

**ANP1105B**

**Anatomy & Physiology I**

**Basic Cellular Physiology & the Anatomy and**

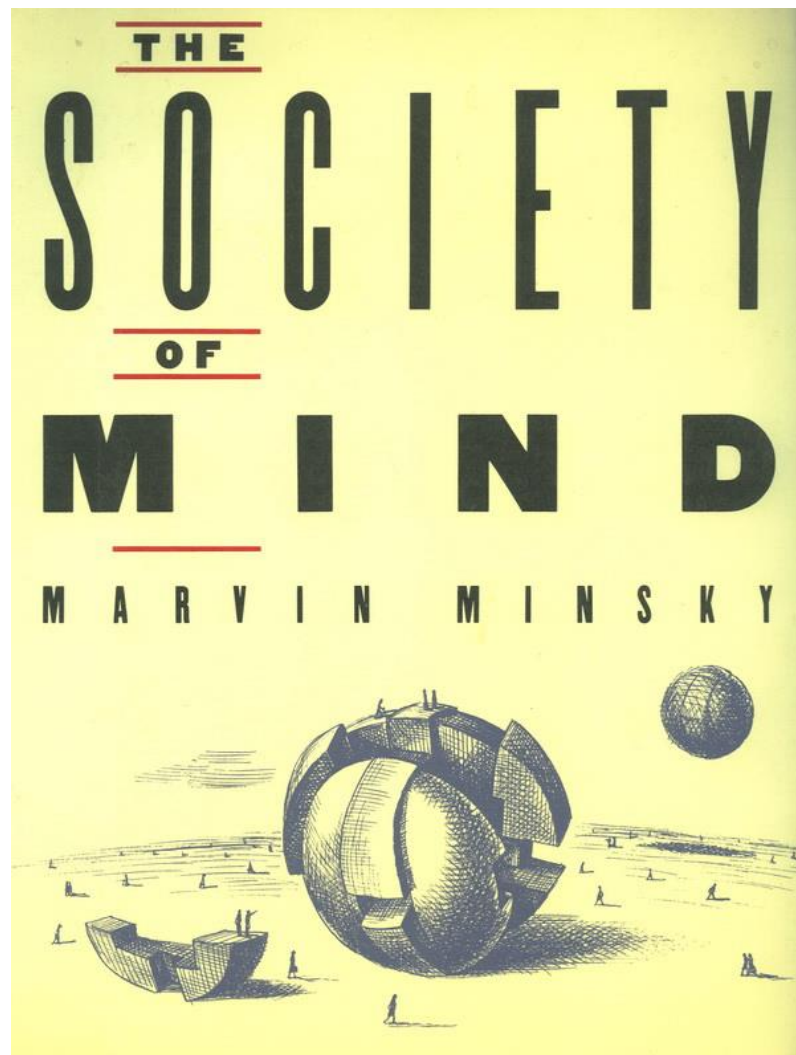
**Physiology of the Cardiovascular, Lymphatic & Respiratory Systems**

# The Triple Package for Student Success

## Amy Chua & Jed Rubenfeld

1. **Sense of exceptionalism** – self confidence – “I belong here and I can do this because I’m good at working hard”
2. **A level of insecurity** – renders one open to learning more because “I don’t know enough yet”
3. **Impulse control** – notion of earning rewards – “I’ve worked hard for the past 2 hours and I’m ready for tomorrow’s classes – I deserve a break to go have coffee with friends.”

**‘You don't understand anything until you learn it more than one way. ‘  
-Marvin Minsky**





## **ANP 1105B COURSE WEB SITE**

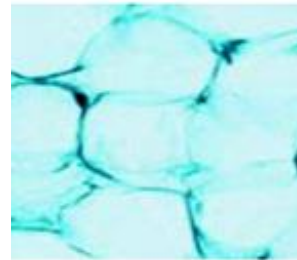
Go to university home page: scroll down to bottom and select Students-uoZone

1. On the Students page, select **Login to Blackboard Learn**
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3. Click "**Login**" and this will bring you to a list of courses for which you have online access.
4. Select **ANP1105B**.

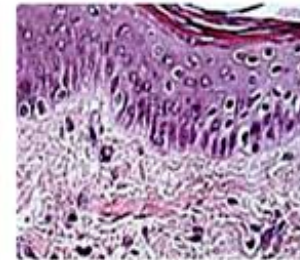
# ANP 1105B

## TOPIC #1: Structural Organization of the Human Body

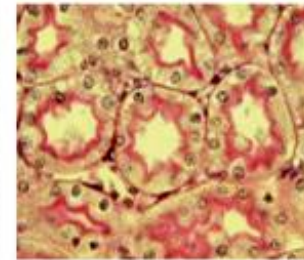
- 1.1 Describe the levels of structural organization that make up the human body (pp. 3-4)
- 1.2 Cells: summarize the major organelles and structures found in cells (pp.83-96)
- 1.4 Describe the different tissues of the human body (Chapter 4)



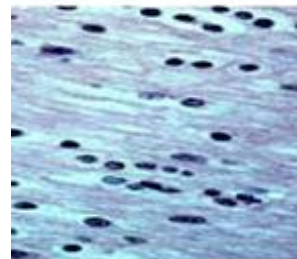
Adipose Tissue



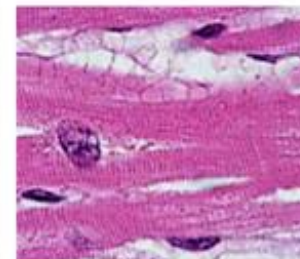
Skin



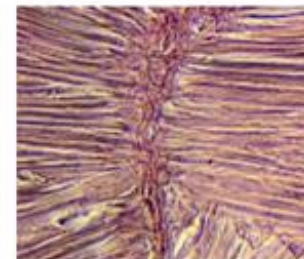
Intestinal Villi



Neural Tissue



Cardiac Muscle



Skeletal Muscle

*J. Carnegie, Uof O*

Figures from Human Anatomy & Physiology, 9th edition, by Elaine Marieb & Katja Hoehn © 2012 by Benjamin/Cummings Publishing Co. are reproduced by permission.

1.1.1 define: atom, molecule, organelle, cell, tissue, organ, organ system; give an example of each & localize each in the hierarchy of anatomical structure

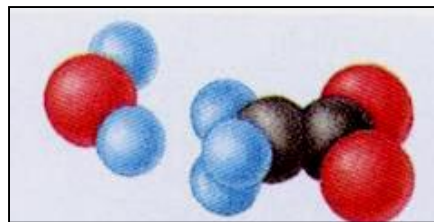
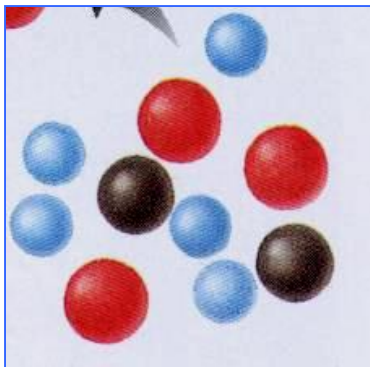
## The Structural Organization of the Human Body

**atom:** smallest particle of an element with all of the properties of that element - *what are the different parts of an atom??*

**molecule:** the smallest amount of a substance that can exist alone = a combination of atoms

**organelle:** molecules associate in specific ways to form *organelles* = basic components of living cells – *give 5 examples of organelles*

**cell:** fundamental structural & functional unit of a living thing; cells vary widely in size & shape, reflecting unique functions in the body



from Fig. 1.1

**tissue:** groups of similar cells that have a common function:

1. **epithelium**
2. **muscle**
3. **connective tissue**
4. **nervous tissue**

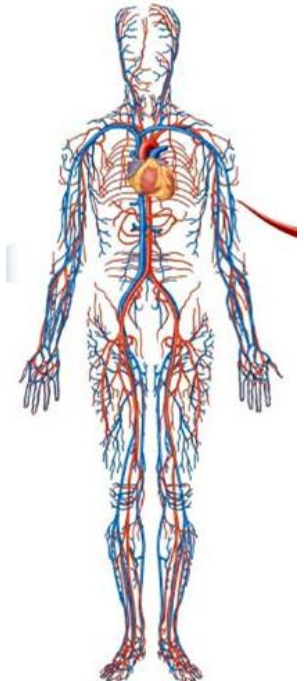
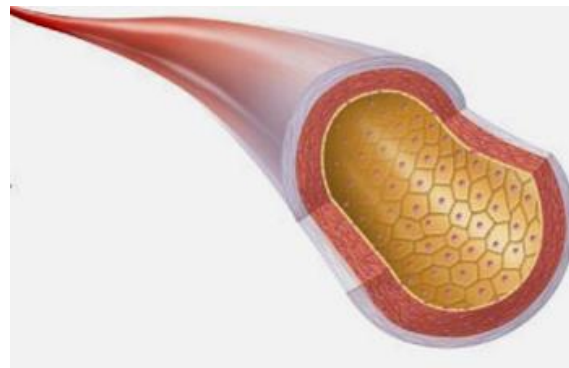
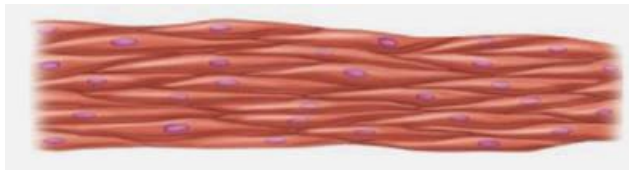
*Indicate the main function for each of these types of tissues*

**organ:** structure composed of at least 2 (but usu 4) tissue types that performs a specific function for the body

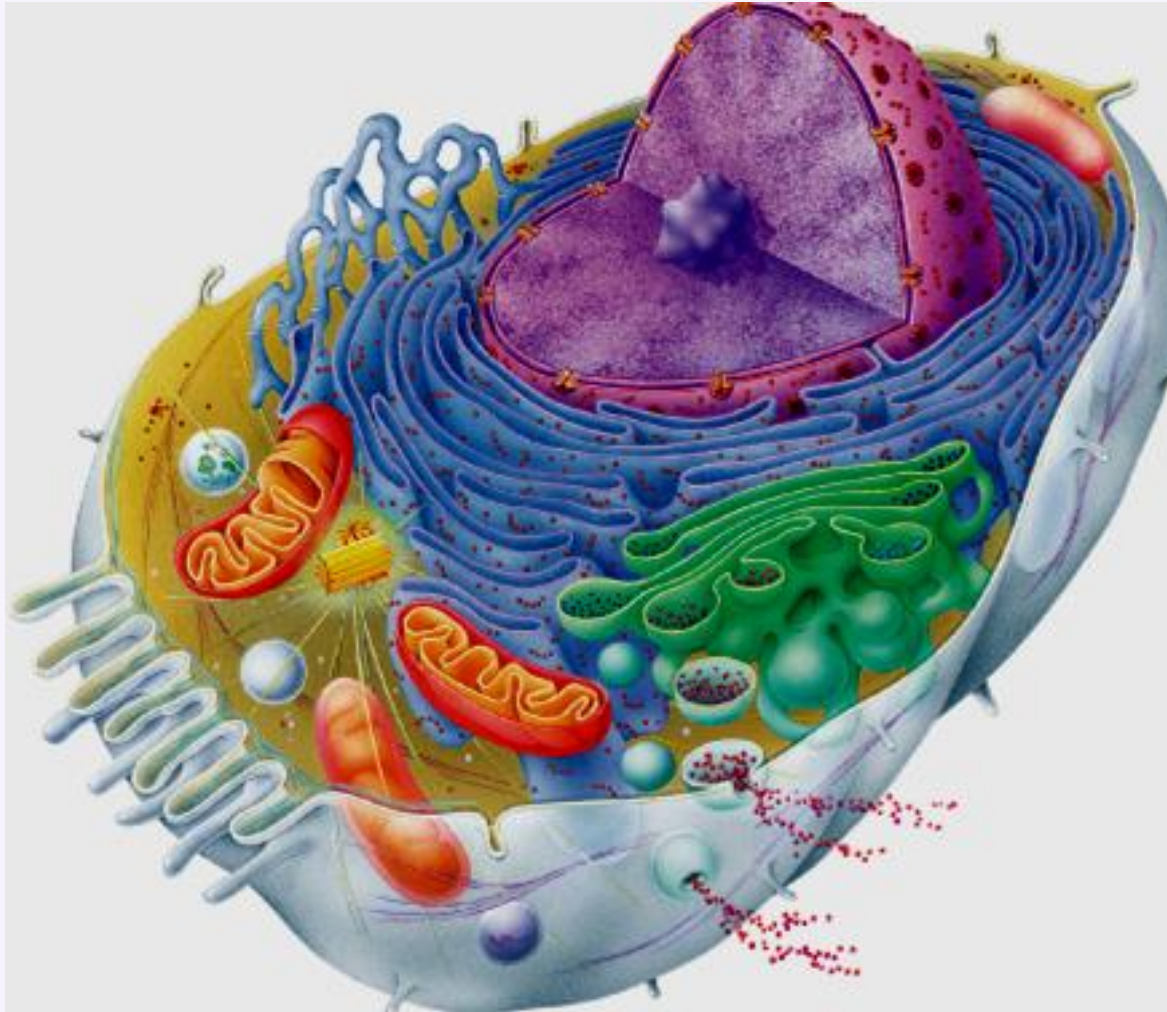
*Give an example of an organ and describe how each of its tissue types contributes to its overall role or function in the body*

**organ system:** organs that work closely with one another to accomplish a common purpose; eg: \_\_\_\_\_

*Name some organs associated with each of these systems.*



## 1.2 Summarize the organelles and structures found in body cells (Chapter 3: pp. 83-95)



We will review (you have already learned it in high school!) this content in class using a video and a Jeopardy game. To fill in the gaps, read pp. 83-96 in your textbook.



Fig. 3.2

## Cells are the basic unit of life.

They come in many different shapes and sizes (see Fig. 3.1), but each type of cell contains everything it needs to function as part of a living human being.

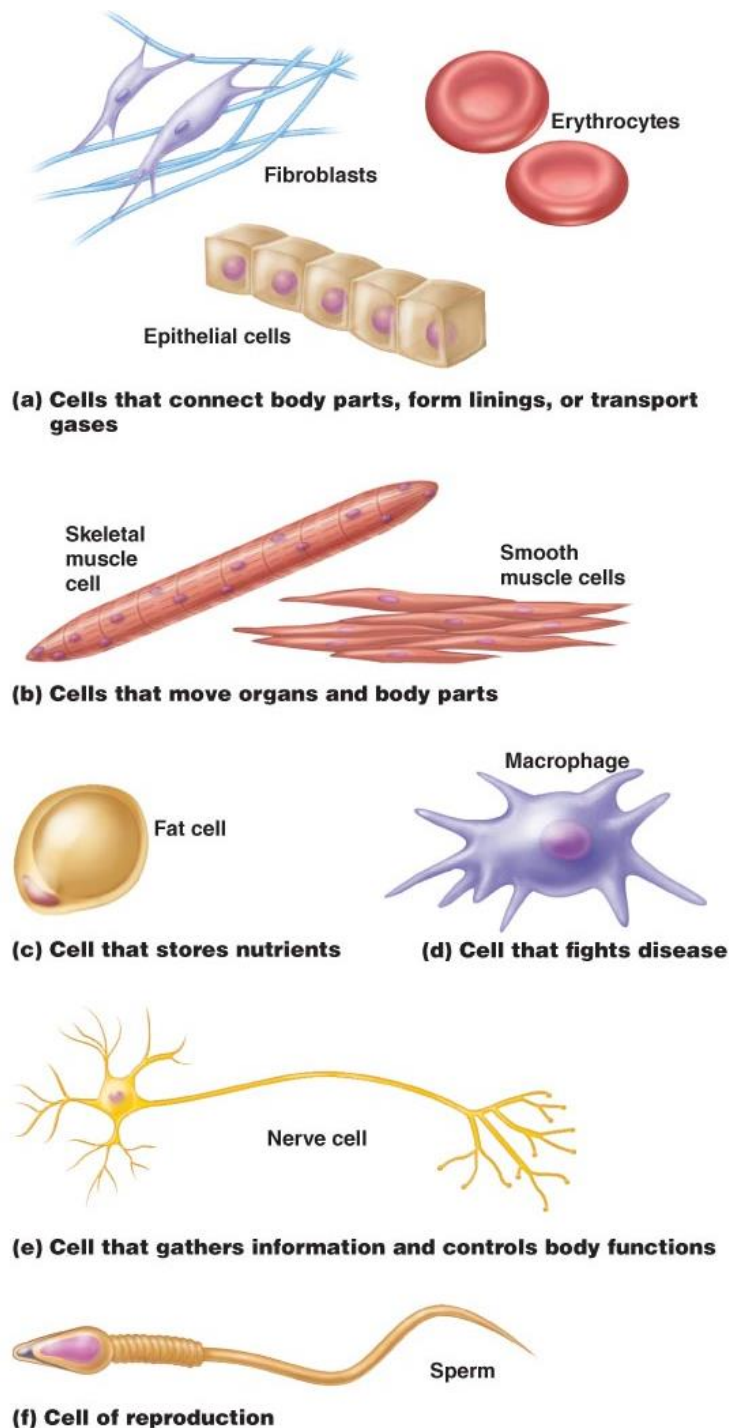


Fig. 3.1

The **nucleus** is the **control centre** of the cell. It contains the genetic inheritance for that cell in the form of instructions for all possible proteins the cell can make.

The **cytoplasm** fills the space between the nucleus and the plasma membrane. **Organelles** are part of the cytoplasm.

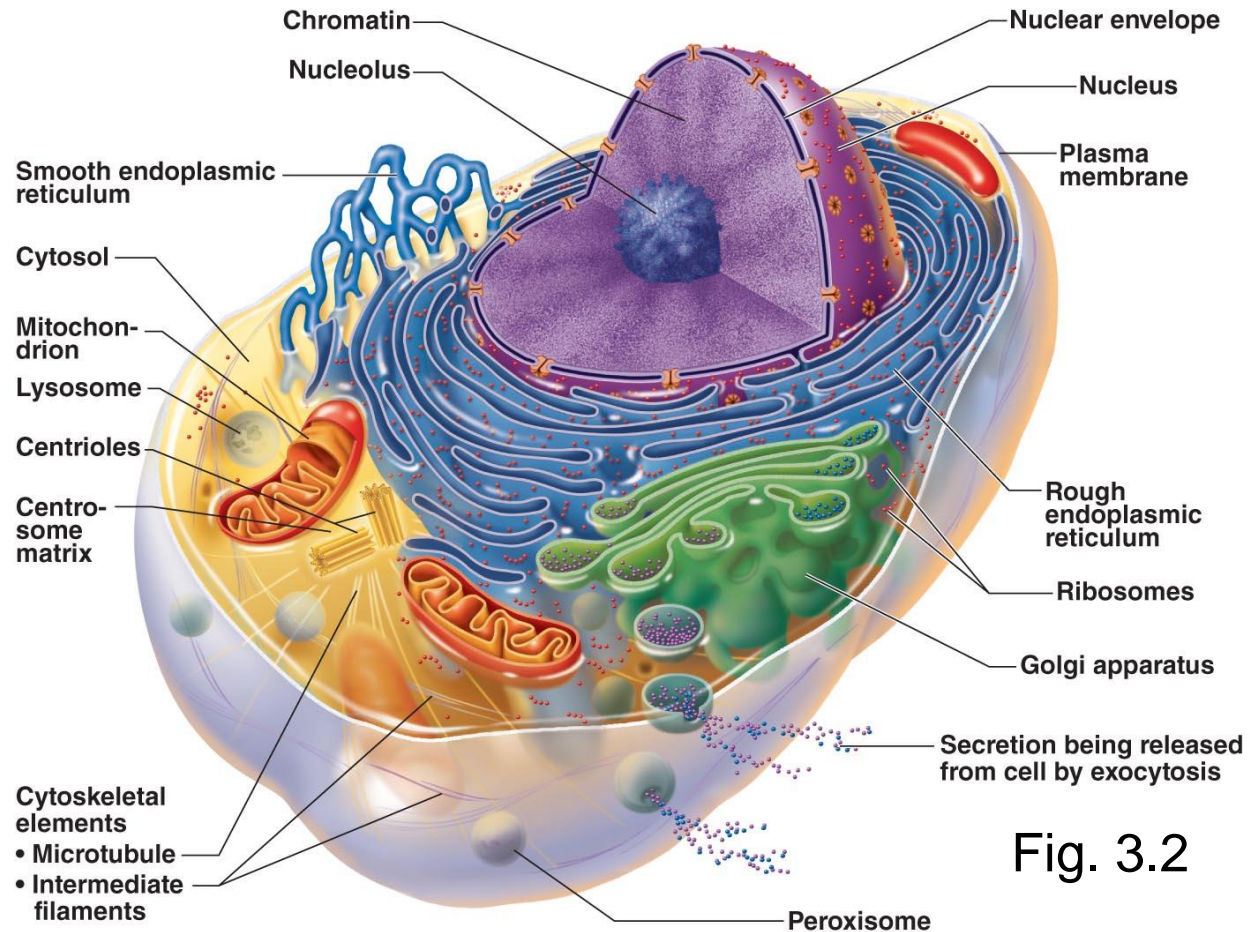


Fig. 3.2

The **plasma membrane** encloses the cell, separating the **intracellular fluid** from the **extracellular fluid**. We will explore the structure of the plasma membrane a little later. The plasma membrane is **semi-permeable** (**selectively permeable**). This means it can allow some substances to cross while restricting the movement of others.

## *The cytoplasm consists of three components:*

1. **Cytosol:** a viscous fluid in which the other components are suspended; consists of water plus proteins, salts, sugars, other solutes
2. **Organelles:** structures that carry out the metabolic activities of the cell such as protein synthesis, ATP production, digestion - we shall explore these next
3. **Inclusions:** cell-type dependent – include substances that may be storage forms of important molecules or have other functions within the cell; examples include: glycogen granules (found in liver and muscle cells), lipid droplets (especially in fat cells), pigment granules (in skin cells)

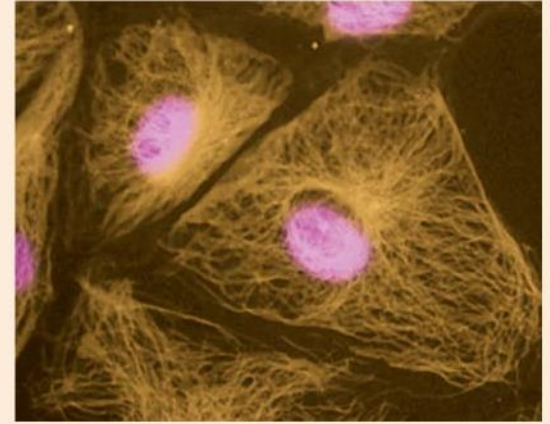
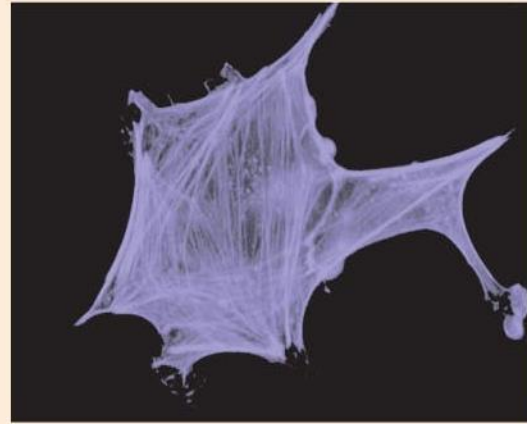
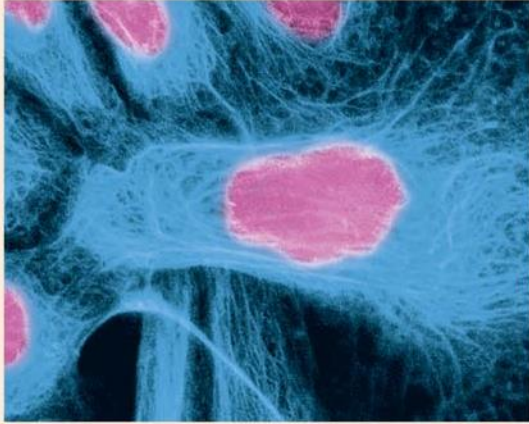
# ORGANELLES

*For each of the 6 organelles listed below, find a picture of their structure in chapter 3 and briefly indicate their function in 8 words or less*

Organelle	Figure No.	Function
Mitochondrion		
Ribosome		
Endoplasmic reticulum		
Golgi apparatus		
Lysosome		
Peroxisome		

1.2.3: Name and briefly describe the 3 types of cytoskeletal filaments.

The cell's cytoskeleton provides structural support, permits shape changes and allows movement. Identify each of the cytoskeletal filaments in the diagram below (Fig. 3.21) and assign a key role to each type of filament.

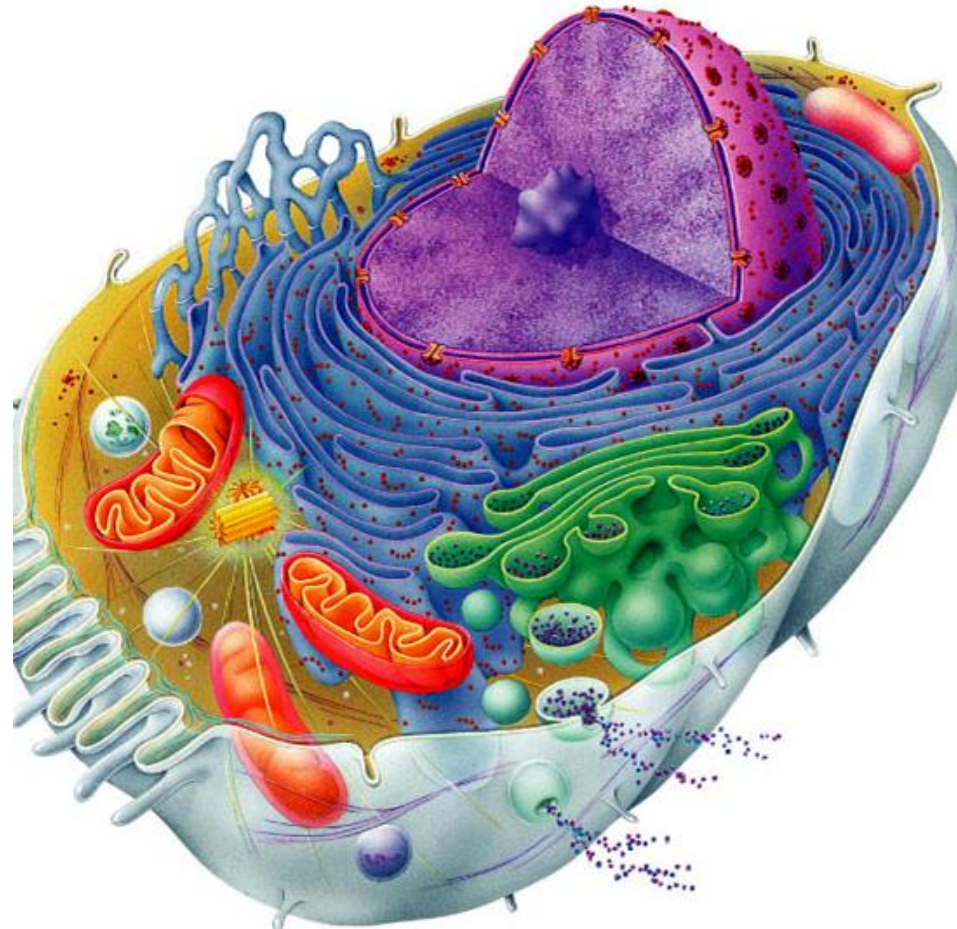


**Function:**

**Function:**

**Function:**

# Why does each cell need a nucleus?



## THE NUCLEUS:

- stores genes on chromosomes
- organizes genes into chromosomes to allow cell division
- transports regulatory factors & gene products via pores
- produces messenger RNA (mRNA)
- produces ribosomes
- organizes the uncoiling of DNA to replicate and decode genes – *this process is highly regulated!!*
- DNA repair

**Remember:** Each nucleus contains a complete set of genes but a given cell type uses just a *subset* of that information – so that needs to be *regulated* . . .

# What is chromatin?



[http://www.lifesci.sussex.ac.uk/home/Julian\\_Thorpe/nucleus.htm](http://www.lifesci.sussex.ac.uk/home/Julian_Thorpe/nucleus.htm)

Chromatin is defined as DNA + associated proteins (histones & nonhistones).

These proteins are critical to package the DNA into the nucleus in such a way that specific genes can be found and made available to direct protein synthesis and so that the DNA strands do not become tangled or broken.

# From nucleus to cytoplasm:

- mRNA – to bring instructions for protein synthesis out to the ribosomes
- Ribosomal subunits – ribosomes are made in the nucleus but work in the cytoplasm
- Interestingly, nuclear pores do not allow assembled ribosomes back into the nucleus

# From cytoplasm to nucleus

- Proteins for the construction of ribosomes: Ribosomes are composed of various ribosomal RNAs and proteins. The RNAs are made in the nucleus but proteins are made in the cytoplasm
- Other regulatory and structural nuclear proteins: e.g. histones that are involved in packaging DNA within the nucleus

# The Nucleolus is the Site of Ribosome Synthesis

The nucleolus is an area rich in DNA, newly transcribed ribosomal RNAs (rRNAs) and ribosomal proteins. The nucleolus is not a membrane-bound region of the nucleus; rather it forms as those areas of DNA that contain genes coding for rRNAs (nucleolar organizers) cluster together and become active in rRNA synthesis. This will ultimately lead to the accumulation of ribosomes in the cytoplasm of the cell – tiny factories that are capable of protein synthesis.



Fig. 113: Electron micrograph of pancreatic acinar cell (Fawcett, 1981)

# 1.3 Describe the different tissues of the human body

1.3.1 define tissue and demonstrate how the organization of cells into tissues contributes to overall homeostasis

1.3.2 list the 4 primary types of tissues

1.3.3 define epithelial tissue; list 6 functions associated with epithelia

- individual body cells **specialized**; division of labour
- at organ level, cooperation for organ to work as a whole

**TISSUE:** groups of structurally similar cells that perform common/related function

- 4 primary tissue types:

- 1) **epithelial:** covering
- 2) **connective:** support
- 3) **muscle:** movement
- 4) **nervous:** control (regulation)

usually all 4 to  
make up  
organ like a  
kidney, heart

- **histology:** study of tissues & their cellular organization

## A. Epithelial Tissue

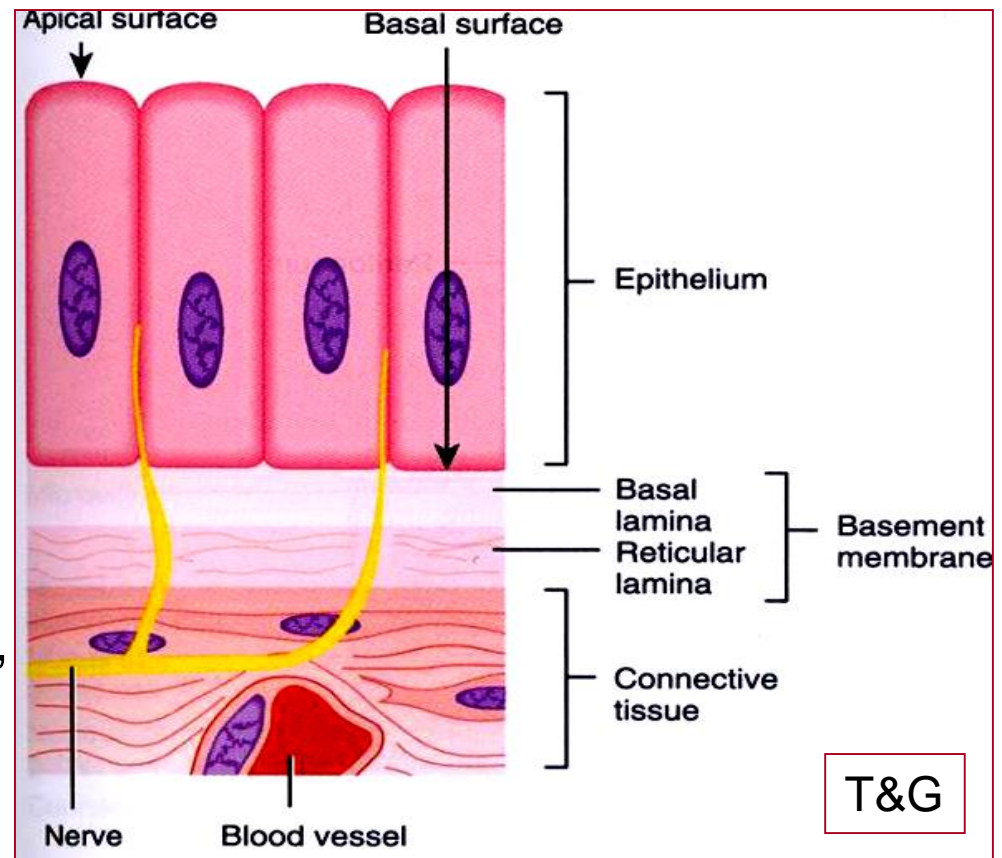
•sheet of cells that covers a body surface or lines a body cavity

*creates boundaries*

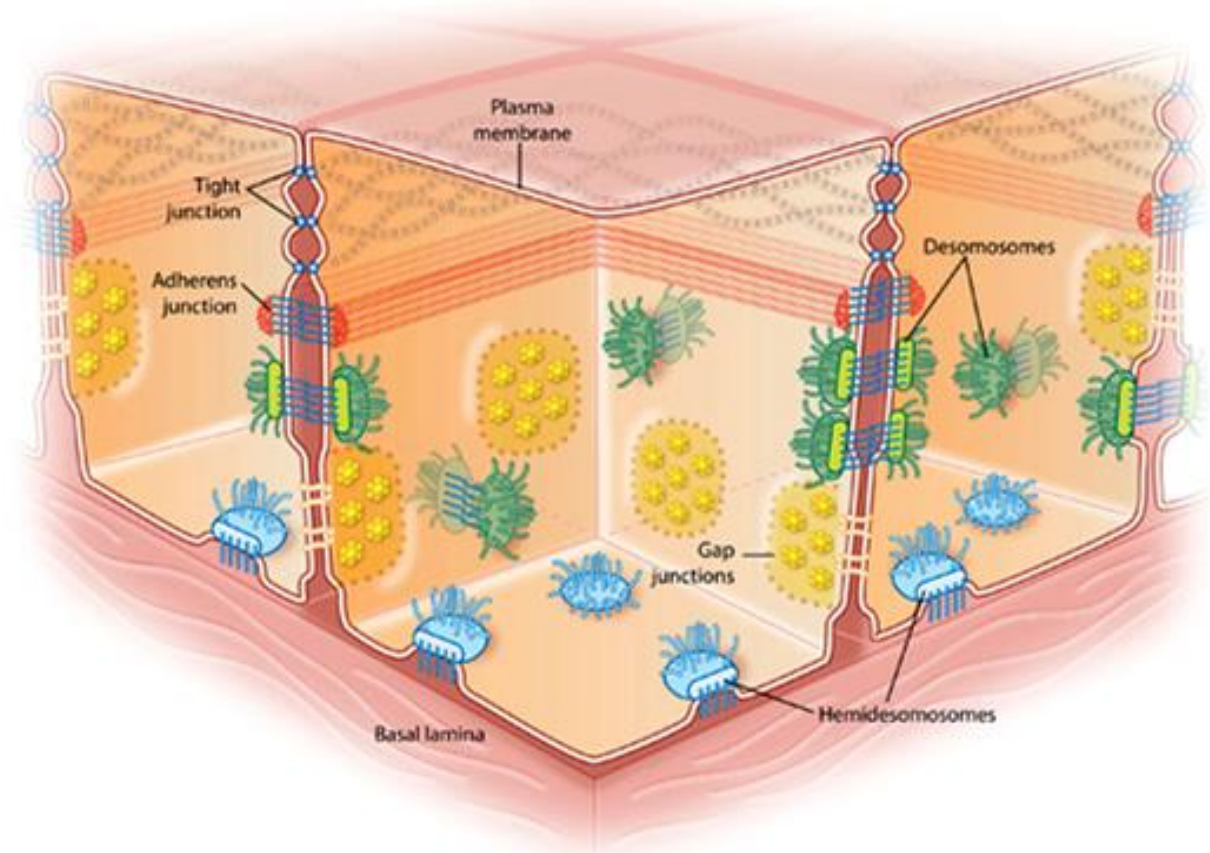
- 1) **covering and lining epithelium** – e.g. ....
- 2) **glandular epithelium**

### functions of various epithelia:

- 1) **protection** (mechanical, chemical, infectious) – skin,
- 2) **absorption** - GI tract,
- 3) **filtration** - kidney,
- 4) **excretion** - kidney,
- 5) **secretion** - glands,
- 6) **sensory reception** - taste buds, olfactory membranes . . .



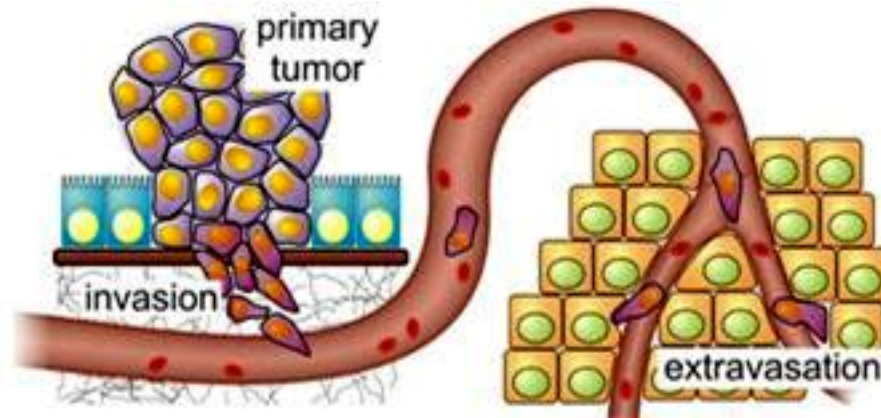
### 1.3.4 list and demonstrate your understanding of 7 special structural characteristics of epithelial tissue



1. **cellularity:**
2. **specialized contacts:** tight junctions & desmosomes - **Why??**
3. **polarity:** apical and basal surfaces; apical surface often specialized such as having ..... Or .....
4. **basal lamina:** noncellular, underlying supportive sheet of primarily glycoproteins - **What are two functions of a basal lamina??**

5. **supported by connective tissue:** basement membrane = basal lamina + underlying **reticular CT** (*what is reticular CT??*)

*an important feature of cancerous epithelial cells is failure to respect the boundary imposed by the basement membrane*



<http://www.nccr-oncology.ch/scripts/index.aspx?idd=93>

6. **innervated but avascular:** how nourished?
7. **regeneration:** high regenerative capacity - *Why??*

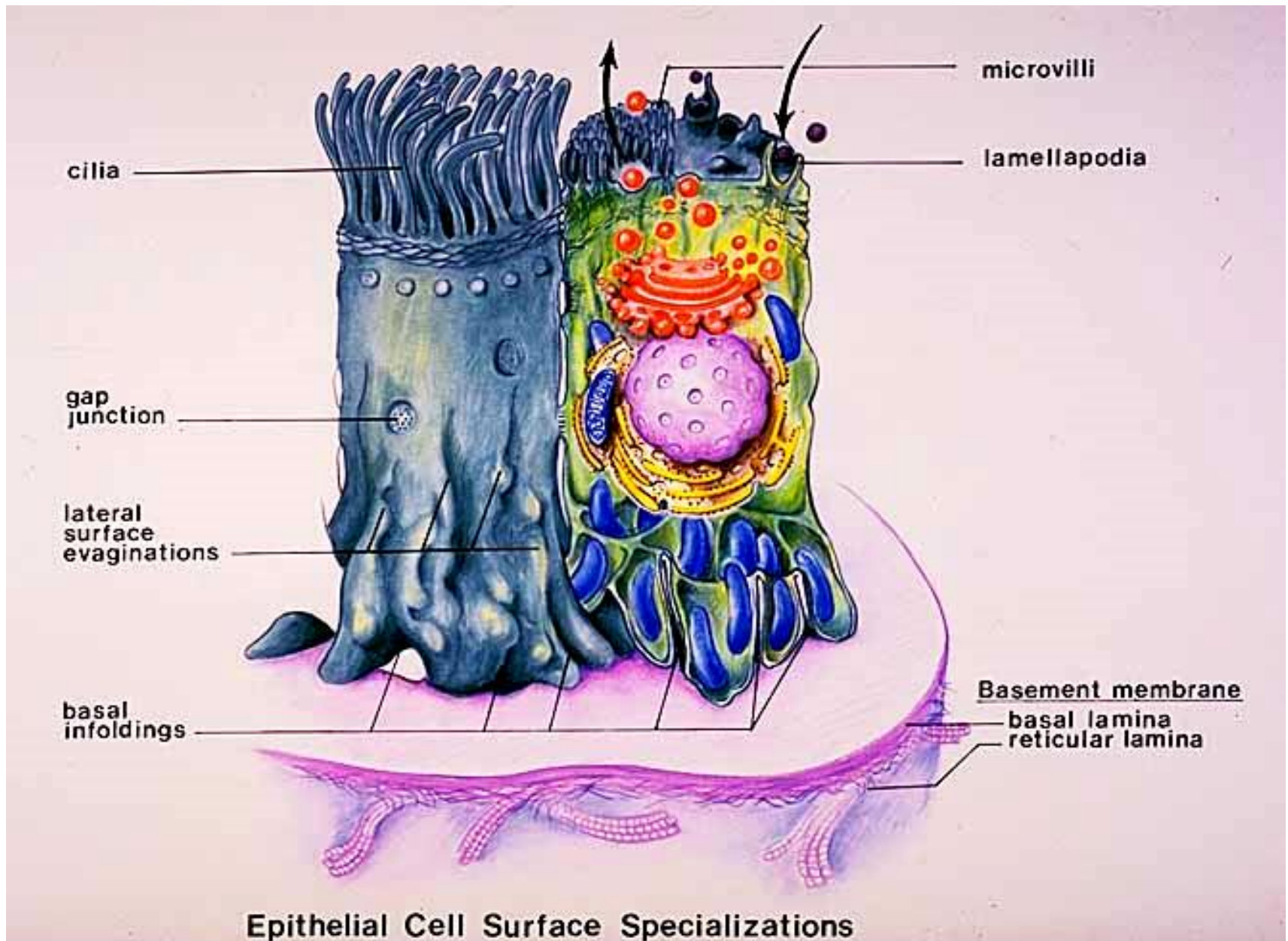
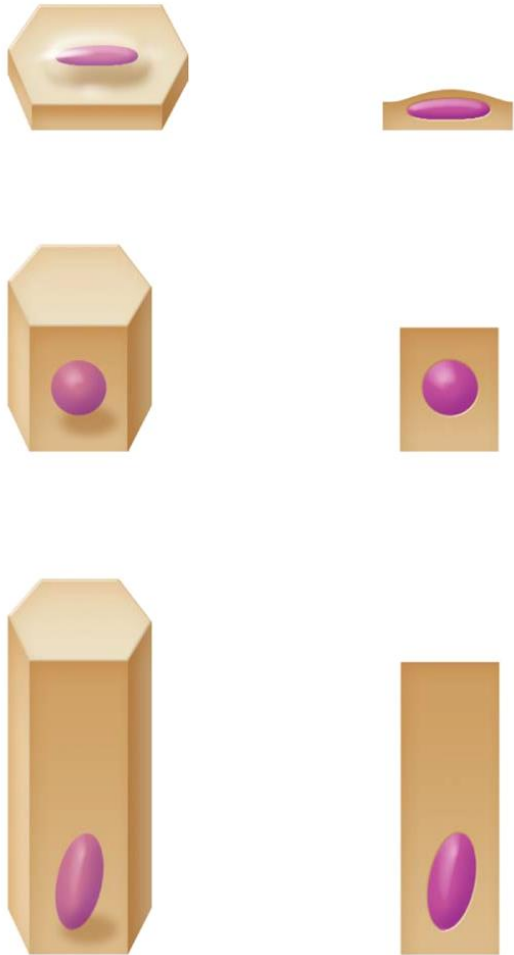


Figure 24. Surface specializations characteristically found in epithelial cells.

### 1.3.5 indicate the 2 criteria used to classify epithelial cells

#### CELL SHAPE

squamous  
cuboidal  
columnar



#### LAYERS

simple epithelia  
stratified epithelia

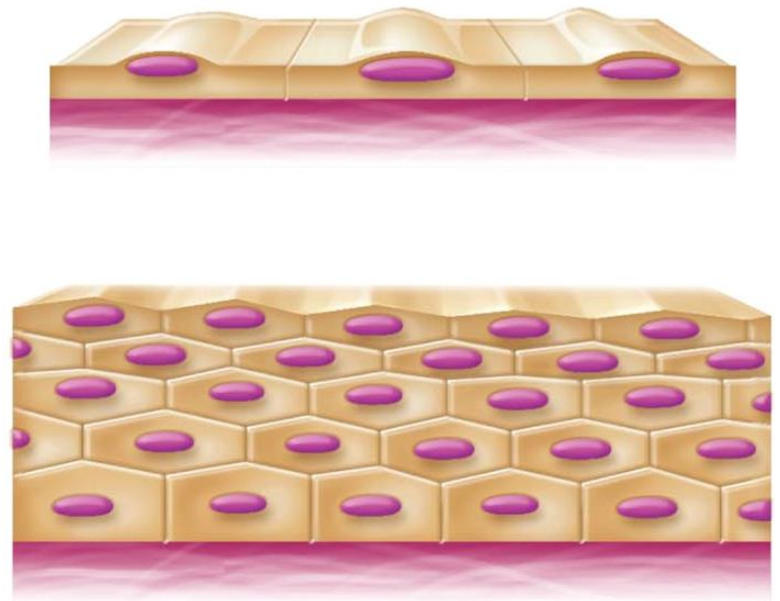
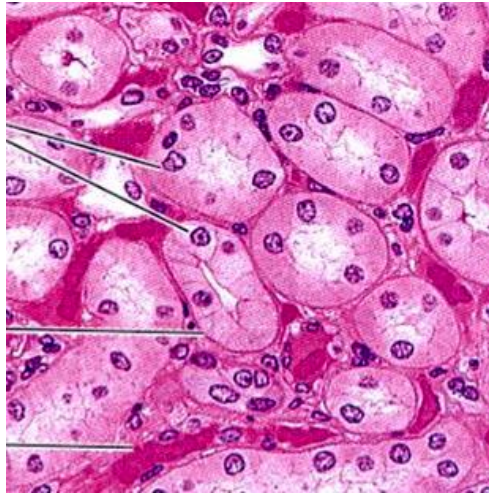
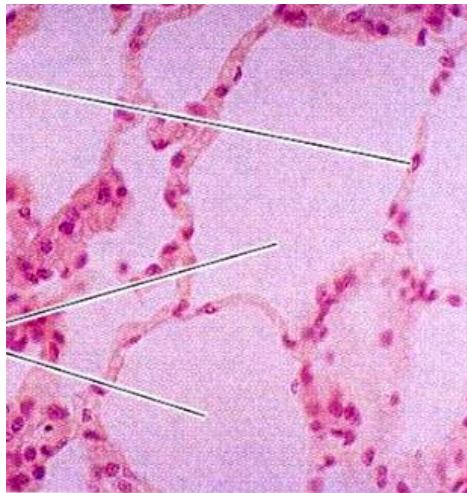


Fig. 4.2

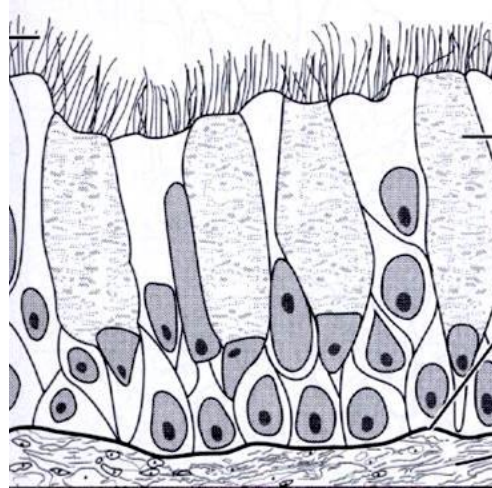
### 1.3.6 list the 4 types of simple epithelia; indicate primary functions associated with each & sample body locations

Examples of Simple Epithelia: (absorption, secretion, filtration)

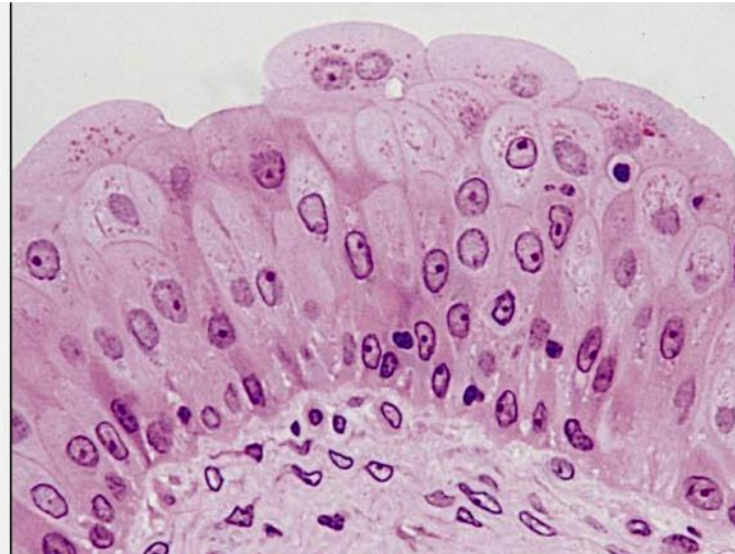
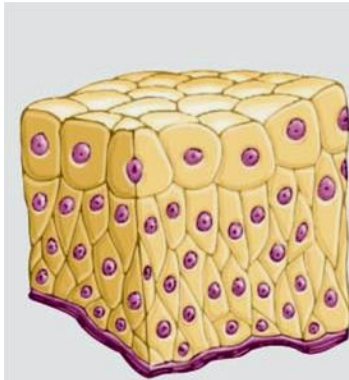
1. **simple squamous epithelium:** thin & permeable - filtration, diffusion - eg: **endothelium** & in **kidney, lungs**
2. **simple cuboidal epithelium:** secretion & absorption - eg: **kidney tubules, small glands**
3. **simple columnar epithelium:** also digestion & secretion – eg. **digestive tract**



4. **pseudostratified columnar epithelium:** a single layer - eg: respiratory tract where **cilia** and **mucus secretion** are local specializations



- Transitional epithelium (not simple!):** lines the bladder, an organ that has to **fill** – the basal layers are columnar to cuboidal and the apical layers become increasingly flattened & squamous-like as filling occurs



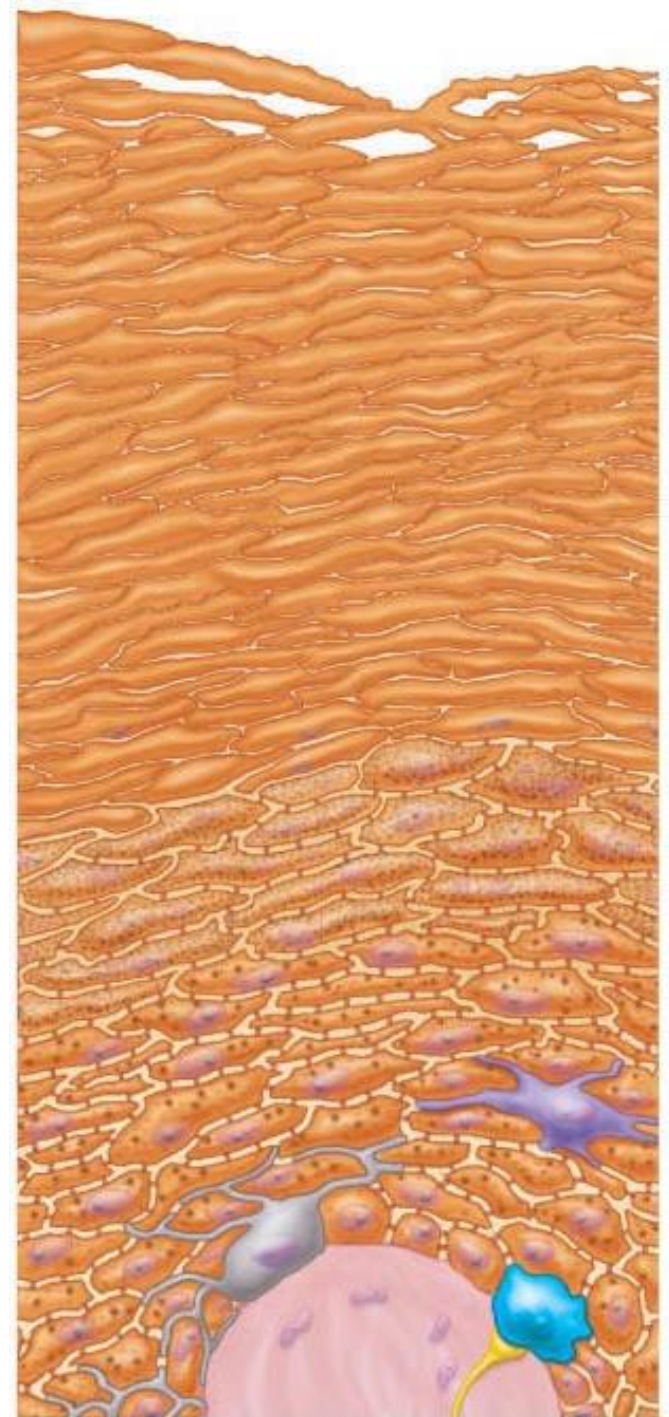
**1.3.7. Describe the structure of stratified squamous epithelium and give a sample body location**

protective role; **basal** cells **cuboidal** & undergo mitosis to keep regenerating the layer from below

*What is the most widespread example of stratified squamous epithelium?*

*What happens to the apical layers of cells?*

Fig. 5.2



## 1.3.8 define: gland, endocrine gland, exocrine gland

### Glandular Epithelia:

- **gland:** 1 or more cells that make & secrete a particular product
- glands are:    **endocrine:** .....
- exocrine:** .....
- unicellular or multicellular**

### Endocrine Glands:

- just know that they are **ductless** - products are called **hormones**

### Exocrine Glands:

- mucous, sweat, oil/salivary glands, liver, pancreas, etc.
- a) Unicellular exocrine glands:
  - no ducts because only one cell!
  - really just the **goblet cells** (digestive & respiratory tracts)

### b) Multicellular exocrine glands:

- **epithelium-derived duct & secretory cells;** surrounded by supportive CT which brings blood vessels & nerves

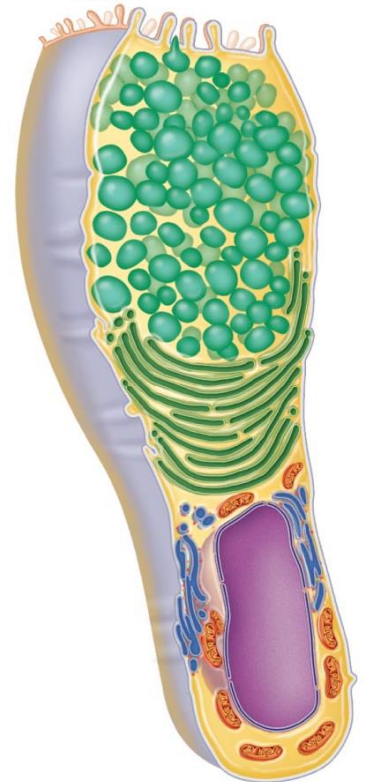


Fig. 4.4

(iii) Secretory method:

**merocrine/eccrine:** exocytosis

most common type

pancreas, salivary glands, most sweat glands

**holocrine:** cell rupture; only sebaceous glands

**apocrine:** cell apex pinches off with secretory product

*Is mammary gland apocrine or merocrine?*

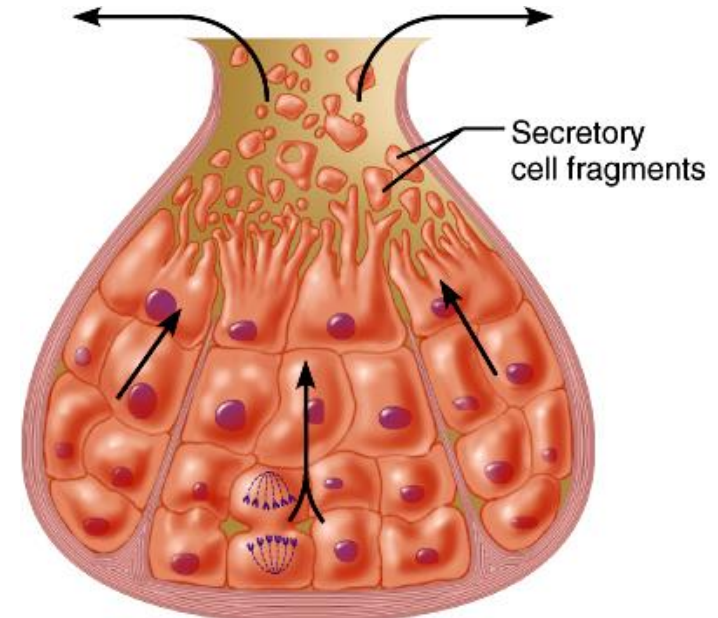
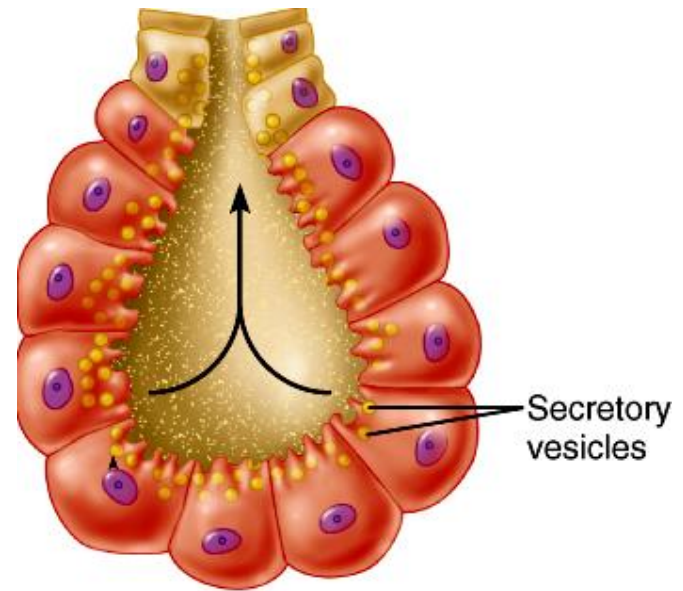


Fig. 4.6



**Match the epithelial type (Column B) with the correct location (Column A)**

**Column A**

- \_\_\_ 1. Lines stomach, most of intestines.
- \_\_\_ 2. Lines the inside of the mouth.
- \_\_\_ 3. Lines much of the respiratory tract.
- \_\_\_ 4. Endothelium
- \_\_\_ 5. Composes lung alveoli

**Column B**

- A. Pseudostratified ciliated columnar
- B. Simple columnar
- C. Simple cuboidal
- D. Simple squamous
- E. Stratified columnar
- F. Stratified squamous

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**The gland type that secretes its product continuously, by exocytosis is:**

- a) merocrine
- b) holocrine
- c) endocrine
- d) apocrine





**1.3.10 describe the structural organization of CT in general; distinguish between collagen, elastic & reticular fibers; distinguish between “blast” and “cyte” types of CT cells**

**Structural Elements of CT:**

- a) **ground substance:** interstitial fluid + cell adhesion proteins & proteoglycans: molecular **sieve**
- fibronectin, laminin - help cells attach to CT elements
  - proteoglycans - What are these? What do they do?

b) **fibers:**

**collagen fibers:** high tensile **strength**

**elastic fibers:** elastin has coiled structure to allow **stretch + recoil**

**reticular fibers:** thin collagen protein; fine network to **support** blood vessels, soft tissues

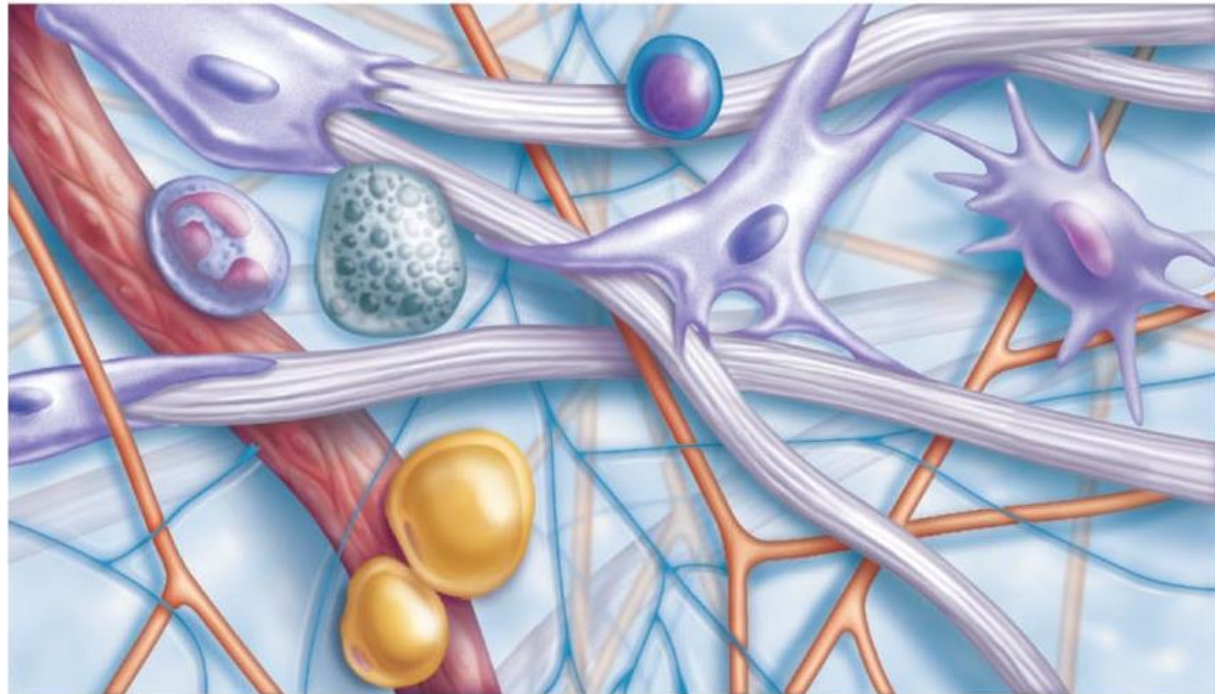


Fig. 4.7 (rotated): Areolar CT

c) **cells:** immature (“blast”) forms vs mature (“cyte”) forms

- “**blasts**” are actively dividing/synthesizing cells during growth & repair
- “**cytes**” primarily provide a level of maintenance

<b>TISSUE TYPE</b>	<b>“BLAST”</b>	<b>“CYTE”</b>
<b>CT proper</b>	<b>fibroblast</b>	<b>fibrocyte</b>
<b>Cartilage</b>	<b>chondroblast</b>	<b>chondrocyte</b>
<b>Bone</b>	<b>osteoblast</b>	<b>osteocyte</b>
<b>Blood</b>	<b>hemocytoblast</b>	<b>RBCs, WBCs, platelets</b>

## Types of CT:

- 1) **Mesenchyme:** first tissue formed from mesoderm germ layer - mesenchymal cells + fluid ground substance & fine fibrils ➤ source of all other CTs
- 2) **CT Proper:** 2 subclasses ➤ ➤
  - A. **Loose CT** (areolar, adipose, reticular)
  - B. **Dense CT** (dense regular, dense irregular, elastic)

### 1.3.11 list and briefly describe the 3 types of loose CT; include key functions for each type as well as sample body locations

## LOOSE CT

- (i) **AREOLAR CT:** gel-like matrix with all 3 fiber types; cells = fibroblasts, macrophages, mast cells, & some WBCs

**Description:** **loose** arrangement of fibers; reservoir of water & salts but is also a prime site of **edema** during inflammatory reaction

**Location:** widely distributed under epithelia of body - eg: \_\_\_\_\_

**Function:** cushioning of organs, immunity (macrophages) & inflammation; fluid reservoir

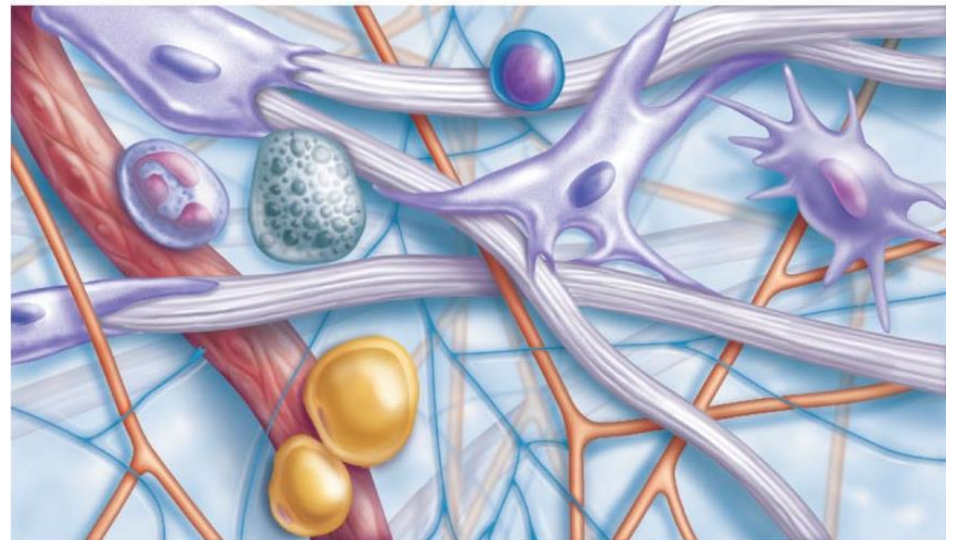
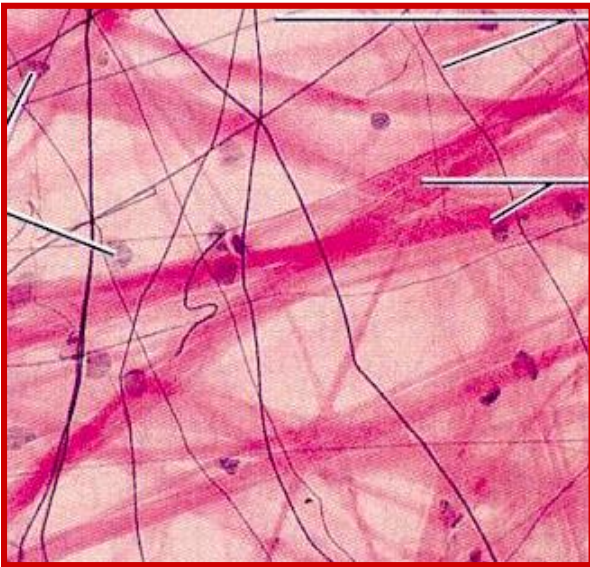


Fig. 4.8

(ii) **ADIPOSE TISSUE:** areolar CT modified to store nutrients; **adipocytes**

**Description:** fat-filled adipocytes with displaced nuclei; do not reproduce; scanty matrix

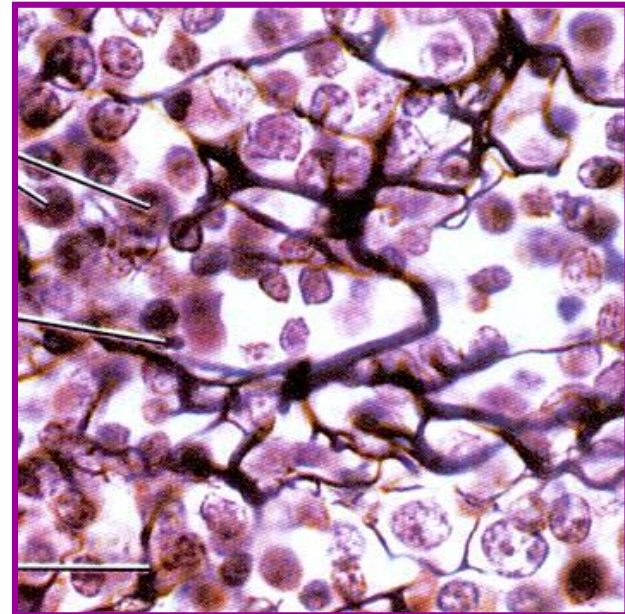
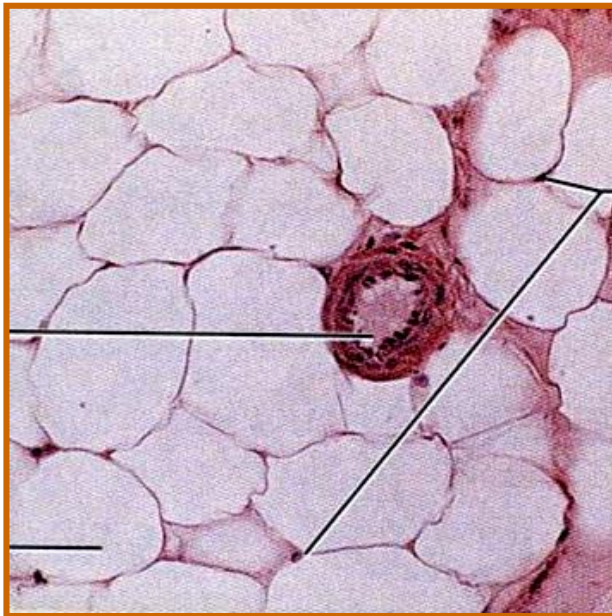
**Location:** under skin, around kidneys & eyeballs, in bones & within abdomen, in breasts; 18% of average wt (15% ♂ & 22% ♀)

**Function:** fuel reservoir, insulation, supports & protects organs

(iii) **RETICULAR CT:** like areolar CT, but **only reticular** fibers

**Loc:** • lymphoid organs (lymph nodes, bone marrow, spleen)

**Fcn:** • fibers form soft internal skeleton that supports free blood cells



### 1.3.12 list and briefly describe the 3 types of dense CT

## DENSE CT (*fibers are the predominant element!!*)

- (i) **DENSE REGULAR CT:** bundles of collagen fibers running parallel to direction of pull → white, flexible tissue with great resistance to tension

**Location:** **tendons** (??? to ??), **ligaments** (?? to ?? at joints), also **aponeuroses**

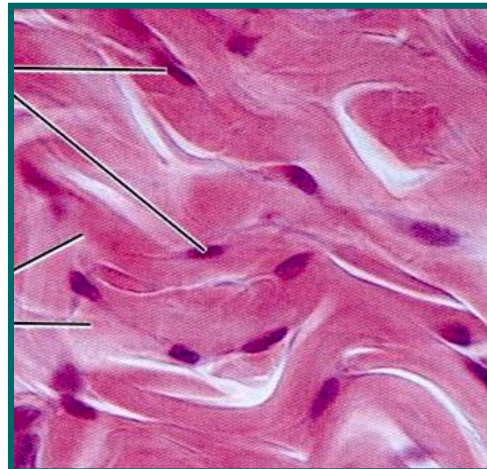
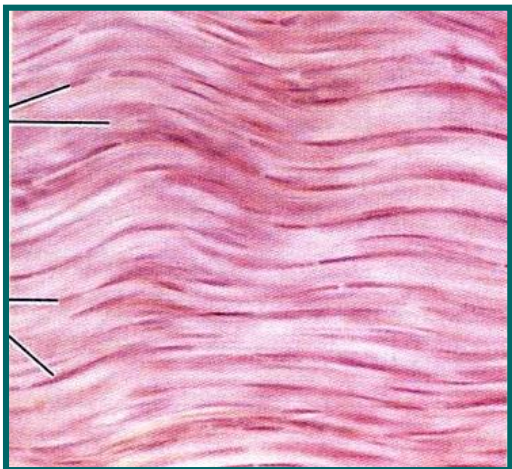
**Function:** attachment with strength

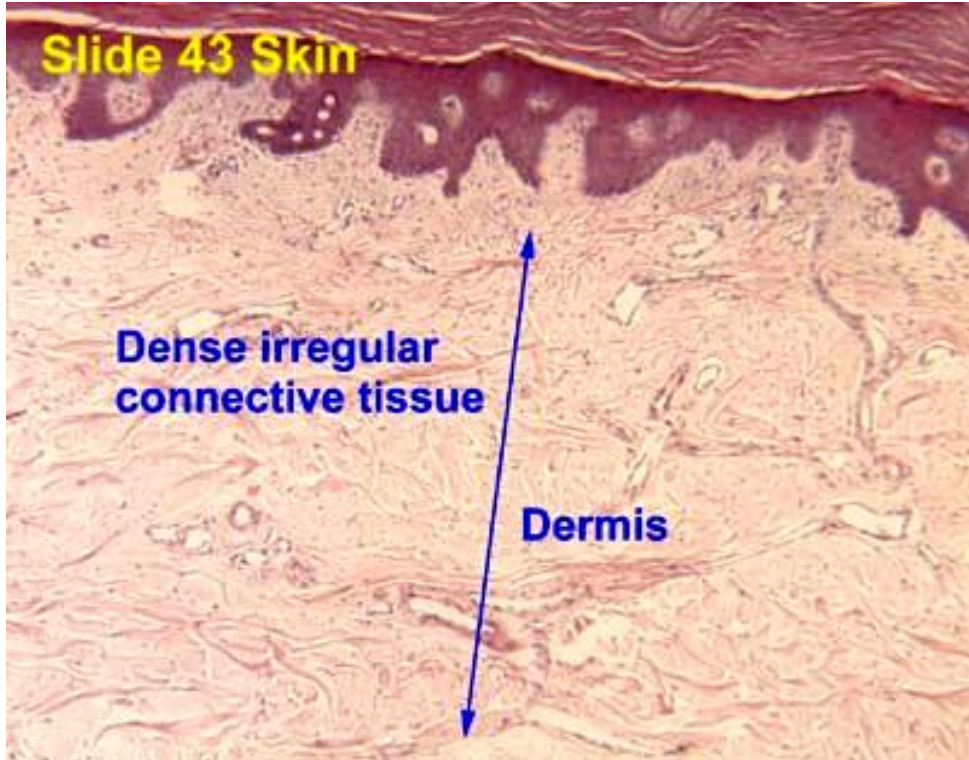
- (ii) **DENSE IRREGULAR CT:** same as regular, but collagen bundles thicker & arranged irregularly

**Location:** dermis, submucosa of digestive tract, fibrous capsules of organs & joints

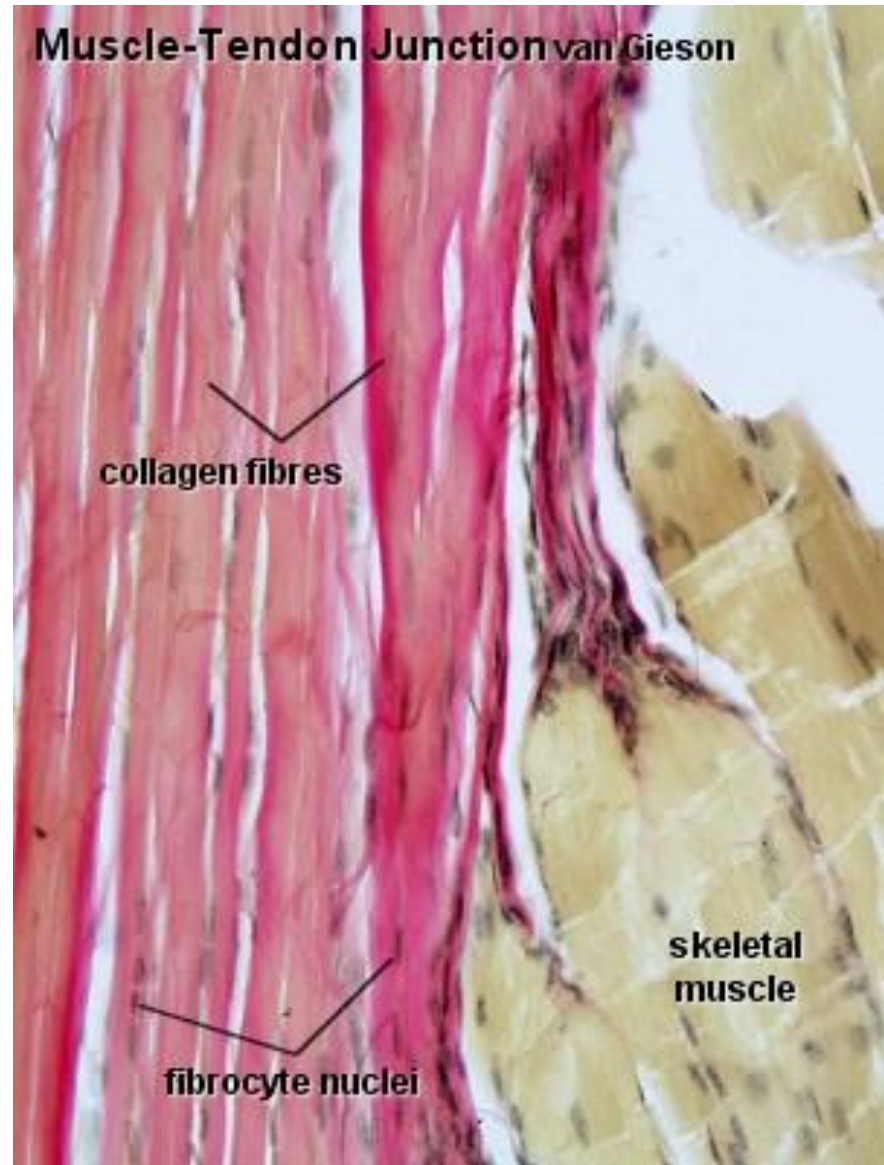
**Function:** withstand tension exerted in many directions; strength

- (iii) **ELASTIC CT:** like dense regular CT, but a very high content of elastic fibers; found in some very elastic ligaments





<http://w3.ouhsc.edu/histology/Text%20Sections/Connective%20Tissue.html>

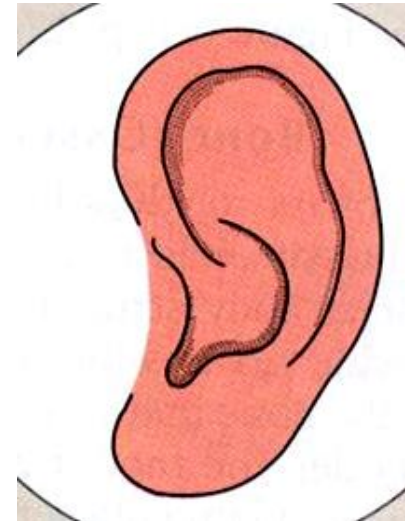
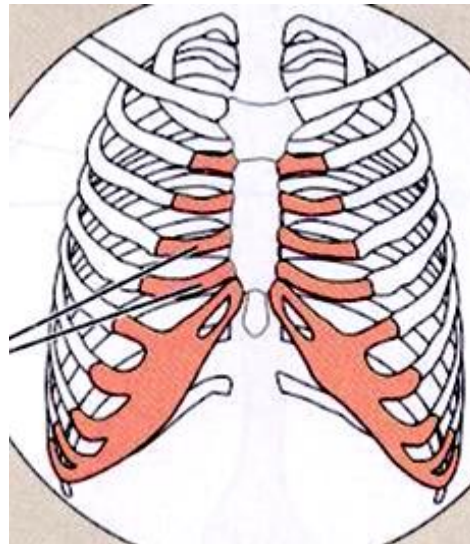


<http://www.lab.anhb.uwa.edu.au/mb140/CorePages/Connective/Images/skm40vg.jpg>

### 1.3.13 List the other remaining types of connective tissue

## 3. CARTILAGE features between dense CT & bone → *tough, but flexible*

- (i) avascular, devoid of nerve fibers
- (ii) ground substance contains lots of the GAGs chondroitin sulfate & hyaluronic acid - also chondronectin, (adhesive protein)
- (iii) collagen fibers (can have some elastic fibers)
- (iv) up to 80% H<sub>2</sub>O

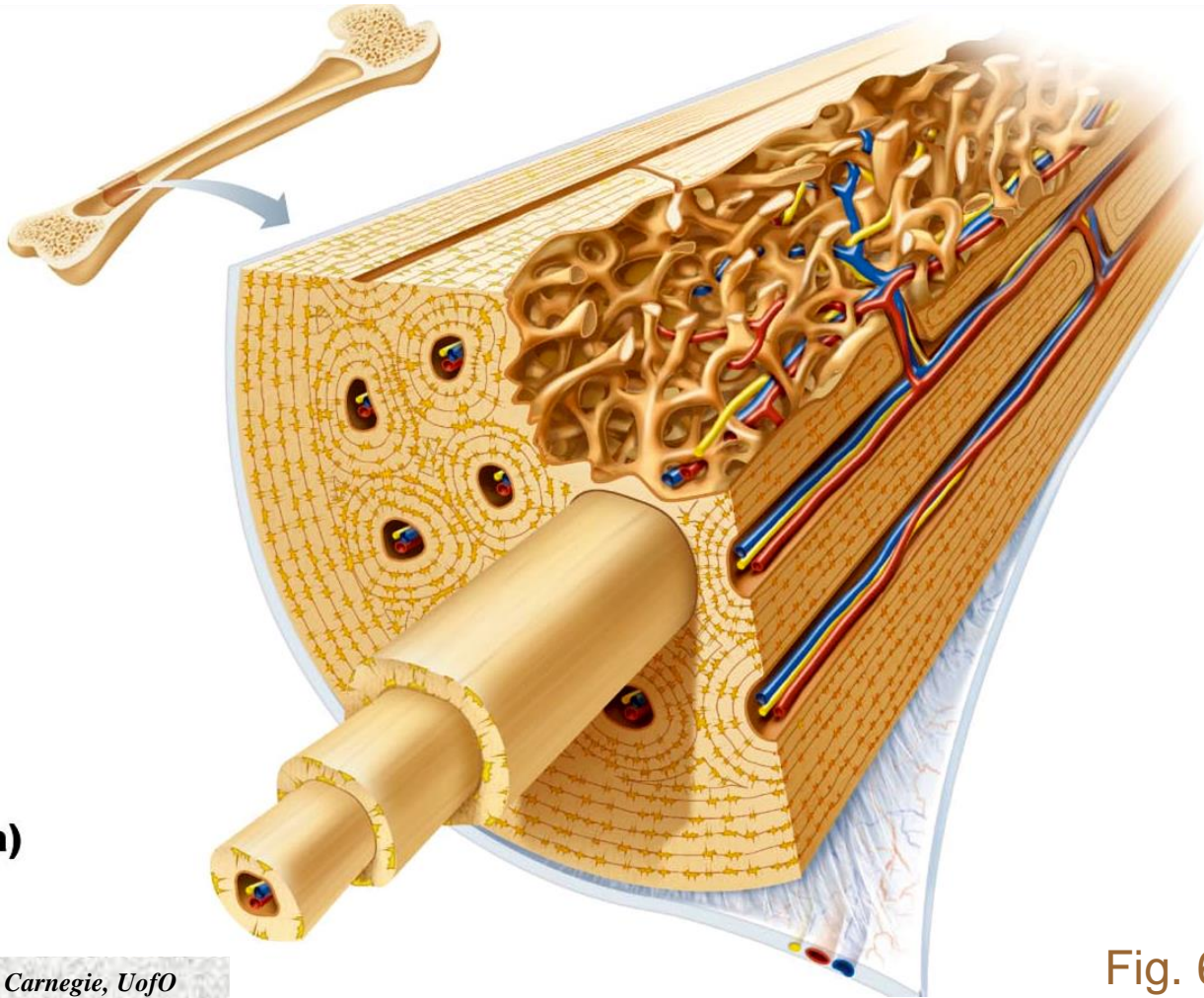


**4. BONE** calcium salts give hardness & strength for support/protection of softer tissues; cavities for fat storage & synthesis of blood cells

**osteoblasts:** .....

**osteocytes:** .....

**osteoclasts:** .....

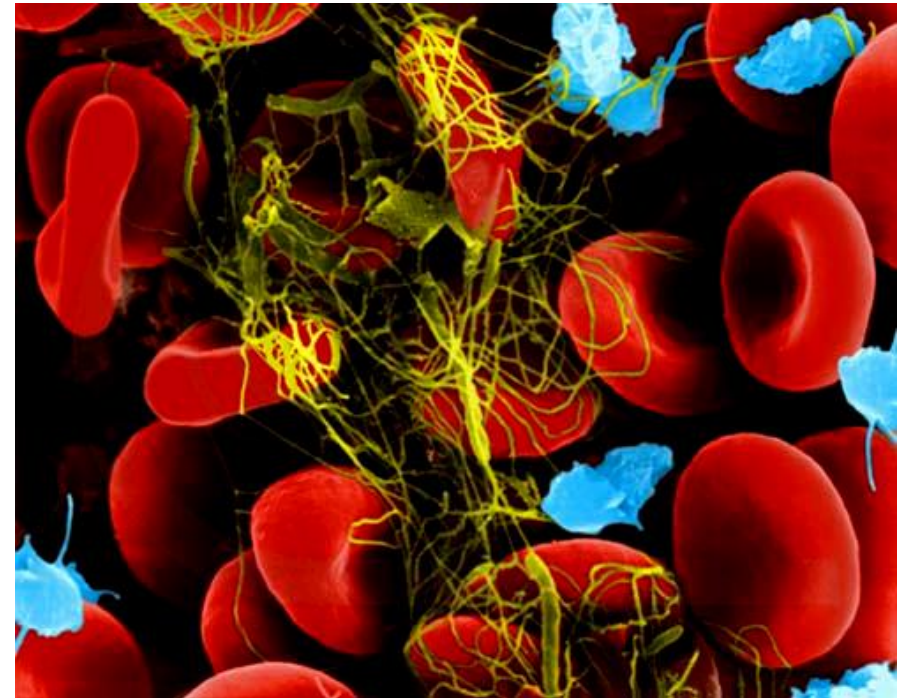
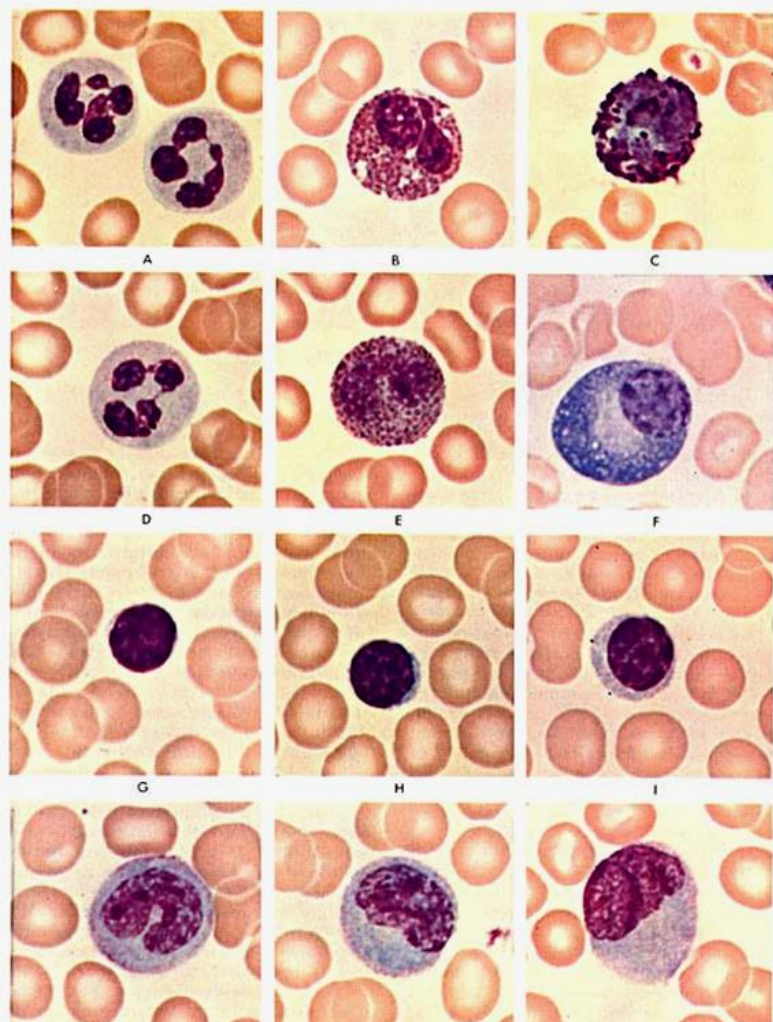


1)

Fig. 6.7: Structure of Bone

**5. BLOOD** classified as a CT because it consists of **cells** (RBCs, WBCs) surrounded by a nonliving fluid matrix, **blood plasma**

“**fiber**” components are soluble protein molecules - only visible during clotting



<http://www.emc.maricopa.edu/faculty/farabee/biobk/BioBookcircSYS.html>

<http://faculty.une.edu/com/abell/histo/histolab3a.htm>

*J. Carnegie, Uof O*



1. **Which of the following fibrous elements give a CT high tensile strength?**

- a) reticular fibers
- b) elastic fibers
- c) collagen fibers
- d) myofilaments

2. **The cell that forms bone is the:**

- a) fibroblast
- b) chondroblast
- c) hemocytoblast
- d) osteoblast
- e) reticular cell

3. **Which kind of CT acts as a sponge, soaking up fluid when edema occurs?**

- a) areolar CT
- b) adipose CT
- c) dense irregular CT
- d) reticular CT
- e) vascular tissue

