## Animal Tissue

#### Lecture by:-

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### INTRODUCTION

Histo-Tissue Logia-study of/knowledge

Histology is the study of the microscopic anatomy (**microanatomy**) of cells and tissues of plants and animals.

It is commonly performed by examining cells and tissues under a light microscope or electron microscope, the specimen having been sectioned (cut into a thin cross section with a microtome), stained, and mounted on a microscope slide.



Marie Francois Xavier Bichat (1771-1802), French anatomist and pathologist discovered tissue. He was known as 'Father of Histology'.



Marie Francois Xavier

### WHERE DO TISSUES FIT IN THE LIVING ORGANISM?

- Life begins as a single cell called a zygote after fertilization
- This cell differentiates into a variety of tissues. (Group of cells with the same function)
- A group of tissues with the same function forms an organ.
- Group of organs Organ system
- Group of organ systems Organism

### WHAT IS TISSUE?

# • SPECIALIZED CELL of the same type that perform a common function in the

body.





### **Basement Membrane**

- The basement membrane is a thin sheet of <u>fibers</u> that underlies the <u>epithelium</u>
- The basement membrane is the fusion of two lamina, the <u>basal lamina-elaborated by</u> <u>epithelial cells</u> and the <u>reticular lamina</u> (or lamina reticularis)-manufactured by cells of connective tissue

#### Hemidesmosome Focal contact Keratin 5/14 Cell membrane Actin Kindlin BPAG1 Plectin CD 151 $\alpha_3\beta_1$ Vinculin $\alpha_6\beta_4$ integrin Talin integrin Collagen Lamina lucida Laminin 311 Collagen XIII XVII Laminin 332 Nidogen Laminin 332 Perlecan Lamina densa Dermal fibril Dermis Collagen VII Anchoring fibrils

Hypothetical relationships of molecules within the dermal-epidermal junction basement membrane

Source: Goldsmith LA, Katz SI, Gilchrest BA, Paller AS, Leffell DJ, Wolff K: Fitzpatrick's Dermatology in General Medicine, 8th Edition: www.accessmedicine.com

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### Structure of Basement membrane

### Basement Membrane

- Basal Lamina
  - Lamina Lucida
    - <u>Extracellular glycoprotein-</u> <u>Laminin, integrins, entactins, dystroglycans</u>
    - Transmembrane laminin receptors-project from epithelial cell membrane into basal lamina
  - Lamina Densa consists of a network of fine filaments.
    - <u>Type IV collagen</u>. forms felt-like network of fibers that gives the basement membrane its tensile strength

### Structure of Basement membrane

- Lamina Reticularis
- Type III collagen (as reticular fibers)
- Attaching proteins (between Basal and Reticular Laminae)-all elaborated by fibroblast of connective tissue
- Type VII collagen (anchoring fibrils)
- fibrillin (microfibrils)
- Fibronectin

### <u>lamina lucida &lamina densa</u>

### Lamina Densa

- dense layer closer to the connective tissue
- 30–70 nm in thickness
- consists of an underlying network of reticular <u>collagen</u> (type IV) fibrils
- Lamina Lucida
  - clear layer close to epithelium



# A poorly functioning basement membrane

### Diseases

- Genetic defects
- Injuries by the body's own immune system
- Other mechanisms
- <u>Alport syndrome</u>
  - -Genetic defects
- <u>Goodpasture's syndrome</u>
  - Collagen type IV is autoantigen (target antigen) of autoantibodies in the autoimmune disease
- <u>Epidermolysis bullosa</u>
  - -Skin
- <u>Muscular dystrophy</u>
  - Dystrophin . a glycoprotein in the plasma membrane of muscle cells. In muscular
    - dystrophy, this protein is defective or missing

### MAJOR TYPES OF ANIMAL TISSUE

- EPITHELIAL TISSUE: Covers or lines body cavity and forms glands.
- CONNECTIVE TISSUE: Binds different organs together and support the body.
- MUSCLE TISSUE: Movement
- NERVOUS TISSUE: Senses and transmits impulses

### I. Generalizations

- A. Definition
- B. Four general categories of animal tissue
  - 1. epithelial
  - 2. muscle
  - 3. nerve
  - 4. connective

### Typical Arrangement of Epithelial Tissue and its Basement Membrane



**Basal surface** 

Surfaces of Epithelial Cells © 1993 by HarperCollins College Publishers

# Epithelial tissue A. General Traits or characteristics

- 1. found on a body surface either internal or external
- 2. tightly packed cells
- 3. free border or free surface
- 4. rest on a basement membrane
- 5. nonvascular



# B. Naming or classifying epithelial tissue

- 1. First Name
  - a. Simple
  - b. Stratified
  - c. Pseudostratified
- 2. Second name
  - a. Cuboidal
  - b. Squamous
  - c. Columnar

# C. Examples of naming

- 1. simple cuboidal
- 2. stratified squamous
- 3. pseudostratified
- 4. stratified cuboidal







Simple Epithelium	Compound Epithelium
It is a single layer of cells.	It consists of more than one layer of cells.
Its main function is absorption, secretion and diffusion.	Its main function is protection against mechanical and chemical stress.
It is found in the lining of blood vessels, air sacs, stomach, intestine, etc.	It is found in the skin lining, pharynx, buccal cavity, etc.

#### Terms that help us understand what kinds of tissues we are identifying: <u>Terms referring to the layers</u>

*Simple* = one layer

*Stratified* = more than one layer

*Pseudostratified* = false layered (appears to be more than one layer, but only one); *ciliated* = with cilia

Terms referring to the cell shapes

Squamous = flat Cuboidal = cube Columnar = rectangular (column) Transitional = ability to change shape

### Epithelial Tissue

A Simple squamous epithelium



B Simple cuboidal epithelium



C Simple ciliated columnar epithelium



### **Epithelial Tissue**

A Stratified squamous epithelium



B Transitional epithelium



C Ciliated pseudostratified epithelium



### Simple Squamous Epithelium

#### L.M. Simple Squamous Epithelium



Histology Department / Faculty of Medicine / Cairo University



Section of a vein. All blood vessels are lined with a simple squamous epithelium called endothelium (arrowheads). Smooth muscle cells in the vein wall are indicated by arrows. Pararosaniline toluidine blue (PT) stain. Medium magnification

#### (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 (430x).

#### (c) Simple columnar epithelium

**Description:** Single layer of tall cells with *round* to *oval* nuclei; some cells bear cilia; layer may contain mucussecreting 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 anal canal), 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 stomach mucosa (860X).

#### (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 mucussecreting 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 (570x).

### **SQUAMOUS EPITHELIAL TISSUE**

### STRUCTURE

- Single layer thin, large, flattened cells
- Cells have irregular shape and are closely packed in mosaic form.
- Cells are attached to a basement membrane.

### FUNCTIONS

- Diffusion of gasses can occur easily over surface.
- Supply friction free surface for blood flow.
- Protects and supports underlying tissue

### SQUAMOUS EPITELIAL TISSUE

### WHERE?

Lining of lungs and blood vessels
In mouth and esophagus.





### **CUBOIDAL EPITHELIAL TISSUE**

### STRUCTUTE

- Square cells, closely packed in a single layer.
- Cells attached to a basement membrane.

### FUNCTION

Absorbs molecules



### **CUBOIDAL EPITHELIAL CELLS** WHERE?

Lining of kidney tubules
Lining various glands.







basement membrane

### **COLUMNAR EPITHELIAL TISSUE**

### STRUCTURE

- Tall elongated, column-shaped cells.
- Nucleus near the base of the cell.
- Cells are attached to a basement membrane.
   FUNCTIONS
- Plays a role in absorption of nutrients.
- Protects and supports underlying tissues.

### **COLUMNAR EPITHELIAL TISSUE** WHERE? Lining of small nucleus intestine, basement membrane stomach and oviducts

### CILLIATED CULUMNAR EPITHELIAL TISSUE

### STRUCTURE

 Comprises of columnar cells with cilia at their free edges

### FUNCTIONS

- Sweeps impurities towards throat
- Improves movement of substance through the ducts.

### CILLIATED COLUMNAR EPITHELIAL TISSUE

### WHERE?

 Lining of trachea and nostrils, bronchi and sperm ducts)



### GLANDULAR COLUMNAR EPITHELIAL TISSUE

### STRUCTURE

- Consist of cuboidal and columnar epithelial cells.
- Unicellular glandular cells with goblet cells scattered among non-glandular cells.

### FUNCTIONS

- Produce mucus which serves to lubricate the intestine and make movement of food easier.
- Keep respiratory passage moist.
- Secrete enzymes, hormones, sweat, wax and saliva.
# GLANDULAR COLUMNAR EPITHELIAL TISSUE

### WHERE?

 In small intestine and respirative passages. Occur in salivary glands, thyroid gland and sebaceous glands in the skin.



- 2. Muscle tissue
  - A. General traits
    - 1. excitable tissue
    - 2. can shorten

### B. Types of muscle tissue

- 1. skeletal muscle
  - a. multinucleate
  - b. voluntary
  - c. striated



Skeletal or striated voluntary muscle tissue.

- 2. Smooth muscle
  - a. Involuntary
  - b. Visceral
  - **c.** structure





- 3. Cardiac muscle-mixture of two
  - a. One nucleus/cell
  - b. Autorythmic
  - c. Striated
  - d. Intercalated disc

faint stripes branching fibres





### Cardiac Muscle Structure

nucleus

Intercalated disks are anchoring structures containing gap junctions

> Cardiac muscle cells are
>  faintly striated, branching, mononucleated cells, which connect by means of intercalated disks to form a functional network.

The action potential travels through all cells connected together forming a functional <u>syncytium</u> in which cells function as a unit.

- 3. Nervous tissue
  - A. General Traits
    - 1. Irritable
    - 2. Conductive



### B. Two cell types

### 1. neurons

- a. Cell body
- b. Axon
- c. Dendrite

# 2. Glia cells (caretakers)



## **Three types of neurons**

### according to structure:

### Unipolar neurons

### **Bipolar neurons**



### 4. Connective Tissues

- A. Common traits
  - 1. possess fibers
  - 2. widely scattered cells
  - 3. ground tissue (matrix)
  - 4. analogy



Figure 1. connective treasur 580x entarged



# CONNECTIVE TISSUE

 FIBROUS CONNECTIVE TISSUE
 SUPPORTIVE CONNECTIVE TISSUE
 FLUID CONNECTIVE TISSUE

# FIBROUS CONNESTIVE TISSUE

LOOSE AREOLAR FIBROUS **CONNECTIVE TISSUE** DENSE WHITE FIBROUS CONNECTIVE TISSUE DENSE YELLOW FIBROUS CONNECTIVE TISSUE ADIPOSE TISSUE

# LOOSE AREOLAR FIBROUS CONNECTIVE TISSUE

- Occurs beneath the skin and most epithelial layers connecting organs together.
- Filling the spaces between organs and muscles, around muscles and blood vessels



## **DESCRIPTION OF AREOLAR-**

- Loosely arranged tissue
- In jelly-like matrix there are 4 types of living cells and two types of non-living cells.
- Macrophages
  Mast cells
  Fat cells
  Fibroblasts
  Collagen fibres
  Elastic fibres



# FUNCTIONS OF AREOLAR-

- Areolar tissue binds organs or organ components together and supports structures.
- Allows for movement between structures.
- The matrix allows for diffusion of substances like gases, nutrients, hormones and wastes to and from the blood.

- Fibroblasts secrete collagen and produce elastic fibres.
- Macrophages Engulf foreign particles by means of phagocytosis to defend the body against infection.
- Mast cells They secrete the matrix, release histamine during inflammation, produce heparin (anticoagulant).
- Fat cells Synthesis and storage of fats.
- Collagen fibres strengthen the tissue.
- Elastic fibres Allows for expansion and contraction.

# Dense white fibrous connective tissue

 In dermis of skin, tendons

### FUNCTIONS: > Attach muscle to bones





### YELLOW FIBROUS CONNECTIVE TISSUE

In ligaments

### **FUNCTIONS:**

- Attach bone to bone
- Hold bones of a joint in place.
- Restrict movement of bones and prevent dislocation during normal movement.



# **ADDIPOSE TISSUE**

- Found beneath the skin, around heart and other organs.
   FUNCTION:
- Insulation
- Stores fat.
- **DESCRIPTION:**
- Large round cells filled with fat or oil.



# COLLAGEN FIBRES AND ADIPOSE CELLS



# SUPPORTIVE FIBROUS CONNECTIVE TISSUE

HYALINE CARTILAGE
 WHITE FIBROUS CARTILAGE
 YELLOW ELASTIC CARTILAGE
 BONE

# **HYALINE CARTILAGE**

- Occurs at the ends of bones in movable joints. Parts of the larynx.
- In the walls of the trachea and bronchi.
- In between the ribs and the sternum.
- On the tip of the nose





# FUNCTIONS

- Chondrocytes produce a rubber matrix called chondrin.
- Reduce friction at joints
- Attach bones firmly to other bones.
- Keeps tubes open (C-shaped in trachea).
- Forms permanent structures (nose).
- Longitudinal growth of long bones.



# WHITE FIBROCARTILAGE

- Occurs as disks between the vertebrae.
- Surrounds the edges of the sockets of ball-andsocket joints.
- Between the pubic bones in front of the pelvic girdle.



# FUNCTIONS

- It serves as shock absorbers between adjacent vertebrae.
- It deepens sockets to make dislocation less easy.





# YELLOW ELASTIC CARTILAGE

- In the ear lobe
- At the tip of the nose
- In the epiglottis.
- Septum of nose









### FUNCTIONS

- It maintains the shape and flexibility of the ear lobe and tip of the nose.
- It strengthens and supports the ear, nose and epiglottis.



# **COMPACT BONE**

### Occur in the bones of the skeleton





# FUNCTIONS

- Support
- Protection
- Locomotion
- Red blood corpuscles and white blood cells are produced in the red bone marrow.





# **COMPACT BONE**

### Occur in the bones of the skeleton





#### B. Compound epithelium :

#### a. Stratified epithelium :

Nucleus is present in stratum germinativum. Cells at free surface become flat and lack nucleus called stratum corneum.

Function : Protection Ex. : Epidermis of skin, oesophagus cornea, vagina, rectum.



ea,

Fig. 10.7 Compound epithelial tissues

#### b. Transitional epithelium:

Structure of transitional epithelium is same like stratified epithelium. The cells can undergo a change in their shape and structure depending on degree of stretch.

Function : Distension of organ

Ex. : Urinary bladder

# B. Areolar Connective Tissue-loose irregular



### C. Tendon-dense regular



### D. Ligament



### E. Bone


# F. Blood



## G. Adipose tissue



## 5. Membranes

- A. Cutaneous
- B. Mucous
  - 1. contain glands
  - 2. open to outside
  - C. Serous
    - 1. occur in paired sheets
    - 2. don't open to outside
    - 3. no glandular tissue







# **FLUID CONNECTIVE**



TISSUE BLOOD **BLOOD PLASMA** ERYTHROCYTES LEUCOCYTES **BLOOD PLATELETS** 



# BLOODPLASMA

#### WHERE?

Matrix in which the blood cells are found.

## FUNCTIONS:

- Transport various formed elements to body parts.
- Dispersion medium.
- Transports digested food.
- Transports cellular waste.
- Transports hormones.
- Plays a role in regulation of body temperature.
- Transports antibodies

DESCRIPTION

 Straw color fluid consisting mainly of water with many substances in solution like nutrients, organic waste, inorganic salts and ions, plasma protein, dissolved gases, hormones, enzymes and antibodies.

# ERYTHROCYTES (RED BLOOD FUNCTIONS: CELLS)

- Transports oxygen in the blood from the lungs to all living cells.
- Transports some of the carbon dioxide from the body tissues the lungs.
- Play a role in the clotting of blood.
- Play a role in the regulating of pH of body fluids



# DESCRIPTION

- Small round biconcave disks filled with cytoplasm, but without a nucleus.
- Contain the red pigment hemoglobin.
- Hemoglobin contains 4 units, each with the protein globin and a complex iron-containing, structure called heme. The iron form a loose association with oxygen and in this way red blood cells transport oxygen and readily give it up to tissues.

# LEUCOCYTES (WHITE BLOOD CELLS)

# **FUNCTIONS:**

- Engulf infections by means of phagocytosis.
- Produce antibodies.
- Defense or immunity of body





# **BLOOD PLATELETS**

#### **DESCRIPTION:**

- Fragments of giant cells, present only in bone marrow.
- They are small discs without nuclei and bounded by a typical cell membrane.
- A characteristic feature of platelets is their tendency to stick to foreign surfaces and to each other to form clumps.

#### FUNCTIONS;

 When blood vessels are damaged, platelets form a plug that seals the vessel, and injured tissues release molecules that help the clotting of blood.



# **Cell junctions**

- Cell junctions consist of multiprotein complexes that provide contact between neighboring cells or between a cell and the extracellular matrix.
- They also build up the paracellular barrier of epithelia and control the paracellular transport.
- Cell junctions are especially abundant in epithelial tissues.

Formation of multicell organisms requires specific interaction between cells to hold the cells together and to communicate in order to coordinate activities.

A. 4 types of <u>Cell Adhesion Molecules (CAMs)</u> are used to hold animal cells together:

- 1. Cadherins
- 2. Ig-like CAMs
- 3. Selectins
- 4. Integrins

All are single-pass transmembrane proteins anchored to the cytoskeleton by their cytoplasmic domains.

# Importance of Cell junction

- Cell junctions enable communication between neighboring cells via specialized proteins called communicating junctions.
- Cell junctions are also important in reducing stress placed upon cells.
- Combined with CAMs( cell adhesion molecule) and ECM, cell junctions help hold animal cells together.

Tight junctions (TJs): These junctions maintain cell polarity, prevent lateral diffusion of proteins and ions.

Hemidesmosomes (HDs) : Allow the cells to strongly adhere to the underlying basement membrane. These maintain tissue homeostasis by signaling.



Desmosomes (Ds) : These provide mechanical strength to epithelial tissue, cardiac muscles and meninges.

Chart 10.8 Types of Cell junction :

#### Gap Junctions (GJs) :

This intercellular connection allows passage of ions and small molecules between cells as well as exchange of chemical messages between cells.

Adherens Junctions (AJs) : It is involved in various signaling pathways and transcriptional regulations.





Figure 19–2. Molecular Biology of the Cell, 4th Edition.

# 1. Occluding - Tight junction



Figure 19–5. Molecular Biology of the Cell, 4th Edition.

# 2. Anchoring junctions

Integral membrane proteins connect a cell's cytoskeleton to another cell or extracellular matrix

cytoskeletal filaments



extracellular matrix

Figure 19–7. Molecular Biology of the Cell, 4th Edition.

# Anchoring junctions

Integral membrane proteins connect a cell's cytoskeleton to another cell or extracellular matrix





cadherins. These receptors

extend out from the cell, binding to other cadherens

Cell to cell connections

2a. Cadherins and desmosomes

Figure 19–9 part 2 of 2. Molecular Biology of the Cell, 4th Edition.

## Cadherins participiate in adherens junctions

Under the cell membrane, contractile fibers of microfilaments connect to cell membrane proteins called cadherins

They surround the cell, forming a belt



Figure 19–9 part 1 of 2. Molecular Biology of the Cell, 4th Edition.

## Desmosomes

## Cadherins can also form localized spot connections

Cadherins attach to intermediate filaments via anchoring proteins: a desmosome



Figure 19–11 part 2 of 2. Molecular Biology of the Cell, 4th Edition.

## Cells-to-ECM attachments: Focal adhesions and hemidesmosomes

Cytoskeletal fibers attach to transmembrane receptors (integrins) that are attached to extracellular matrix components ·Focal adhesions use ME

## ·Hemidesmosomes use IF



## Gap junctions

Gap junctions allow cells to exchange electrical and/or chemical signals

Composed of proteins that form channels that allow small molecules to pass.

Subunits of these channels are connexins that are assembled together to make connexons. The connexons from 2 cells join together to make a gap junction.

# Gap junctions





Figure 19–19 part 1 of 2. Molecular Biology of the Cell, 4th Edition.

## Summary

name	function
tight junction	seals neighboring cells together in an epithelial sheet to prevent leakage of molecules between them
adherens junction	joins an actin bundle in one cell to a similar bundle in a neighboring cell
desmosome	joins the intermediate filaments in one cell to those in a neighbor
gap junction	allows the passage of small water-soluble ions and molecules
hemidesmosome	anchors intermediate filaments in a cell to the basal lamina

Figure 19–19 part 2 of 2. Molecular Biology of the Cell, 4th Edition.

Simple squamous epithelial tissue



#### Where in the body would you find this tissue?

lungs

#### What kind of tissue does this represent? Simple squamous epithelial tissue (superior view)



# Lets'

# See

#### Simple cuboidal epithelial tissue



#### Where in the body would you find this tissue?

Kidneys (tubules)

The lining of the kidney glomerulus (sing.)/glomeruli (pl.) is simple squamous

epithelial tissue

Simple columnar epithelial tissue



Where in the body would you find this tissue?

small intestine

#### Pseudostratified (ciliated) columnar epithelial tissue

"false layered"; it looks like more than one layer, but it is not



#### Where in the body would you find this tissue? trachea lining

#### What kind of tissue does this represent? Stratified squamous epithelial tissue



#### Where in the body would you find this tissue? mouth lining

#### What kind of tissue does this represent? Stratified cuboidal epithelial tissue



Where in the body would you find this tissue?

salivary glands, sweat glands

#### What kind of tissue does this represent? Stratified columnar epithelial tissue



#### Where in the body would you find this tissue?

male reproductive tract

#### What kind of tissue does this represent? Transitional epithelial tissue



#### Where in the body would you find this tissue? <u>empty</u> bladder
## What kind of tissue does this represent? Transitional epithelial tissue



## Where in the body would you find this tissue? <u>distended (full)</u> bladder

