Histology, Epithelial Tissue

1. Tissues. Classification
2. General properties of basic tissues
3. Epithelial tissue – principal characteristics and functions
4. Classification of epithelium
5. Types of epithelia:
   - covering epithelia – types
   - glandular epithelia – types
Tissues - concept

- **Histology:**
  (Gr. ἱστός, histos, tissue + logos, study)

- general histology
- special histology = microscopic anatomy of the organ systems
Tissues – classification

- Marie François Xavier Bichat, 1797; Fr. tissu = tissue 1801 – 21 types of tissue
- August Franz Josef Karl Mayer, histology; 1819 – 8 types of tissue
- Franz von Leydig, 1857 – 4 basic types:
  ✓ Epithelial tissue
  ✓ Connective tissue
  ✓ Muscle tissue
  ✓ Nervous tissue

Table 4-1. Main Characteristics of the Four Basic Types of Tissues.

<table>
<thead>
<tr>
<th>Tissue</th>
<th>Cells</th>
<th>Extracellular Matrix</th>
<th>Main Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nervous</td>
<td>Intertwining elongated processes</td>
<td>None</td>
<td>Transmission of nervous impulses</td>
</tr>
<tr>
<td>Epithelial</td>
<td>Aggregated polyhedral cells</td>
<td>Very small amount</td>
<td>Lining of surface or body cavities, glandular secretion</td>
</tr>
<tr>
<td>Muscle</td>
<td>Elongated contractile cells</td>
<td>Moderate amount</td>
<td>Movement</td>
</tr>
<tr>
<td>Connective</td>
<td>Several types of fixed and wandering cells</td>
<td>Abundant amount</td>
<td>Support and protection</td>
</tr>
</tbody>
</table>
**Tissues – general properties**

- **Regeneration:**
  - physiological – permanent and cyclic
  - reparative

- **Degeneration**

- **Hypertrophy** – increase in cell size
  (Gr. ὑπέρ, excess + τροφή, nourishment)

- **Hyperplasia** – increase in cell number
  (Gr. ὑπέρ, excess + plésein, to form)

- **Atrophy** – wasting away of a part of the body:
  - numerical (myocardium)
  - volumetric

- **Aplasia** (Gr. a, not + plésein, to form)

- **Metaplasia** (Gr. change in form):
  - physiological
  - pathological

- **Neoplasia** (Gr. new growth) = tumor degeneration
Epithelial tissue

Textus epithelialis:

- Gr. ἐπί, epi, upon + θηλή, thēlē, nipple
- Origin – from all three germ layers of the embryo
- The tissue that:
  - covers surfaces in the body – epidermis
  - lines cavities of hollow organs – epithelium
    - digestive system
    - respiratory system
    - urinary system
    - reproductive (genital) system
    - cardiovascular system
- Many glands are also formed from epithelial tissue (sweat and sebaceous glands, pancreas, liver) – parenchyma
Epithelial tissue – functions

**Main functions:**
- protection (barrier), transport and secretion

**Multilayered epithelia:**
- Protect against friction and injury
- Barrier to water, disease some toxins, etc
- Lower layers regenerate upper layers

**Single layer epithelia:**
- Communication/gateway
- Important in regulated transport of cells/molecules
Epithelial tissue – characteristics

- **Common features:**

  ✅ epithelial cells rest on a basement membrane
  ✅ morphological and functional cell polarity – basal and free apical poles
  ✅ avascular tissue – lacks blood vessels
  ✅ rich innervation
  ✅ limited intercellular space
  ✅ high regeneratory capacity
□ Main components:

✓ Basal lamina, lamina basalis:
  - 50-100 nm
  - Proteins: type IV collagen, (types XV and XVIII)
  - Heparane sulfate proteoglycans: perlecan, agrin
  - Glycoproteins: laminin, entactin (or nidogen)
✓ Anchoring fibrils:
  - Type VII collagen
✓ Reticular lamina, lamina reticularis:
  - Type III collagen

□ Major functions:

✓ Lamina basalis – 120-250 nm:
  - Lamina densa – 60-120 nm
  - Lamina rara (lucida) externa et interna – 40 nm
✓ Lamina reticularis s. fibroreticularis – Type III collagen
- **Main components:**
  - Basal lamina, *lamina basalis*:
    - 50-100 nm
    - proteins: **type IV collagen**, (types XV and XVIII)
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    - glycoproteins: laminin, entactin (or nidogen)
  - Anchoring fibrils:
    - type VII collagen
  - Reticular lamina, *lamina reticularis*:
    - type III collagen

- **Major functions:**
  - elastic support
  - semiconductive filter

**Basement membrane**

**Lamina basalis** – 120-250 nm:
- lamina densa – 60-120 nm
- lamina rara (lucida) externa et interna – 40 nm

**Lamina reticularis s. fibroreticularis** – type III collagen
3 types intercellular junctions:

**Barrier (impermeable) junctions:**
- tight junction, zonula occludens
- occluding strip, fascia occludens
- occluding spot, macula occludens

**Adhering (anchoring) junctions:**
- punctum adhaerens
- belt desmosome, zonula adhaerens
- spot desmosome, macula adhaerens (Gr. desmos, band + soma, body)

**Communicating junctions:**
- gap junction, nexus
- synapse

**Junctional complex**
Epithelial tissue - classification

1. Как се классифицира епитела?
2. В зависимост от броя на слоевете
   - Един слой
     - Еднослойен
   - Повече слоеве
     - Няколко слоя ядра
     - Привидно многослойен
     - Многослойен
Simple epithelium – classification

В ЗАВИСИМОСТ ОТ ФОРМАТА НА КЛЕТКИТЕ

плоски → плосък → lumen

кубични → кубичен → lumen

призматични → призматичен → lumen

Simple squamous
Simple cuboidal
Simple columnar
Epithelial tissue - classification

Epithelial tissues

- Simple (one cell thick)
  - Squamous
  - Cuboidal
  - Columnar
  - Ciliated
  - Pseudostratified
    - Columnar
    - Cuboidal
      - Columnar
      - Ciliated
    - Stratified
    - Transitional
      - Squamous
      - Cuboidal
        - Keratinized
        - Non-Keratinized
        - Columnar
        - Columnar ciliated

Classification of Epithelial Tissues

Shapes | Simple | Stratified
-------|--------|-----------
- Squamous
- Cuboidal
- Columnar

A
B
C
D
E
F
G
H
I
Epithelial tissue – classification

- Covering epithelia:
  - simple
    - squamous
    - cuboidal
    - columnar
    - pseudostratified ciliated columnar
  - stratified
    - squamous nonkeratinized
    - squamous keratinized
    - columnar
    - transitional (of Henle)

- Glandular epithelia:
  - exocrine
  - endocrine
Simple squamous epithelium

- Epithelium that lines blood and lymph vessels (*endothelium, vasothelemium*)
  - squamous in shape cells
  - a prominent, protruding nucleus
  - covering and metabolic functions

- Epithelium that lines certain body cavities, such as the pleural and peritoneal cavities (*mesothelium*)

TYPE: Simple squamous
DESCRIPTION: Single layer flattened cells
COMMON LOCATIONS: Blood vessel walls; air sacs of lungs
FUNCTION: Diffusion
Simple cuboidal epithelium

- **covering:**
  - ducts of the exocrine glands
  - ovary

- **absorption:**
  - walls of renal tubules

- **secretion:**
  - thyroid gland (follicles)

**TYPE:** Simple cuboidal;

**DESCRIPTION:** Single layer cubelike cells; may have microvilli at its free surface;

**COMMON LOCATIONS:** Part of gut lining, part of respiratory tract lining;

**FUNCTION:** Secretion, absorption.
Simple columnar epithelium

- **covering:**
  - ducts of the exocrine glands

- **absorption:**
  - intestinal villi

- **secretion:**
  - stomach
  - large intestine
  - uterus

- **ciliated:**
  - Fallopian tubes
  - distal bronchi
Simple columnar epithelium

- **types of cells:**
  - absorptive cells, enterocytes (90%) – 30 µm
  - mucous (goblet) cells
  - basal (stem) cells
Pseudostratified columnar epithelium

- covering:
  - large ducts of the exocrine glands
- ciliated:
  - upper respiratory tract
  - epididymis
Transitional epithelium

Uroepithelium (urothelium):
- lining of renal calyces
- urinary tract – ureters & bladder

- The form of the cells changes according to the degree of distention of the organ:
  - five or six cells in thickness
  - small basal cells
  - larger pear-shaped cells in the middle layers
  - superficial cells are rounded and frequently binucleate
Skin (epidermis):
- covers dry surfaces
- most superficial cells involute and are transformed into dead scales of protein (keratin) without discernible nuclei
- 5 layers of keratinocytes:
  - stratum basale
  - stratum spinosum
  - stratum granulosum
  - stratum lucidum
  - stratum corneum – keratin
- **Mucous epithelium** – covers wet surfaces:
  - oral cavity
  - oropharynx
  - esophagus
  - anal canal
  - vagina

- **Metaplasia**

- **Corneal epithelium**
- Bilayered cuboidal epithelium:
  - ducts of the sweat glands

- Stratified columnar epithelium:
  - rare – only in small areas
  - large ducts of salivary glands
  - part of the urethra
  - ocular conjunctiva
- **Exocrine glands** (Gr. exo, outside, + krinein, to separate):
  - retain their connection with the surface epithelium
  - tubular ducts

- **Endocrine glands** (Gr. endon, within, + krinein)
  - connection with the surface is lost during development
  - ductless
## Types of Glands

<table>
<thead>
<tr>
<th>TABLE 5.5</th>
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<tbody>
<tr>
<td><strong>Exocrine Glands</strong></td>
<td><strong>Endocrine Glands</strong></td>
</tr>
<tr>
<td>Merocrine</td>
<td>Apocrine</td>
</tr>
</tbody>
</table>

- **Exocrine Glands**:
  - Merocrine
  - Apocrine
  - Holocrine

- **Endocrine Glands**:

- **Paracrine Glands**:
Exocrine glands

- General composition:
  - secretory portion
  - ducts

- Some exocrine glands:
  - salivary glands
  - exocrine pancreas
  - prostate
  - sebaceous and sweat glands
  - mammary glands etc.
Principal types of exocrine glands

- Many ways of classifying:
  - structure
  - product secreted
  - method of secretion

- Structural types:
  - simple (unbranched)
    - tubular
    - acinar
  - compound (branched)
    - tubular
    - acinar (alveolar)
    - tubuloacinar
Principal types of exocrine glands

a Simple glands

Simple tubular
Simple branched tubular
Simple coiled tubular
Simple acinar
Simple branched acinar

b Compound glands

Compound tubular
Compound acinar
Compound tubuloacinar
Exocrine glands – types

- Exocrine glands – product secreted:
  - serous (*glandula serosa*)
  - mucous (*glandula mucosa*)
  - mixed (*glandula seromucosa*)
Serous glands

- Serous glands - examples:
  - parotid gland
  - lacrimal gland
  - exocrine pancreas

- Serous cells:
  - arranged in acini
  - produce a watery material, isotonic with blood plasma
Serous acinus

- a spherical mass of cells (serocytes):
  - with a small lumen in the center
  - polarized, pyramidal in shape cells
    - containing zymogen granules
    - secrete a fluid, rich in proteins (enzymes)
**Mucous acinus**

- a spherical mass of cells (mucocytes):
  - with a larger lumen in the center
  - cuboidal to columnar in shape cells, organized as tubules
    - containing PAS-positive mucous material
    - produce a viscous lubricating gel, rich in glycoproteins (mucins)

- **Mucous glands - examples:**
  - labial and buccal glands
  - esophageal and pyloric glands
  - Brunner’s duodenal glands

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**Diagram:**

- Exocytosis
- Accumulation of glycoprotein granules
- Golgi complex: Terminal glycosylation and sulfation of proteins
- RER: Protein synthesis and initial glycosylation
- Basal lamina
- Capillary
- Amino acids and monosaccharides
- Monosaccharides and sulfate

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Mixed acinus

- a spherical mass of cells:
  - with a large number of mucous cells forming tubules
  - relatively fewer serous cells, constituting serous demilunes (of Gianuzzi or Heidenhein)
  - myoepithelial cells surround each secretory portion

- Mixed glands - examples:
  - most salivary glands
  - anterior lingual glands
Types of glandular exocrine secretions

- Exocrine glands - method of secretion:

  ✓ merocrine (eccrine) glands - exocytosis:
    Gr. *meros*, part + *krinein*, to separate
    - most of the exocrine glands (eg, the pancreas)
    - some endocrine glands

  ✓ apocrine glands: Gr. *apo*, away from + *krinein*
    - aromatic glands
    - large sweat glands
    - mammary glands

  ✓ holocrine glands:
    Gr. *holos*, whole + *krinein*
    - sebaceous glands in the skin
    - tarsal (Meibomian) glands
Functional classification

Prof. Dr. Nikolai Lazarov

- **a Merocrine gland**
  - Secretory contents
  - Secretory vesicle
  - Nucleus
  - Secretory vesicles releasing their contents via exocytosis

- **b Holocrine gland**
  - Disintegrating cells with contents becoming the secretion
  - Cells dividing

- **c Apocrine gland**
  - Lumen of tubule
  - Pinching off of apical portion of secretory cell
  - Nucleus of secretory cell
Endocrine glands

- Endocrine glands:
  - secrete their products, hormones, directly into the blood
  - ductless

Endocrine glands – types:

- endocrine cells may form anastomosing cords
  - anterior lobe of the pituitary
  - parathyroid gland
  - adrenal gland

- endocrine cells may arrange as vesicles or follicles
  - thyroid gland
Thank you...