Epithelium
(One of four basic types of Tissue)
Objectives

Embryonic origin and tissue organization

Cell junction and cell polarity

How to classify epithelia?

Different types of glands and mechanisms of glandular secretion
Four basic types of tissues in the body

- Epithelium (90% of tumors)
- Connective tissue
- Muscular tissue
- Nervous tissue
Protoplasms – Living Substance

**CELL** – Smallest unit of protoplasm
Simplest animals consist of a single cell.

**TISSUE** – Groups of cells with same general function and texture (texture = tissue)
  e.g., muscle, nerve, connective tissue, epithelium

**ORGAN** – Two or more types of tissues;
larger functional unit
  e.g., skin, kidney, intestine, blood vessels

**ORGAN SYSTEM** - Several organs
  e.g., respiratory, digestive, reproductive systems
**Epithelium**

**Functions:**

cover organs, line viscera and blood vessels, and secretory cells of glands

**Distinguishing features and distribution:**

Always sit on a *basement membrane*, but come in a variety of configurations: classified on the basis of the shape of the *surface cells* and whether one *(simple)* or more *(stratified)* layers of cells are stacked upon each other. These cells are always attached to their neighbors by desmosomes, tight junctions, and gap junctions.
Epithelia: Histological Identification

**Simple squamous** – single layers of flat cells (blood vessels, covering of organs)

**Simple cuboidal** – single layer of square cells (kidney tubules, liver cells, many others)

**Simple columnar** – single layer of tall, thin cells (intestinal epithelium)

**Stratified squamous** – multiple layers of cells with flat ones at the surface (skin, gums)
Epithelia

**Pseudostratified columnar** – single layer of tall, thin cells packed together in such a jumble that they seem to be in layers, although all of the cells reach the basement membrane (respiratory passage)

**Transitional** – stratified cuboidal epithelium of urinary passage

Some epithelia have surface specializations such as numerous microvilli or cilia. Others have enfolded base.
Origin and Distribution of Epithelium

Ectoderm - epidermis of skin and epithelium of cornea together covers the entire surface of the body and oral cavity; sebaceous and mammary glands

Endoderm - alimentary tract, liver, pancreas, gastric glands, intestinal glands
• Endocrine glands - lose connection with surface

Mesoderm
Endothelium - lining of blood vessels
Mesothelium - lining serous cavities
Epithelia are Specialized for Functions

Absorption - intestine
Secretion – pancreas

Transport - eye, endothelium in vessels
Excretion – kidney

Protection – against mechanical damage and dehydration

Sensory reception – pain to avoid injury, taste buds, olfactory, etc.
Contraction – myoepithelium
Sensory cells are of epithelia

Figure 3–29. Principal types of paraneurons. A, Endocrine cell of gut; B, gustatory cell of taste bud; C, Basal granulated cell of bronchus; D, chief cell of the carotid body; E, olfactory cell; F, hair cell of the inner ear; G, Merkel cell of the skin; H, avian pinealocyte; I, visual cell of retina; J, adrenal chromaffin cell; K, endocrine cell of adenohypophysis, parafollicular cell of thyroid, or pancreatic islet cell. (Modified after Fujita, T., et al. In Farner, D., and K. Lederis, eds.: Neurosecretion: Molecules, Cells, Systems. New York, Plenum Press, 1982.)
Surface Specializations of Epithelia

1. Microvilli - intestine absorptive cell
2. Cilia - respiratory epithelium
3. Basal lamina - all epithelium
4. Intercellular canaliculus - hepatocyte
5. Secretory (intracellular) canaliculus - gastric parietal cell
6. Flagella
Surface specializations of epithelia
Surface specializations of epithelia

Secretory (intracellular) canaliculus – gastric parietal cell
Surface specializations of epithelia

Bile (intercellular) canaliculus – hepatocyte
Surface specializations of epithelia flat cells for easy passage of blood fluid and cells
Endothelium - active cell

Has enzymes and receptors

Transport without much energy

Flat for less turbulence

Negatively charged surface

Not wettable surface
Transcytosis - to get antibodies into secretions

Surface specializations of epithelia

EXTRACELLULAR FLUID

IgA dimer

membrane-bound Fc receptor

TRANSCYTOSIS

1. recycling apical plasma membrane

2. degradation

3. transcytosis

early endosome

transport vesicles

tight junction

lysosome

basolateral plasma membrane

nucleus

Milk
Tears
Bile
Cervical fluid
Etc.
Specialization of Epithelia

- Maintain extensive contacts among cells (little space between cells).
- Structurally and functionally polarized.

**Junctions**
- Zonula occludens – tight junction (belt)
- Zonula adherens – adhering belt
- Desmosome (macula adherens) - spot attachment
- Gap junctions - communication
Terminal bars
Terminal bars

Belts around each cell
Zonula Occludens - Tight Junction (Belt)
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Zonula Adherens – adhering belt
Desmosome (macula adherens) – spot attachment
Gap junctions - communication
Figure 2-15. Schematic drawing of the connexons and their subunits in a portion of a gap junction. The hydrophilic pores through the connexons permit passage of ions and small molecules, such as AMP or the dye fluorescein, but exclude larger molecules. (Redrawn after Tagawa, B. and T. Lowenstein. 1975. In G. Weismann and R. Caiborne, eds. Biochemistry Cell Biology and Pathology. New York, H.P. Publishing Co.)
Figure 14–13 When fluorescent molecules of various sizes are injected
Actin also interacts to some degree with the tight junction – maybe to position it?
Classification of Epithelia

Number of layers
• Simple - one layer
• Stratified - more than one layer

Shape of superficial cells
• Squamous - flat
• Cuboidal - cube
• Columnar – column

Other
• Pseudostratified - not truly stratified
• Transitional - urinary tract
Simple squamous

Blood vessels
Simple cuboidal

Kidney

Lens of eye

Simple cuboidal
Gallbladder

Simple columnar

Intestine
Stratified Squamous Epithelium

Nonkeratinized Stratified Squamous

Keratinized Stratified Squamous

CORNEA

SKIN
Stratified Squamous Skin
Stratified Cuboidal in sweat ducts
Stratified columnar = male urethra
Figure 2-20. Electron micrograph of the apical region of four cell types, which are much longer and less highly ordered than the typical pseudostratified columnar epithelium.
• http://www.youtube.com/watch?v=miEEeluVlemQ&feature=related

http://www.youtube.com/watch?v=F0RuU2QHghM&feature=related
Fig. 2-17, A. Transitional epithelium, contracted from almost empty urinary bladder, Azan. 750X.

Fig. 2-17, B. Transitional epithelium, from full urinary bladder, Azan. 750X.

Transitional epithelium may be found in the valleys between microvilli. Examples: bile ducts, g
Summary of Tissue Features of Epithelium

- Avascular
- Extraneous cells
- Regeneration
- Migration
- Metaplasia
- Basement membrane
Secretion – active process consuming energy

**Exocrine glands** - deliver their secretion into ducts opening into external or internal surface

**Endocrine glands** - ductless, deliver their secretions into the lymph or blood stream
Mechanism for Release of Secretory Products

**Merocrine secretion** – exocytosis w/o loss of surface membrane

**Apocrine secretion** – loss of part of apical cytoplasm and some plasma membrane

**Holocrine secretion** – release of whole cell

**Cytocrine secretion** – melanin granules transferred from melanocyte to keratinocytes
Figure 33–11. Schematic representation of the transcellular pathways involved in milk secretion. Casein, lactate calcium, and citrate are packaged in vacuoles arising in the Golgi complex and released by exocytosis. Water and ions diffuse freely through the cell membrane. Lipid droplets enclosed in detached portions of plasmalemma are released in a unique form of apocrine secretion.

Figure 33–10. Micrograph of a mammary epithelial cell with a lipid droplet protruding into the lumen covered by merocrine secretion.
Lumen of follicle

Uptake of colloid by pinocytosis

Secretory droplets

Lysosome coalescing with absorption droplet

Golgi complex

Golgi complex

Lysosomes

Distended cisternae of reticulum

NORMAL

TSH-STIMULATED
Gland (endocrine) secretion effect
Exocrine Glands

Duct
• Simple - unbranched duct
• Compound - branched duct

Secretory portion
• Tubular
• Coiled tubular
• Branched tubular
• Alveolar
• Branched acinar
• Tubuloacinar
• Tubuloalveolar

Mucus vs. serous
Tubular
Coiled tubular
Branched tubular
Alveolar
Branched acinar
Tubuloacininar
Tubuloalveolar
Summary

ECTODERM

MESODERM

ENDODERM

Epithelium

Fig. 2-3. Simple epithelium.

Fig. 2-4. Stratified epithelium.
**Functions**

Apical plasma membrane
- regulation of nutrient and water uptake
- regulated secretion (pathway A)
- protection

Lateral plasma membrane
- cell contact and adhesion
- cell communication

Basal-lateral membrane
- signal reception and transduction
- generation of ion gradients
- constitutive secretion (pathway B)

Basal membrane
- cell-substratum contact

**Components**

Apical plasma membrane
- Hydrolases
- Amiloride-sensitive Na⁺ Channel
- Na⁺-dependent Transporters
- Cl⁻ channel
- H⁺-ATPase
- Proteins linked via glycosyl-phosphatidylinositol
- Glycolipids

Lateral plasma membrane
- Cell Adhesion Molecules
- Junctional Complex:
  - Zonula occludens (ZO)
  - Zonula adherens (ZA)
  - Desmosomes (D)
  - Gap junctions (GJ)

Basal-lateral membrane
- Anion Channel
  (Cl⁻/HCO₃⁻ exchanger)
- Na⁺,K⁺-ATPase
- Growth factor receptors
- Hormone and Neurotransmitter receptors
- Transduction systems associated with receptors

Basement membrane
- Laminin, Type IV Collagen, Proteoglycans

Basal membrane
- Basement Membrane Receptors
(A) DIRECT SORTING OF MEMBRANE PROTEINS IN THE TRANS GOLGI NETWORK

(B) INDIRECT SORTING VIA ENDOSONES
Many illustrations in these VIBS Histology YouTube videos were modified from the following books and sources: Many thanks to original sources!

- Internet images and videos on biological presentations
Next time

Connective Tissue