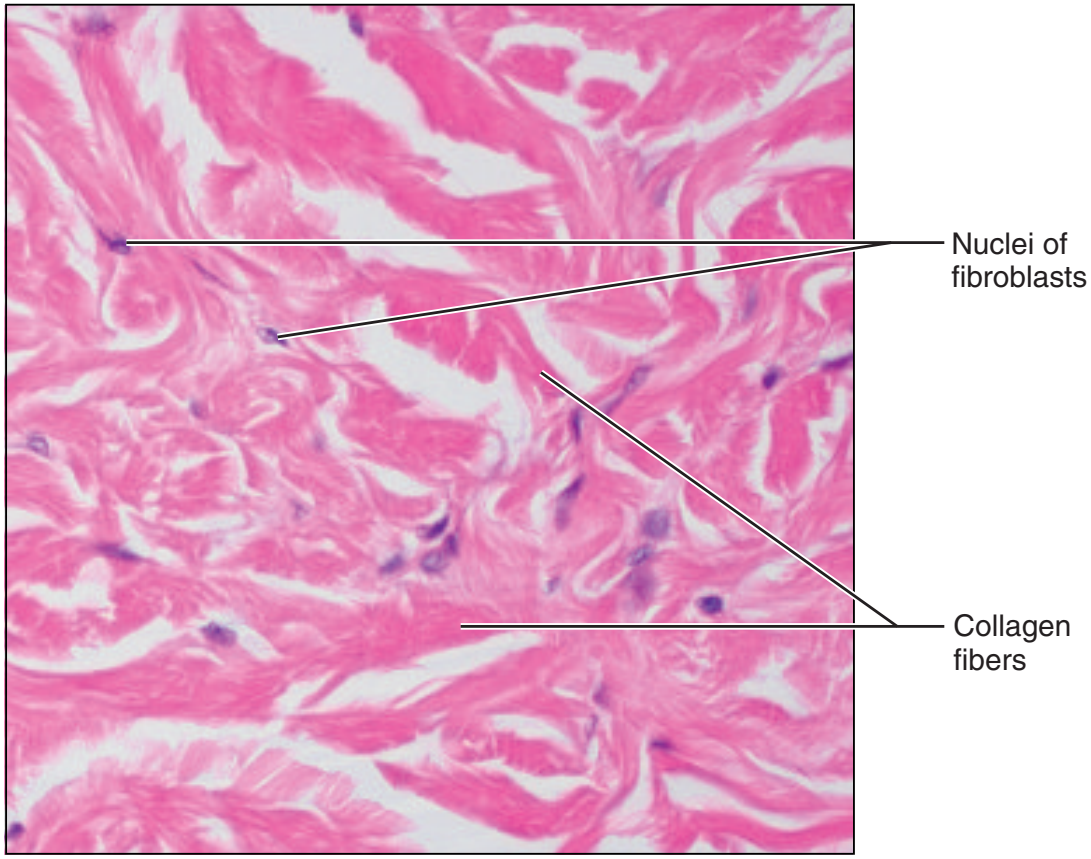
Description: Primarily irregularly arranged collagen fibers; some elastic fibers; major cell type is the fibroblast; defense cells and fat cells are also present.



Function: Able to withstand tension exerted in many directions; provides structural strength.

Location: Fibrous capsules of organs and of joints; dermis of the skin; submucosa of digestive tract.





Photomicrograph: Dense irregular connective tissue from the dermis of the skin (300×).

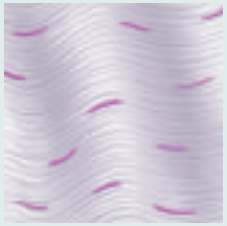
皮膚的真皮

Dense Regular Connective Tissue

- Collagen fibers run in the same direction
- Poorly vascularized and contains no fat cells or defense cells
- Ligaments, tendons, aponeuroses, fascia (deep fascia) (cf: superficial fascia is fatty hypodermis of the skin)

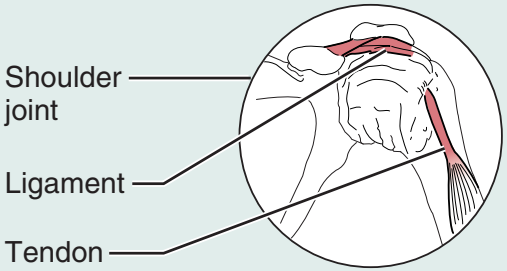
韧带　　肌腱

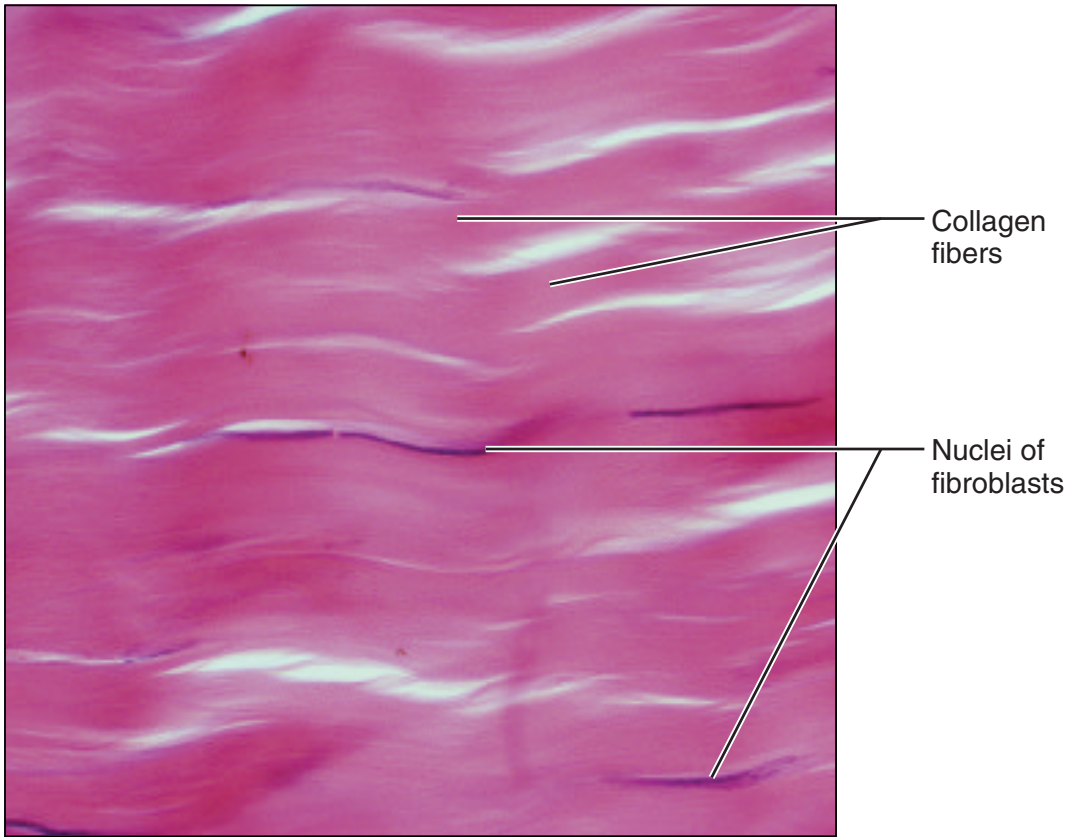
Description: Primarily parallel collagen fibers; a few elastic fibers; major cell type is the fibroblast.



Function: Attaches muscles to bones or to muscles; attaches bones to bones; withstands great tensile stress when pulling force is applied in one direction.

Location: Tendons, most ligaments, aponeuroses.



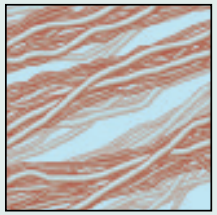


Photomicrograph: Dense regular connective tissue from a tendon (425×).

Elastic Connective Tissue

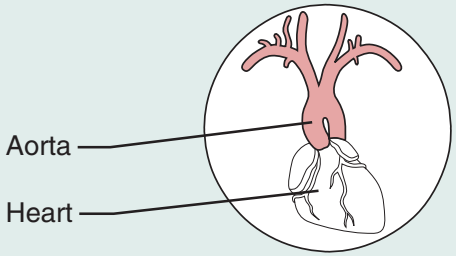
- Elastic fibers are the predominant type of fiber
- Structures where recoil from stretching is important:
  the walls of arteries, ligaments (*ligamentum nuchae* and *ligamentum flavum,* which connect successive vertebrae), and surrounding the bronchial tubes in the lungs

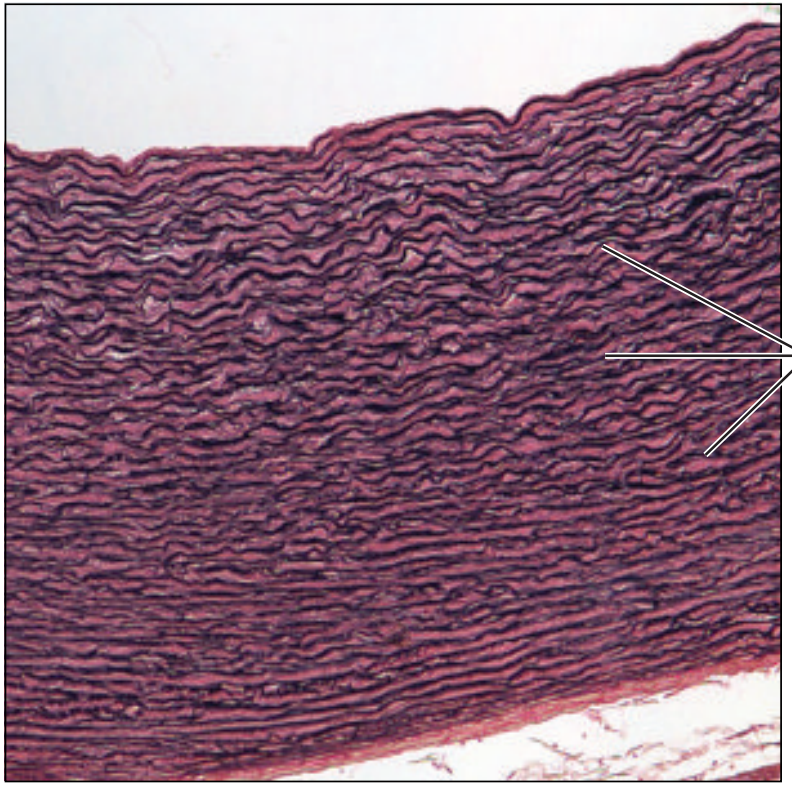
Description: Dense regular connective tissue containing a high proportion of elastic fibers.



Function: Allows recoil of tissue following stretching; maintains pulsatile flow of blood through arteries; aids passive recoil of lungs following inspiration.

Location: Walls of large arteries; within certain ligaments associated with the vertebral column; within the walls of the bronchial tubes.





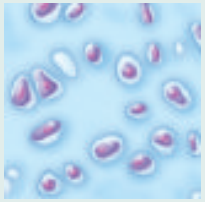
主動脈

Photomicrograph: Elastic connective tissue in the wall of the aorta (250×).

軟骨 (Cartilage)

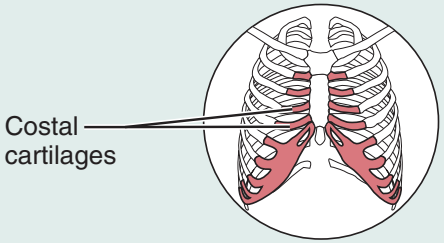
- Contains thin **collagen fibrils**, a ground substance, and an exceptional quantity of tissue fluid; in fact, cartilage consists of up to 80% water
- No blood vessels and nerves
- Chondrocytes resides in **lacuna (軟骨腔)**
- Chondroblasts (immature chondrocyte) secrete the matrix during cartilage growth
- Hyaline cartilage, elastic cartilage, fibrocartilage

Description: Amorphous but firm matrix; collagen fibers form an imperceptible network; chondroblasts produce the matrix and, when mature (chondrocytes), lie in lacunae.



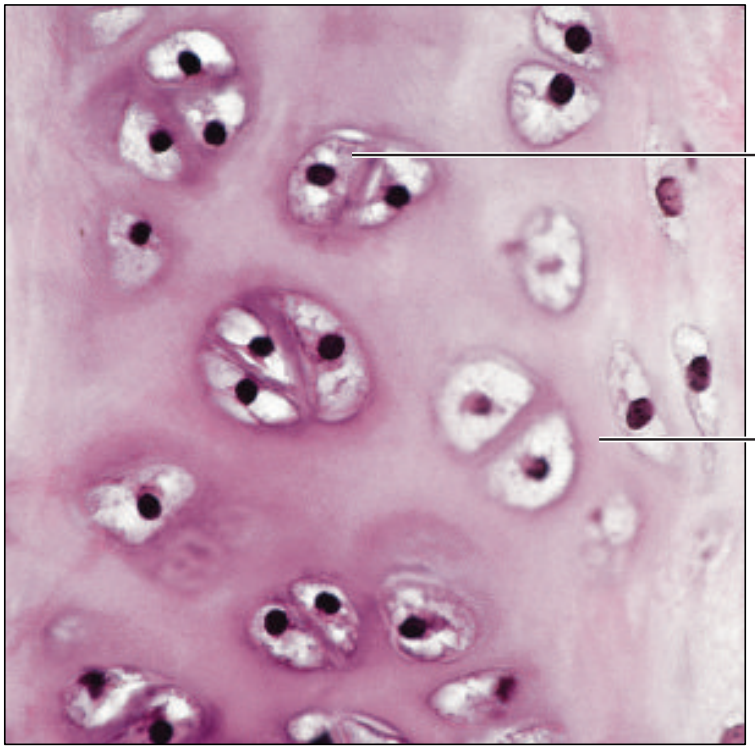
Function: Supports and reinforces; serves as resilient cushion; resists compressive stress.

Location: Forms most of the embryonic skeleton; covers the ends of long bones in joint cavities; forms costal cartilages of the ribs; cartilages of the nose, trachea, and larynx.



Hyaline cartilage

透明軟骨

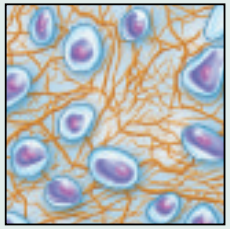


Photomicrograph: Hyaline cartilage from a costal cartilage of a rib (470×).

肋軟骨

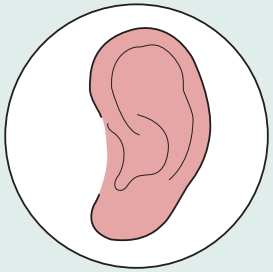
Elastic Cartilage (彈性軟骨)

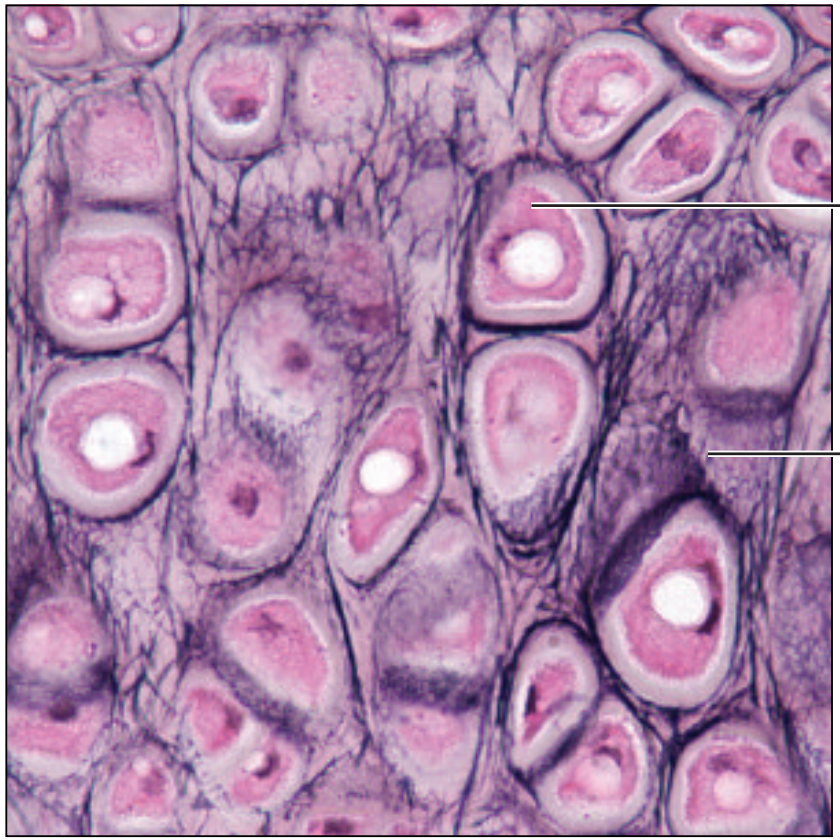
Description: Similar to hyaline cartilage, but more elastic fibers in matrix.



Function: Maintains the shape of a structure while allowing great flexibility.

Location: Supports the external ear (pinna); epiglottis.



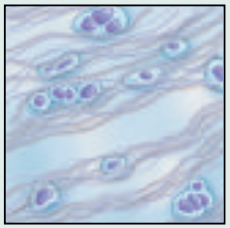


Photomicrograph: Elastic cartilage from the human ear pinna; forms the flexible skeleton of the ear (510×).

耳殼

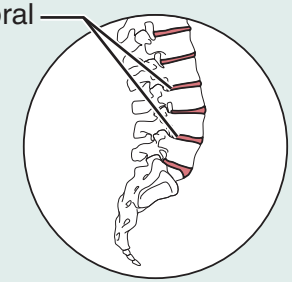
Fibrocartilage (纖維軟骨)

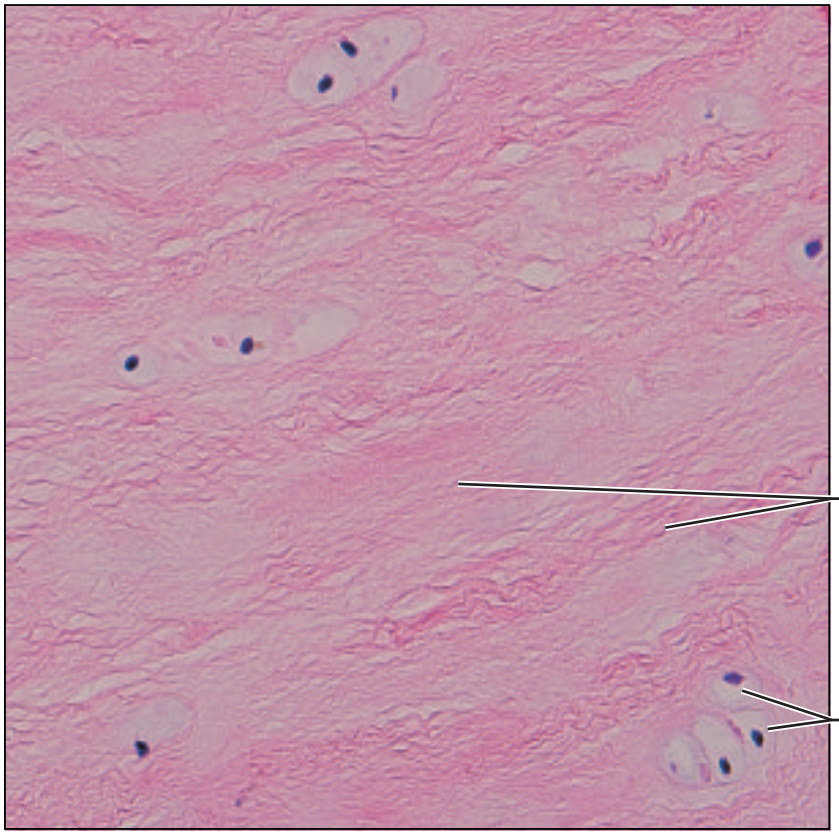
Description: Matrix similar to but less firm than that in hyaline cartilage; thick collagen fibers predominate.



Function: Tensile strength with the ability to absorb compressive shock.

Location: Intervertebral discs; pubic symphysis; discs of knee joint.





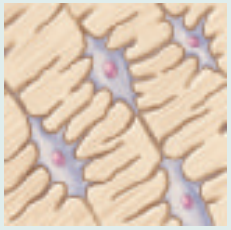
Photomicrograph: Fibrocartilage from an intervertebral disc (175×).

椎間盤

硬骨 (Bone)

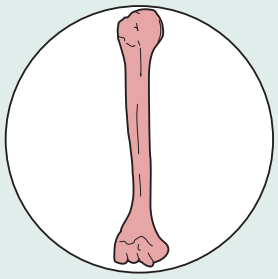
- Bone matrix contains inorganic calcium salt (resist compression); collagen fibers (withstand strong tension)
- Osteoblasts (骨母細胞) secrete collagen fibers and ground substance
- Osteocytes inhabit cavities (lacuna, 骨小腔)
- Well supplied with blood vessels

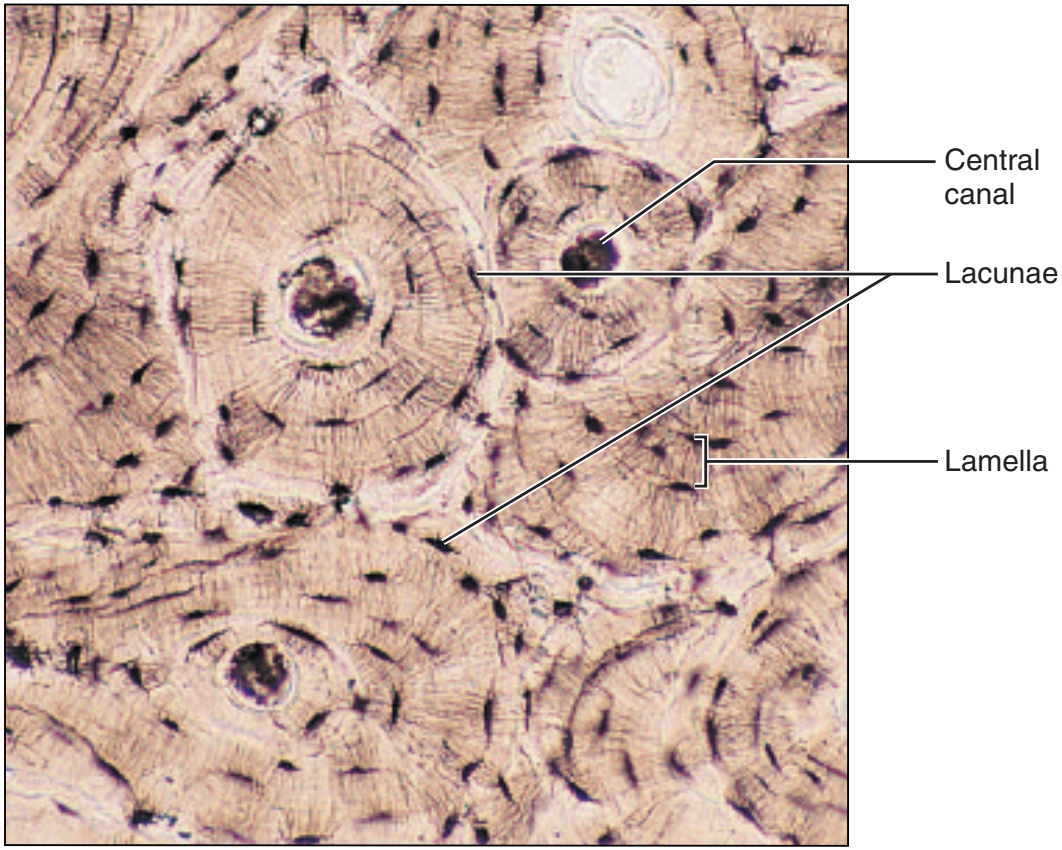
Description: Hard, calcified matrix containing many collagen fibers; osteocytes lie in lacunae. Very well vascularized.



Function: Supports and protects (by enclosing); provides levers for the muscles to act on; stores calcium and other minerals and fat; marrow inside bones is the site for blood cell formation (hematopoiesis).

Location: Bones.

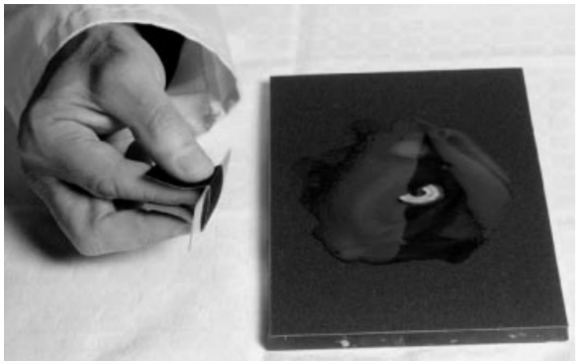
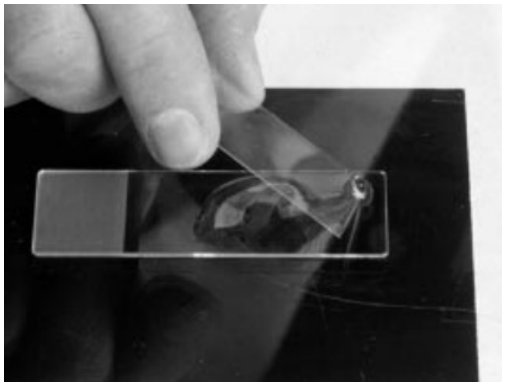
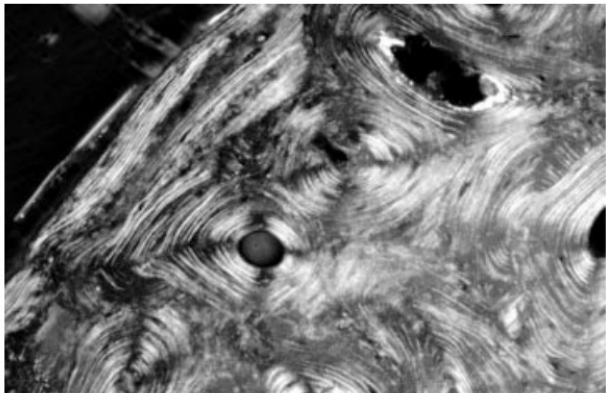




Photomicrograph: Cross-sectional view of bone (175×).

骨頭切片製作

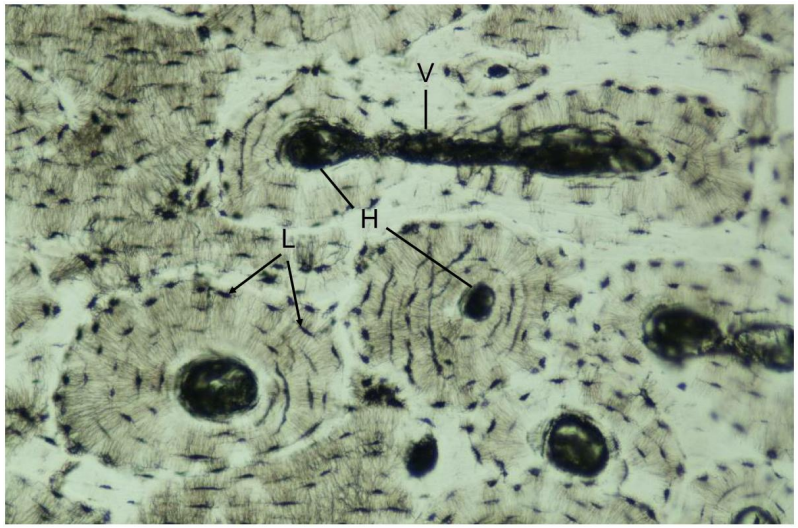
1. Ground bone section (骨研磨法)
   - Observation of inorganic substance
   - Bone lamellae, lacuna, bone canaliculi, Haversian canal, Volkmann's canal

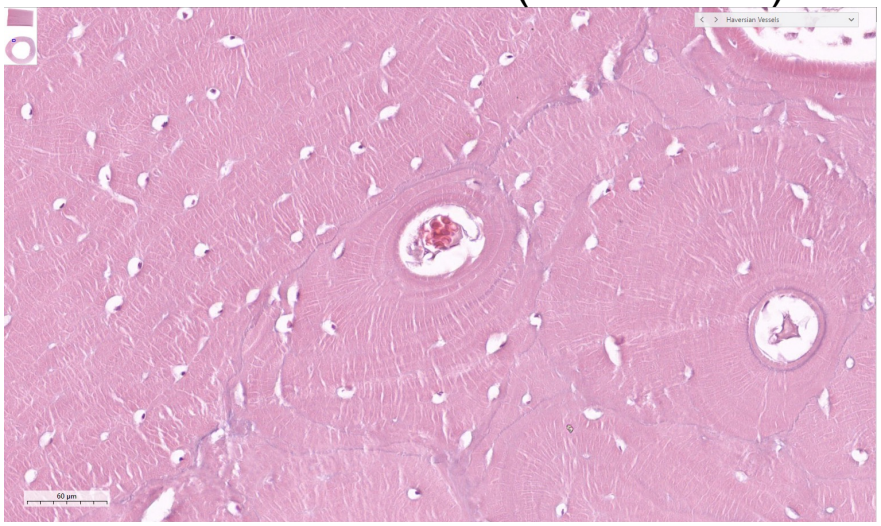
2. Decalcified bone
   - Decalcification agents: formic acid or EDTA (抓住二價離子), 溶掉無機的部分（主要是鈣離子）
   - 石蠟包埋，切片, H&E 染色
   - 可觀察到有機的部分(如periosteum, collagen fiber, cells, fibers)

3. 電解：將bone置入電解槽中，利用電解的方式去除鈣離子，留下有機的部分

Ground bone section (觀察無機質)



Decalcified bone (觀察有機質)



Composition of Bone		Bone Contains ...
Calcium	39%	99% of the body's Calcium
Potassium	0.2%	4% of the body's Potassium
Sodium	0.7%	35% of the body's Sodium
Magnesium	0.5%	50% of the body's Magnesium
Carbonate	9.8%	80% of the body's Carbonate
Phosphate	17%	99% of the body's Phosphate
Total inorganic components	67%	

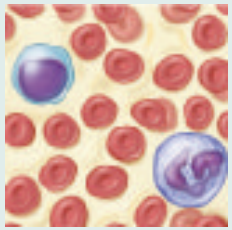
Organic compounds (mostly collagen) 33%

http://www.easynotecards.com/notecard_set/18419

Blood

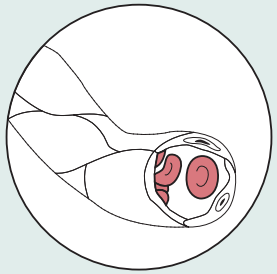
- Atypical connective tissue
- Develops from mesenchyme
- Transport vehicles, carrying defense cells, nutrients, wastes, gases

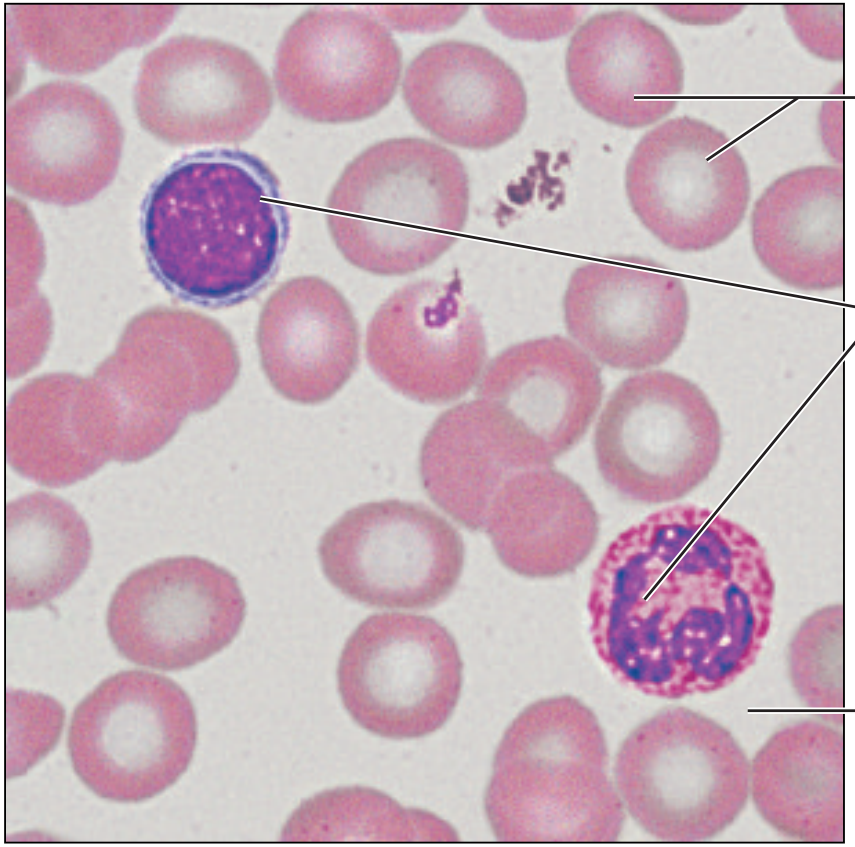
Description: Red and white blood cells in a fluid matrix (plasma).



Function: Transport respiratory gases, nutrients, wastes, and other substances.

Location: Contained within blood vessels.

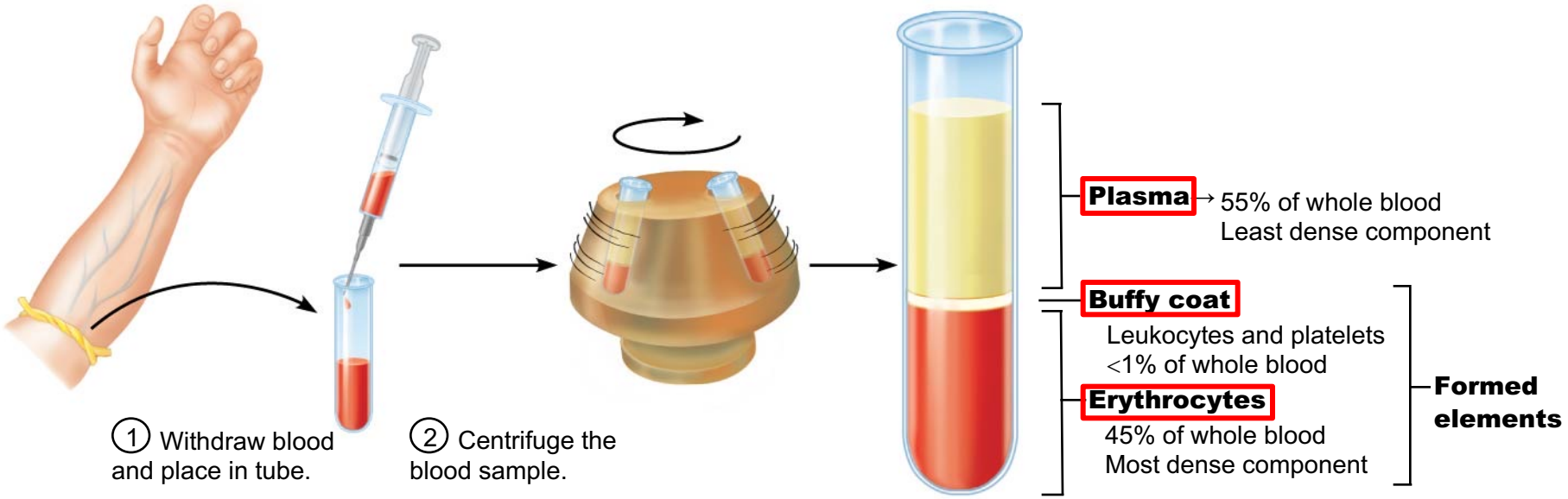




Photomicrograph: Smear of human blood (1650×); shows two white blood cells surrounded by red blood cells.

Blood composition

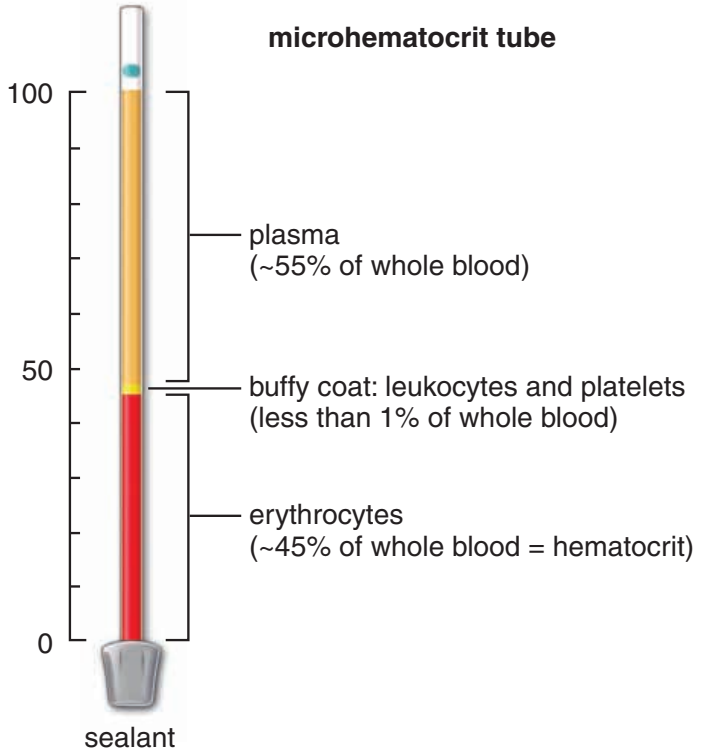
- A specialized connective tissue:
  - blood cells→formed component
  - fluid →plasma
- Hematocrit(血球容積比): percentage of erythrocyte in blood
  - average →45 %
  - males→47 %± 5 %
  - females →42 %± 5 %
- Buffy coat(白細胞層): a thin, gray layer present at the junction between the erythrocytes and the plasma (< 1 %)
  - leukocytes (white blood cells), platelets (thrombocytes)
- Plasma: compose 55 % of blood



Blood

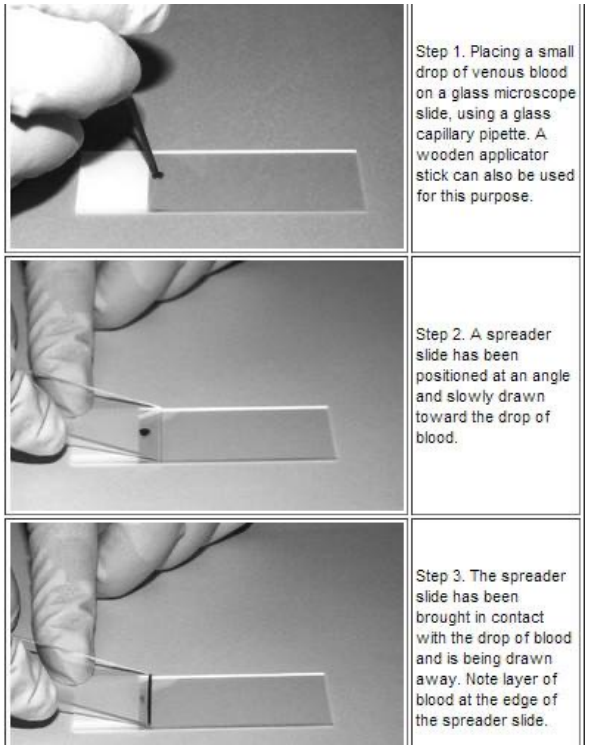
- Cells and extracellular components
- Total blood volume: 6 L or 7 %-8 % total body weight
- Functions: 1. Delivery of nutrients and oxygen
  2. Transport wastes and CO_2 away from cells
  3. Delivery of hormones and regulator substances
  4. Maintenance of homeostasis (coagulation and thermoregulation)
  5. Transport of humoral agents and cells of the immune system to protect the body

- Blood composition:
  - Cells (45 %) erythrocytes
    leukocytes
    thrombocytes
  - Plasma (55 %)
  - Hematocrit (HCT) /packed cell volume (PCV)
    →volume of packed erythrocyte in a sample of blood
- Normal HCT →39 %-50 % in men
  35 %-45 % in women
- Low HCT →anemia (blood loss)

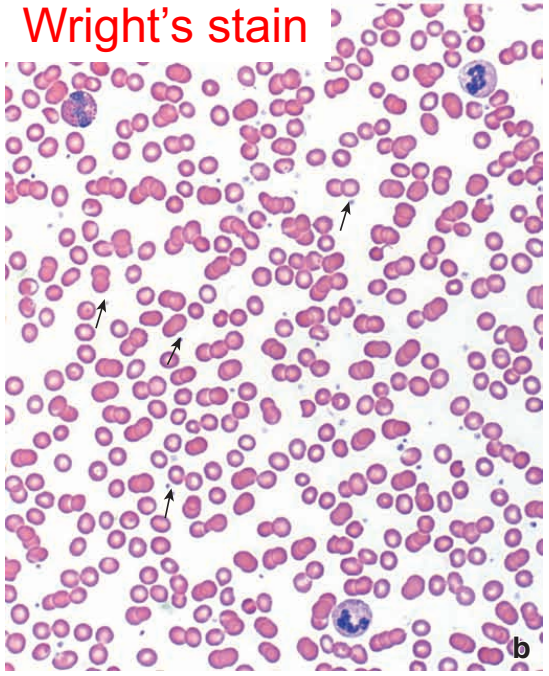


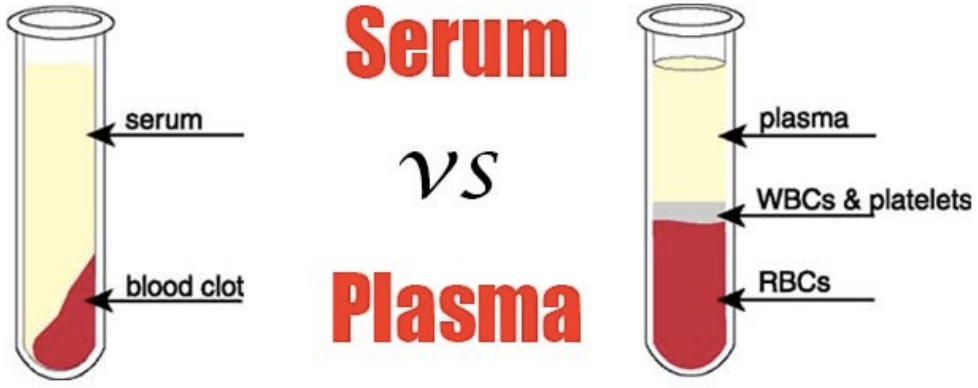
Plasma

- Plasma vs. serum (血清):
  - venipuncture→blood clot (erythrocyte+fibrin)
  - add anticoagulant (citrate or heparin) to obtain plasma
  - only plasma can be used to test the clotting ability
- **Interstitial fluid**: the fluid that surrounds tissue cells
- Blood smear: monolayer of cells; stained by Wright's stain
- **Romanovsky-type stain:**
  - mixture of methylene blue (basic dye), related azure (basic dye), eosin (acidic dye)
  - granulocytes (neutrophils, eosinophils, basophils)
  - agranulocytes (lymphocytes and monocytes)



Wright's stain

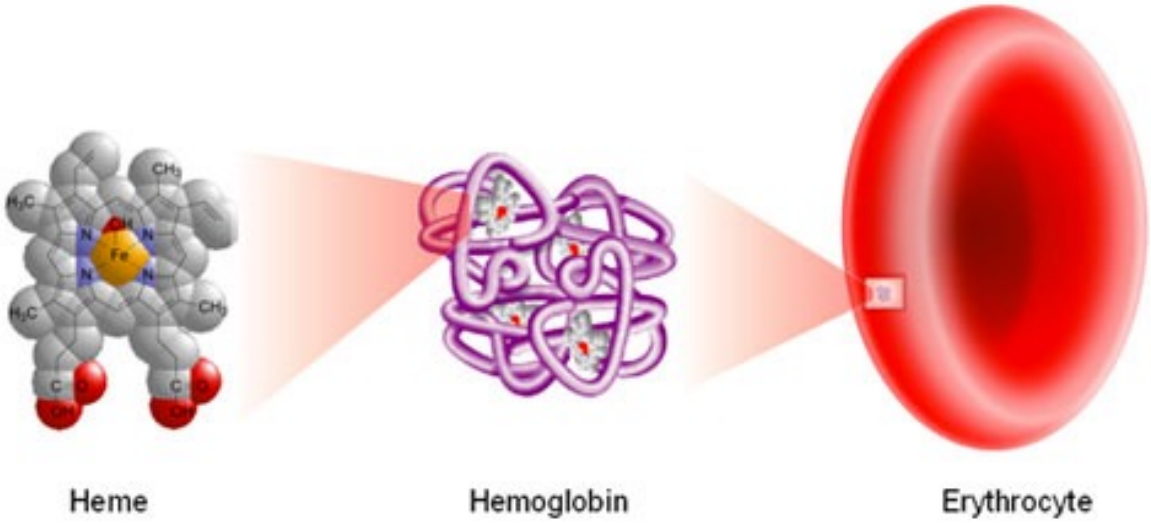


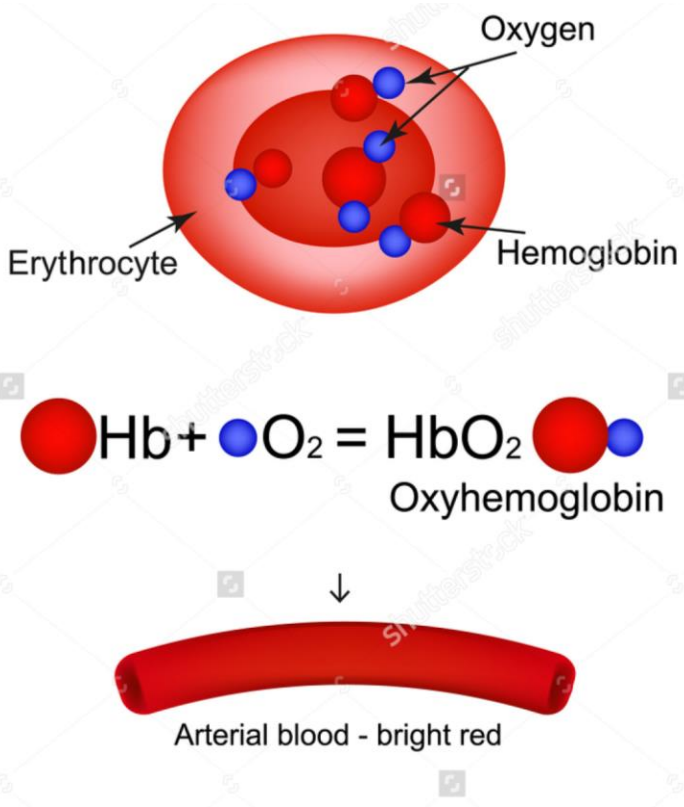


Serum = Plasma – Clotting Factors

Erythrocyte (紅血球)

- The most numerous formed element:
  - 4.3-5.2 million cells in women
  - 5.1-5.8 million in men
- Biconcave discs, no nuclei or organelles
- Hemoglobin(血紅素) in cytoplasm: 4 chains of amino acids, each bears an iron atom for oxygen binding
- Oxidation of iron atoms gives blood its red color

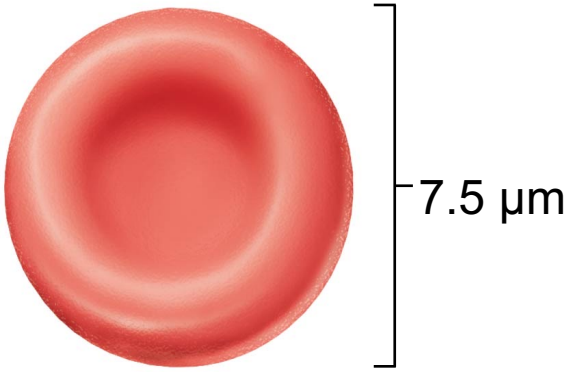




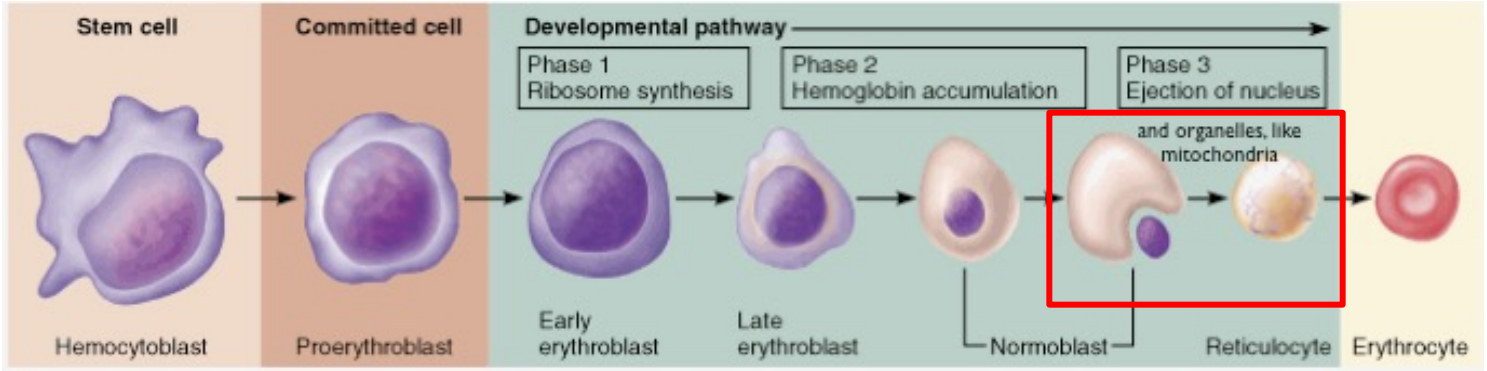
Erythrocyte

- Special structural characteristics for respiratory function:
  →Biconcave shape provides 30 % more surface area, allowing rapid diffusion of oxygen into and out of erythrocytes
  →Contains over 97 % hemoglobin
  →Lack mitochondria, generate energy by anaerobic mechanisms
- Hemoglobin in erythrocyte also carries 20 % CO_2
- Originate from red bone marrow, where they expel their nucleus and organelles
- Live for 100-120 days

Side view (cut)



Top view

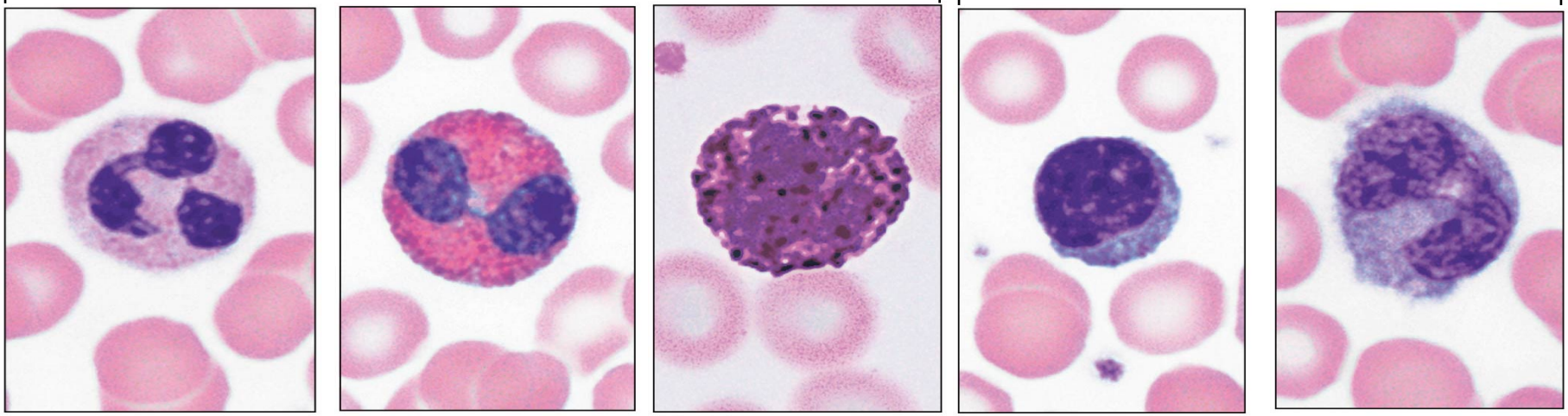


Leukocytes (白血球)

- Five types of leukocytes:
  - Granulocytes(neutrophils, eosinophils, basophils)
    → contain many obvious granules, larger and much shorter lived
    → all are phagocytic
  - Agranulocytes (lymphocytes, monocyte)
- Never Let Monkey Eat Banana (most abundant to least abundant)

Granulocytes

Agranulocytes



(a) Neutrophil: Multilobed nucleus, pale red and blue cytoplasmic granules

(b) Eosinophil: Bilobed nucleus, red cytoplasmic granules

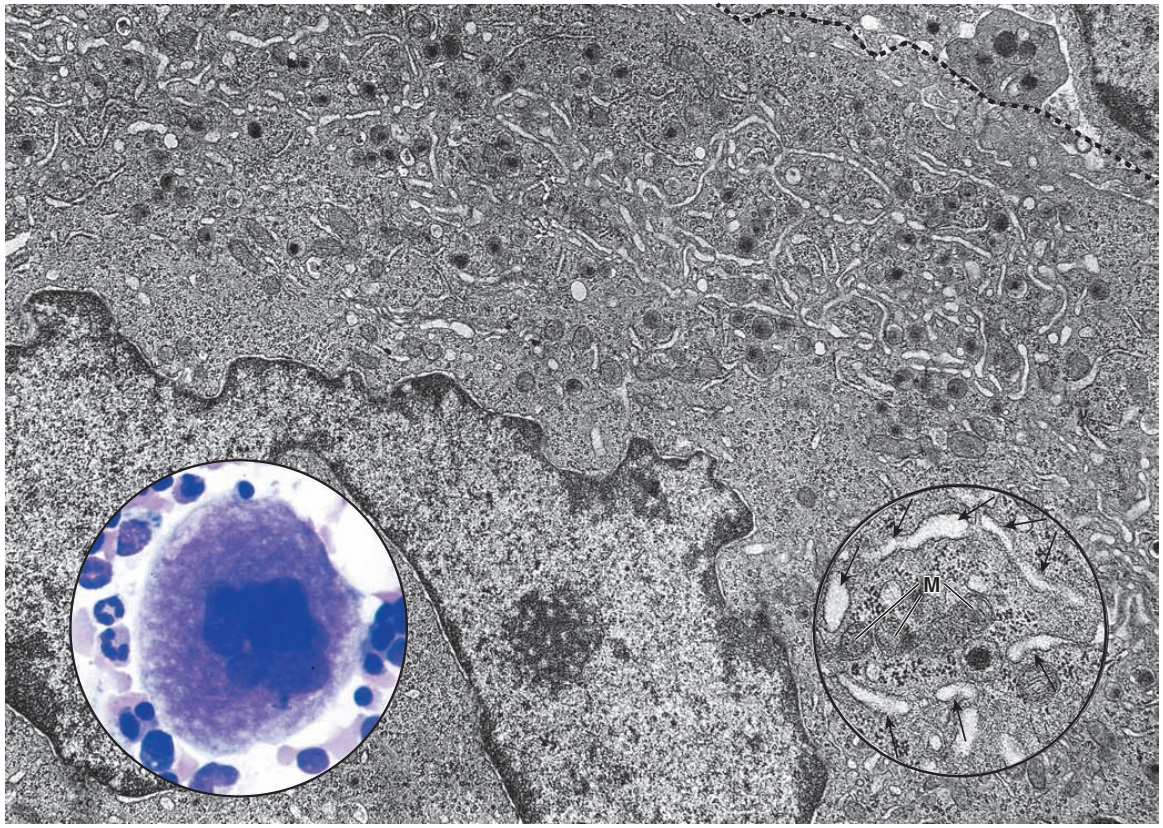
(c) Basophil: Bilobed nucleus, purplish-black cytoplasmic granules

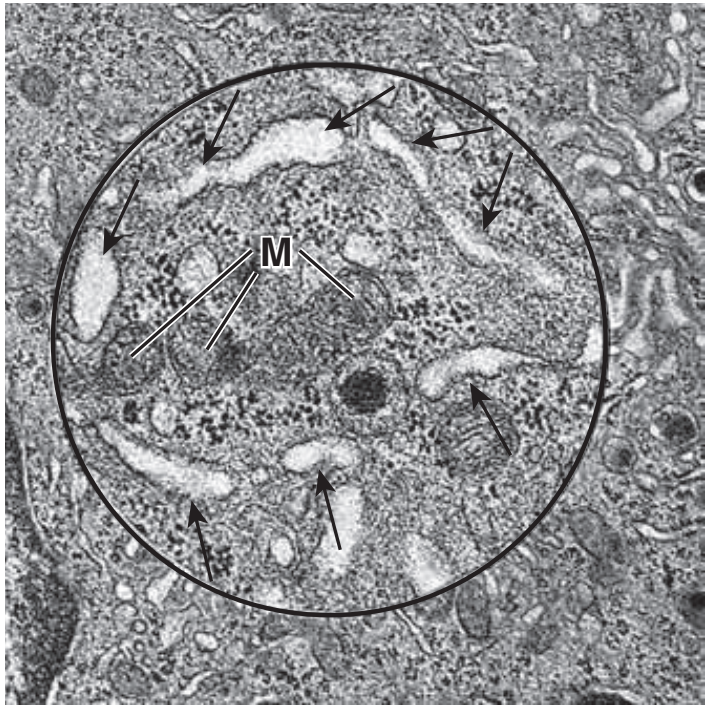
(d) Lymphocyte (small): Large spherical nucleus, thin rim of pale blue cytoplasm

(e) Monocyte: Kidney-shaped nucleus, abundant pale blue cytoplasm

Thrombocytes (platelets)

- Derived from large polyploid cells in the bone marrow (called **megakaryocytes,** 巨核細胞)
- **Platelet demarcation channels**
- membrane-bounded, anucleate cytoplasmic fragments
- 2- 3 μm (cf. erythrocyte: 7 μm)
- Life span: 10 days

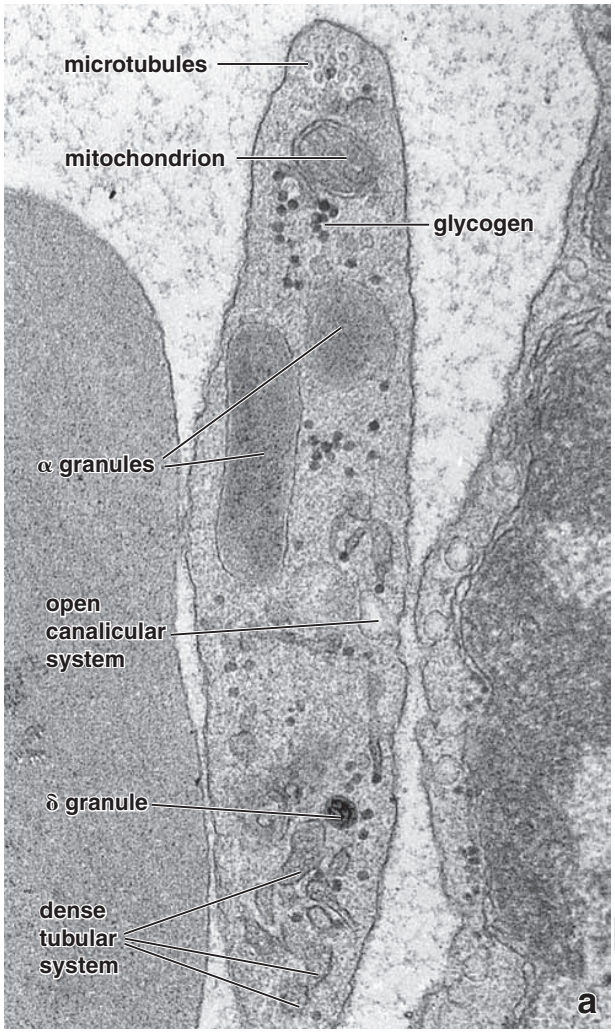


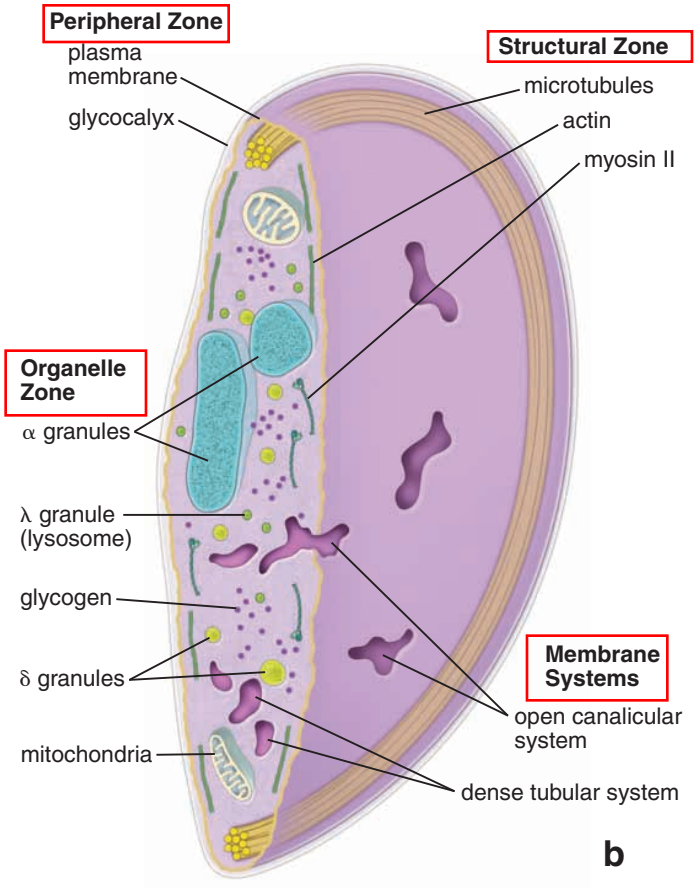


→: platelet demarcation channels
M: mitochondria

Thrombocytes (platelets)

- **Peripheral zone**: cell membrane covered by glycocalyx (function as receptors)
- **Structural zone**: microtubules, actin filaments, myosin and actin-binding proteins (maintain the discoid shape)
- **Organelle zone**: mitochondria, peroxisomes, glycogen particles, granules





α granules
fibrinogen, coagulation factors, plasminogen, plasminogen activator inhibitor, platelet-derived growth factor **blood coagulation**
δ granules
ADP, ATP, serotonin, histamine **platelet adhesion and vasoconstriction**
λ granules
hydrolytic enzymes **clot resorption**

- **Membrane zone**:
  - open canalicular system(OCS)
  - dense tubular system (DTS)→storage site for Ca^{2+}

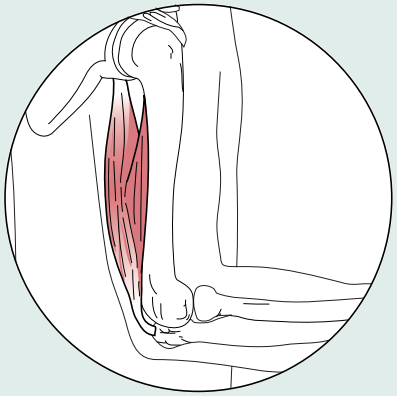
肌肉組織 (Muscle tissues)

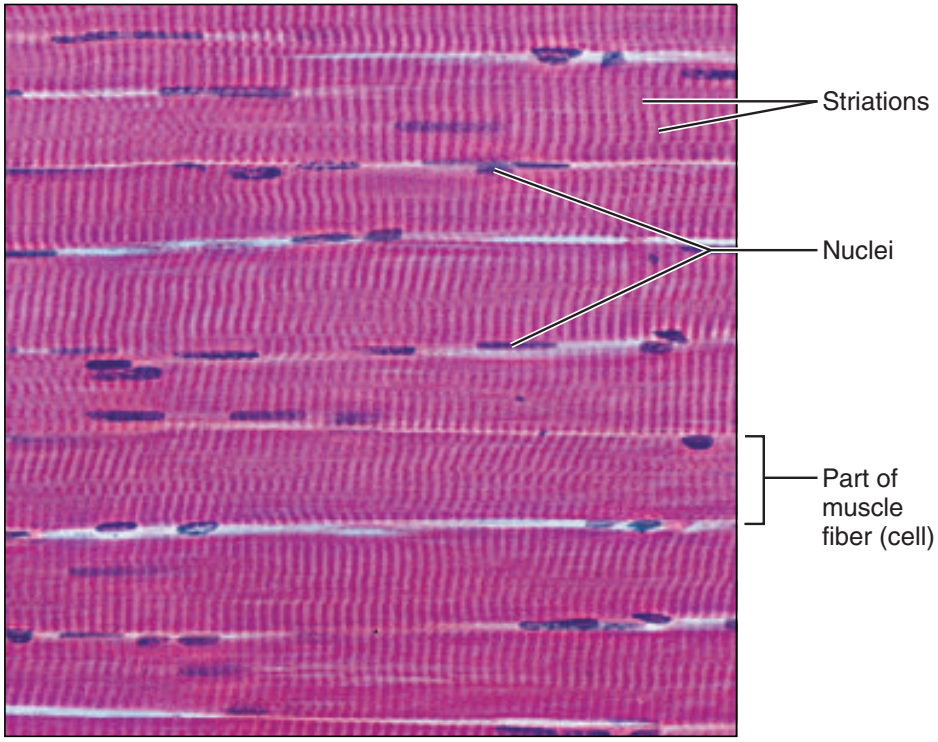
- Muscle cells (muscle fibers): elongated shape and contract force
- Cellular organelles filled with the actin and myosin laments that bring about contraction
- **Skeletal muscle (骨骼肌)**
  - long, large cylinders that contain many nuclei (多核), striated (有横纹)

Description: Long, cylindrical, multinucleate cells; obvious striations.

Function: Voluntary movement; locomotion; manipulation of the environment; facial expression.

Location: In skeletal muscles attached to bones or occasionally to skin.

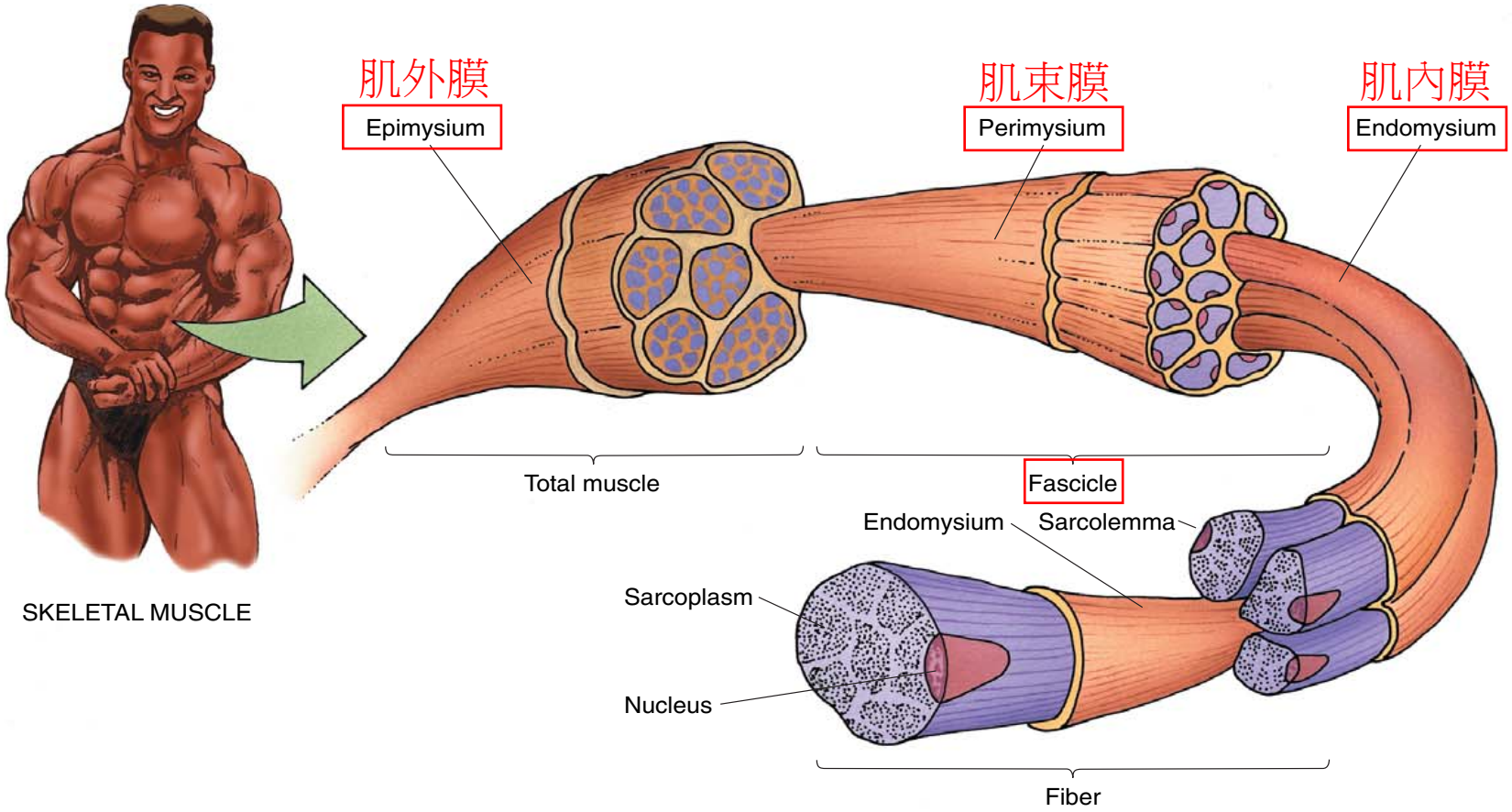




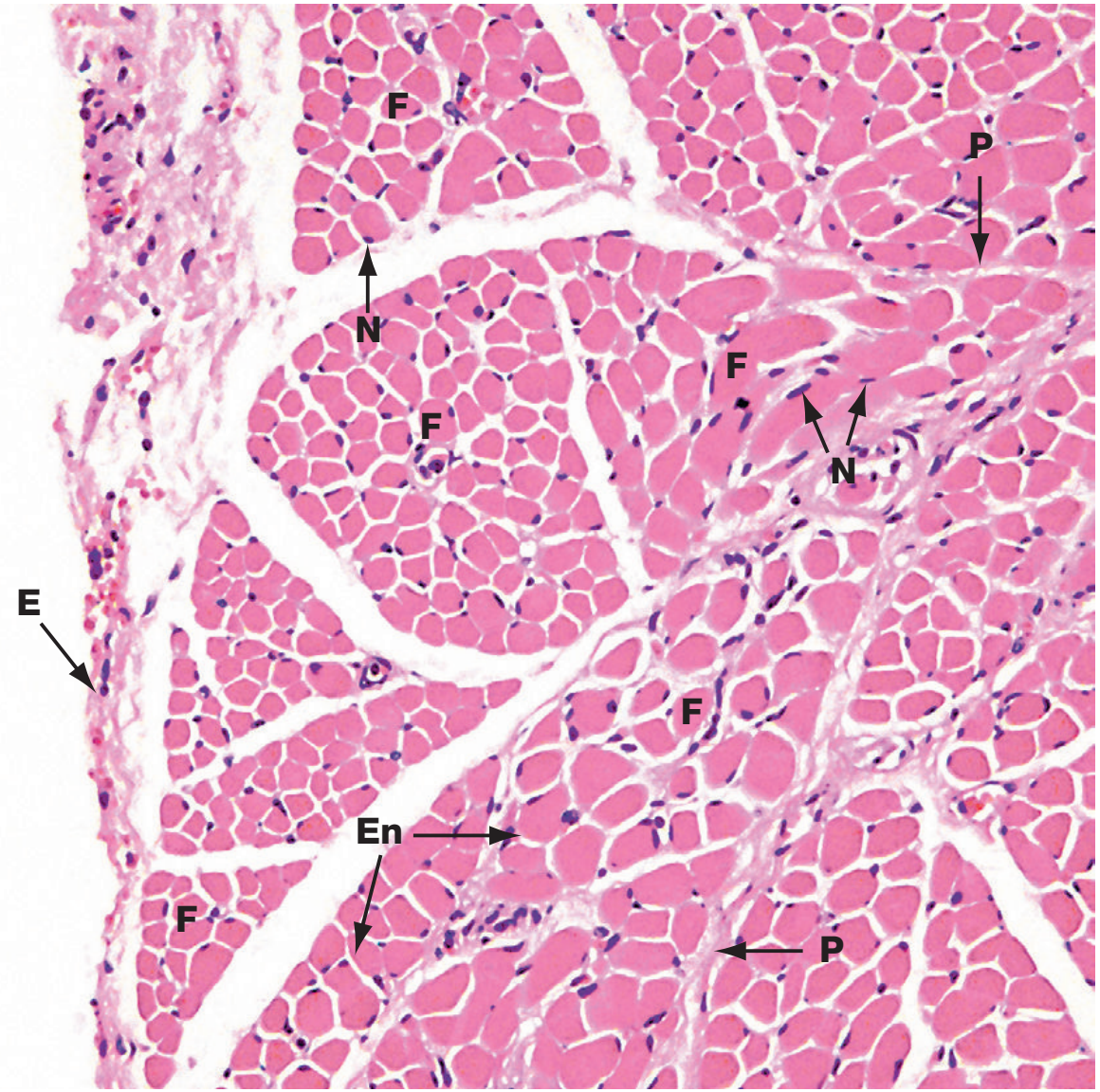
Photomicrograph: Skeletal muscle (450×). Notice the obvious banding pattern and the fact that these large cells are multinucleate.

骨骼肌 (Skeletal muscle)

- The individual muscle cells (muscle fibers) are grouped together into elongated bundles called ***fasciculi*** or ***fascicles*** with delicate supporting tissue called ***endomysium*** occupying the spaces between individual muscle fibers
- Each fascicle is surrounded by loose collagenous tissue called ***perimysium***
- ***Epimysium:*** a dense collagenous sheath invests many fasciculi
- Large blood vessels and nerves enter the epimysium and divide to ramify throughout the muscle in the perimysium and endomysium.



Skeletal muscle



- Polygonal in shape
- Nuclei lying at the peripheries of the cells
- **Endomysium**, which consists mainly of reticulin fibers and a small amount of collagen, conveys numerous small blood vessels, lymphatics and nerves throughout the muscle
- **Perimysium*:*** composed of collagen and through which larger vessels and nerves run
- **Epimysium**: a collagenous sheath that binds the fascicles into a single muscle

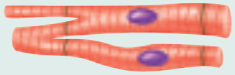
E: epimysium **En:** endomysium **F:** fascicle
N: nucleus **P:** perimysium

Cardiac muscle (心肌)

- In the wall of the heart
- Contrast to propel blood
- Striations (横纹)
- One nucleus; branch (分支) and joint at special cellular junctions called intercalated discs (闰盘)

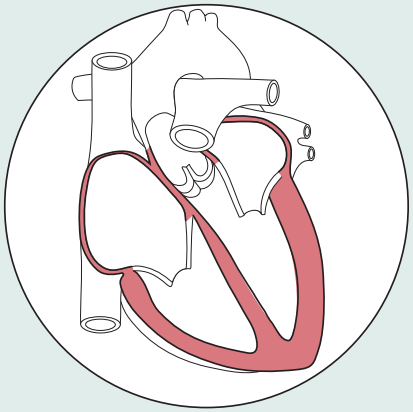
(b) Cardiac muscle

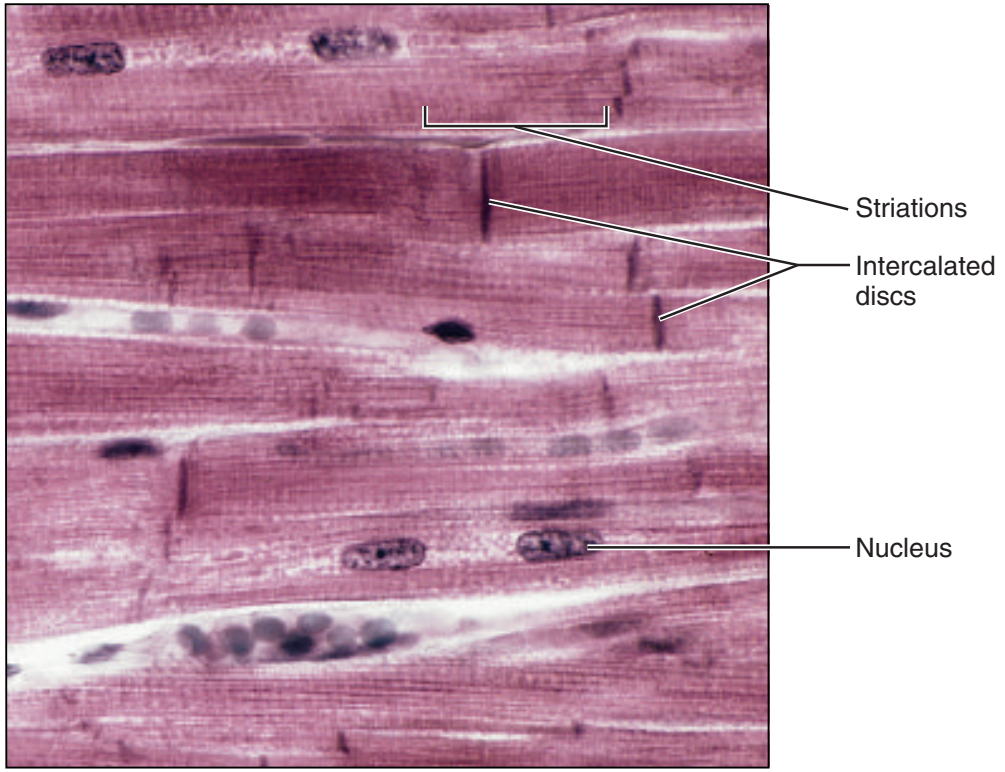
Description: Branching, striated, generally uninucleate cells that interdigitate at specialized junctions (intercalated discs).



Function: As it contracts, it propels blood into the circulation; involuntary control.

Location: The walls of the heart.





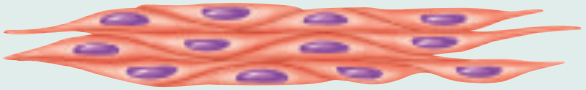
Photomicrograph: Cardiac muscle (355×); notice the striations, branching of cells, and the intercalated discs.

Smooth muscle (平滑肌)

- Elongated with tapered ends and contain one centrally located nucleus
- In the walls of hollow viscera such as the digestive and urinary organs, uterus, and blood vessels

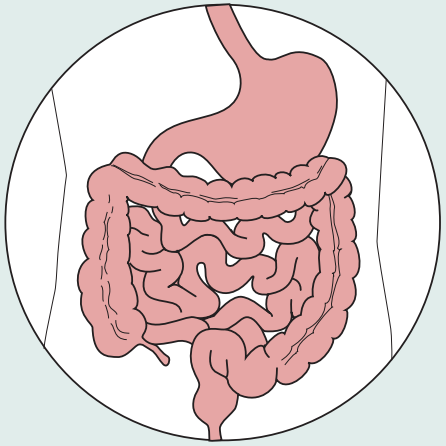
(c) Smooth muscle

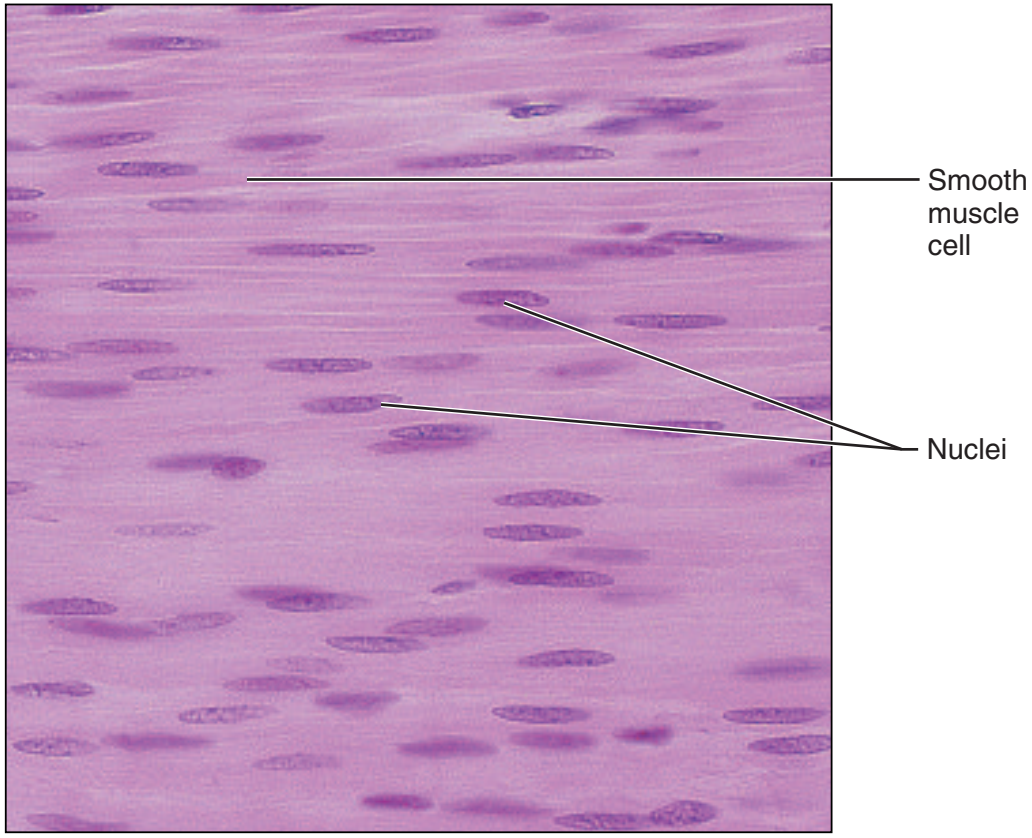
Description: Spindle-shaped cells with central nuclei; no striations; cells arranged closely to form sheets.



Function: Propels substances or objects (foodstuffs, urine, a baby) along internal passageways; involuntary control.

Location: Mostly in the walls of hollow organs.



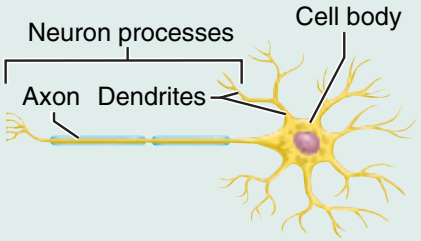


Photomicrograph: Sheet of smooth muscle from the digestive tract (465×).

神經組織 (Nervous tissue)

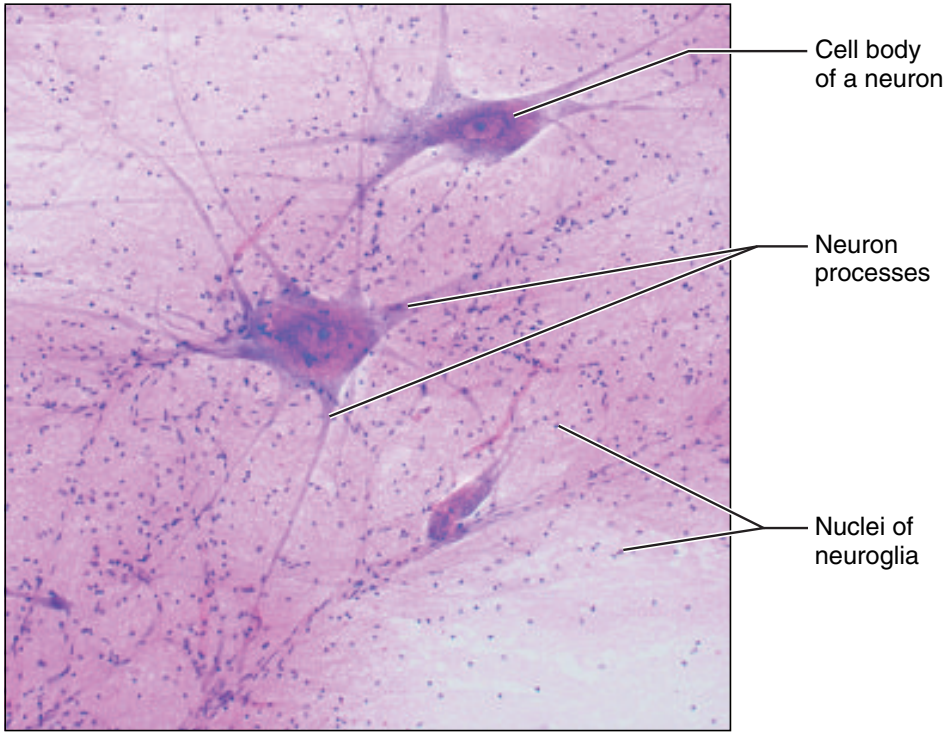
- Regulate and control body functions
- **Neurons (神經細胞)**
  - Generate and conduct electrical impulses
  - **Dendrites**: receptive region of the neuron
  - **Axon**: generates nerve impulses and transmits them away from the cell body
- **Neuroglia (神經膠細胞)**
  - Supporting cells, nourish, insulate, and protect the delicate neurons.

Description: Neurons are branching cells; cell processes that may be quite long extend from the nucleus-containing cell body; also contributing to nervous tissue are nonconducting supporting cells, neuroglia (not illustrated).



Function: Transmit electrical signals from sensory receptors and to effectors (muscles and glands) that control the activity of the effector organs.

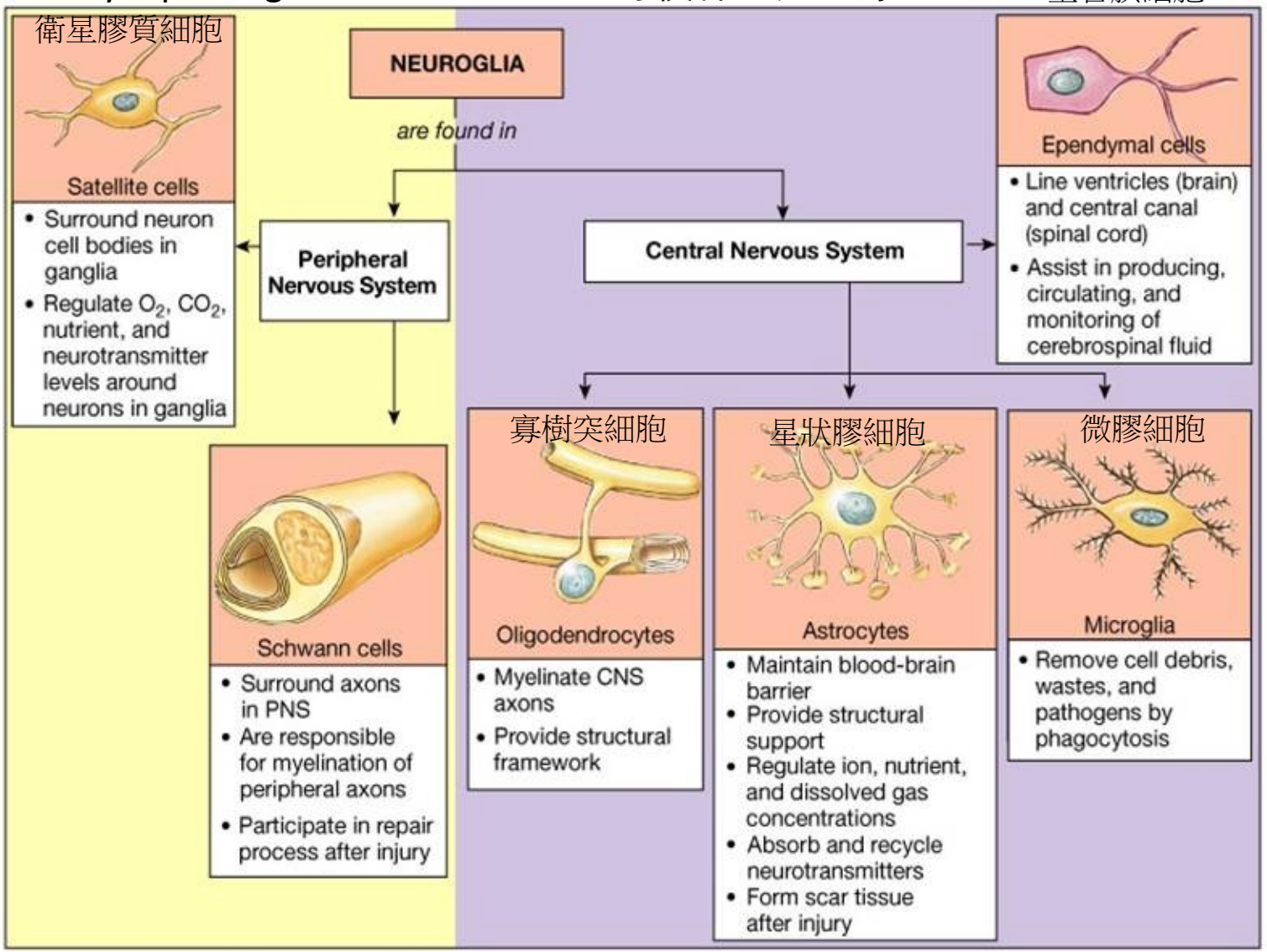
Location: Brain, spinal cord, and nerves.



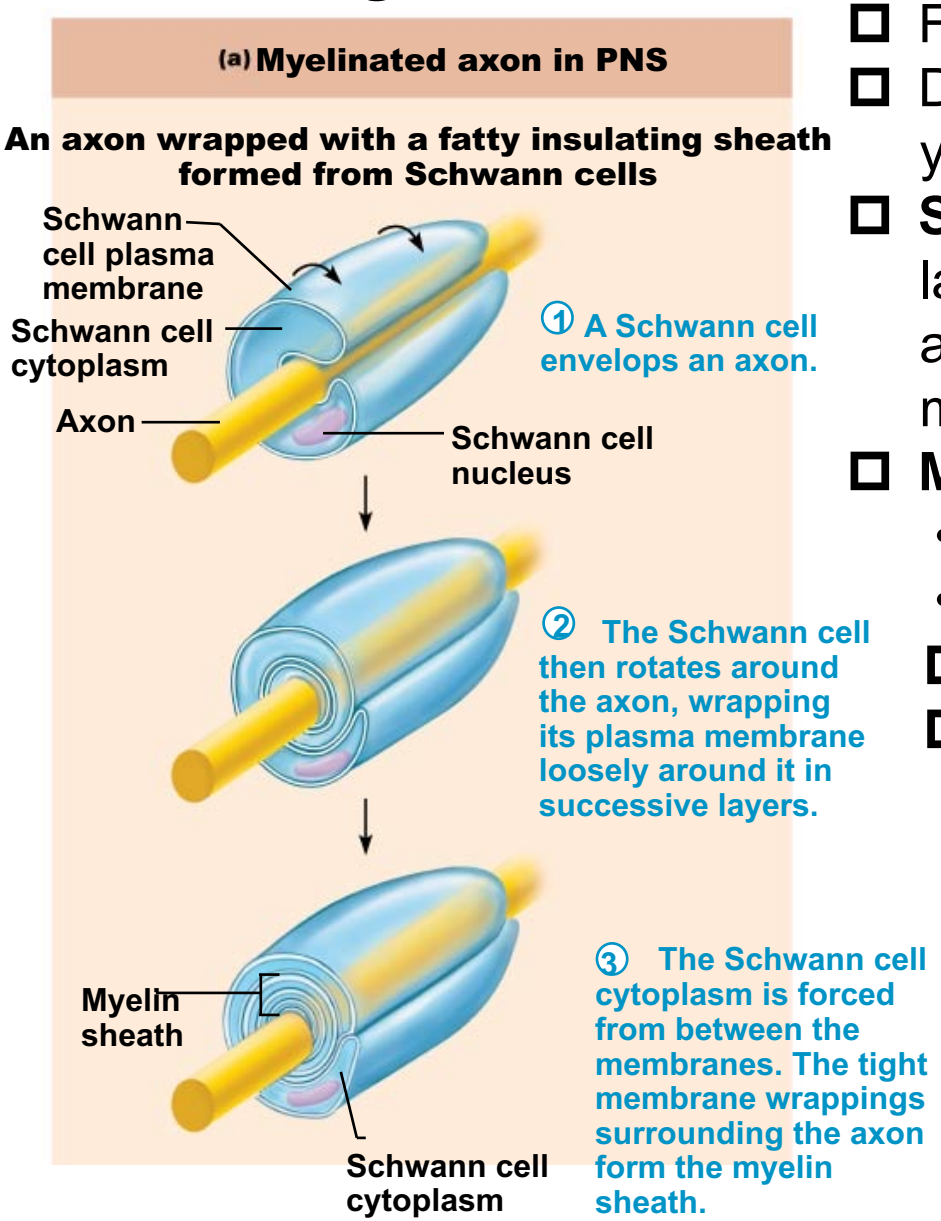
Photomicrograph: Neurons (125×).

Neuroglia (神經膠細胞)

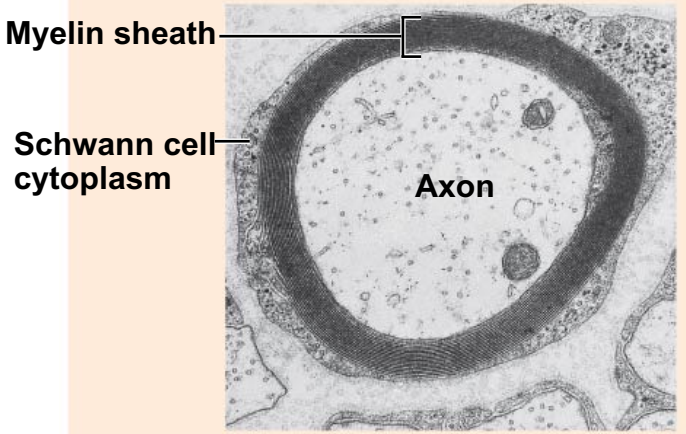
- Six types of neuroglia- 4 in the CNS, 2 in the PNS
- Provide supportive functions for neurons
- Cover nonsynaptic regions of the neurons-可使神經元絕緣



Myelin Sheaths in the PNS

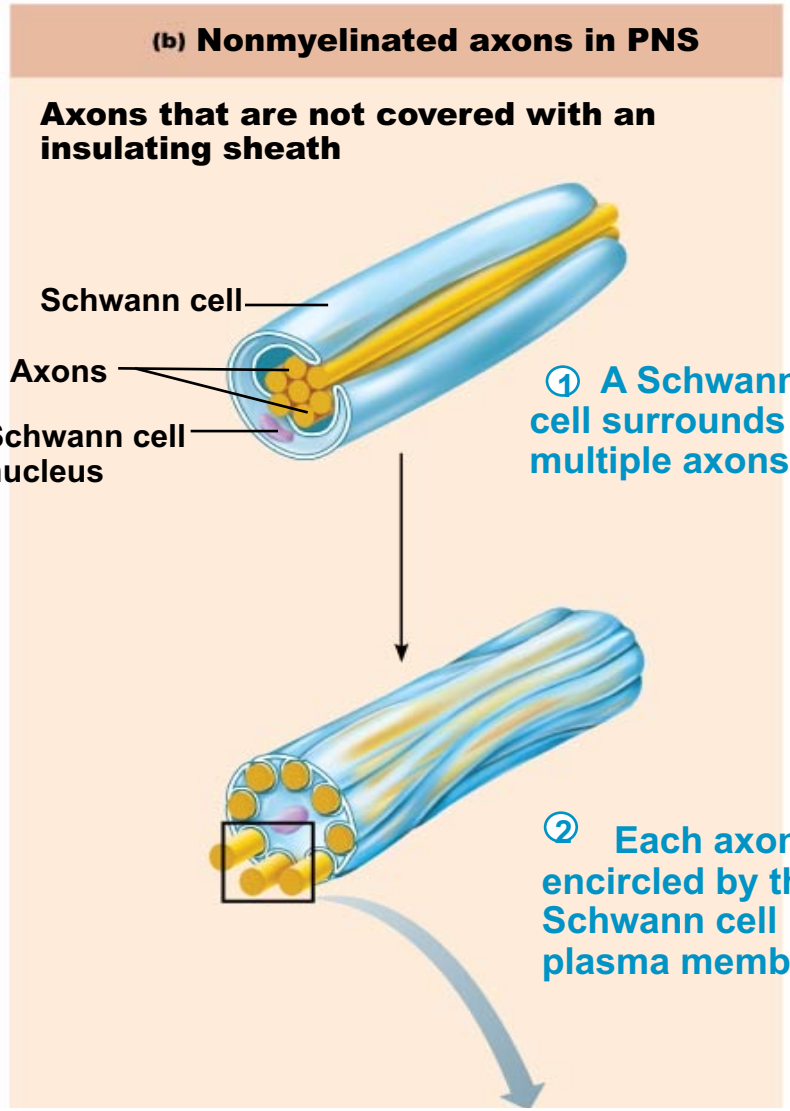


- Formed by Schwann cells
- Develop during fetal period and the first year of postnatal life
- **Schwann cells** wrap in concentric layers around the axon, and cover the axon in a tightly packed coil of membranes
- **Myelin sheath gaps (nodes of Ranvier)**
  - are gaps （1 mm) along axon
  - speed up nerve transmission
- Thick axons are sheathed with myelin
- Thin axons lack a myelin sheath

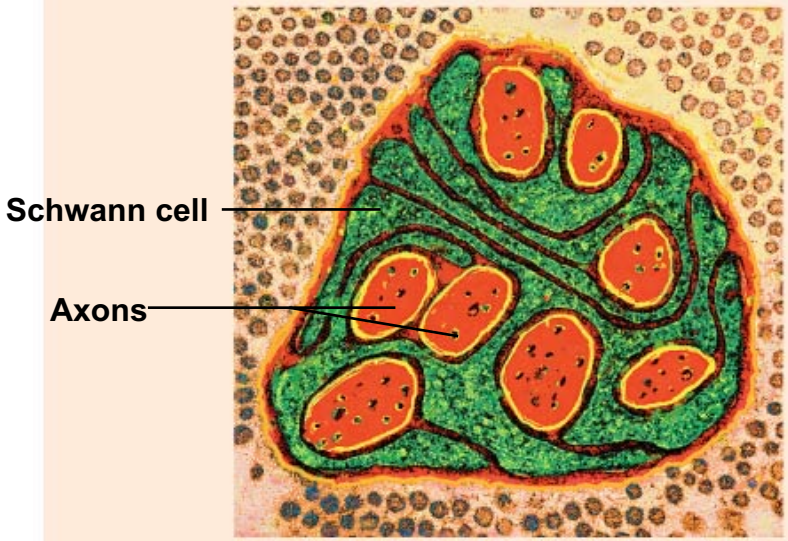


Cross section of a myelinated axon (TEM 135,000×)

Nonmyelinated axons (無髓鞘軸突)



- Slowly conducting axons lack a myelin sheath
- Schwann cells surround axons but do not wrap around them in concentric layers of membrane
- A single Schwann cell can partly enclose 15 or more nonmyelinated axons
- Found in portions of ANS and some sensory fibers



Cross section of nonmyelinated axons (TEM 27,000×)