EPITHELIAL SPECIALIZATIONS

NOTE: This is a long laboratory for a 1 hour time slot. If you do not finish in the allotted time, you should have time in the next laboratory session to finish up this lab and complete the lab on glands.

OBJECTIVES:

After completing this exercise, students should be able to do the following:

1. Identify specializations of epithelial cells and epithelia at the light microscopic level.
2. Identify specializations of epithelial cells and epithelia at the electron microscopic level.

ASSIGNMENT FOR TODAY'S LABORATORY

GLASS SLIDES - https://medmicroscope.uc.edu/

SL 026 (Thick skin) "intercellular bridges"
SL 020 (Bronchus) basement membrane
SL 011 (Ileum) striated border
SL 019 (Jejunum) PAS striated border with glycocalyx also goblet cells
SL 156 (Epididymis) stereocilia
SL 111 (Trachea) cilia

ELECTRON MICROGRAPHS (in Grey envelope)

EM 16 junctional complex and microvilli
EM 20-6 desmosomes
EM 22 gap junctions
EM 9 interdigitation of lateral membranes
EM 19-2 basal lamina

POSTED ELECTRON MICROGRAPHS

# 5	Organelles
# 9	Epithelial cell apical surface modifications
# 10	Lateral surface modifications
# 30, # 30a	Autoradiography

Lab 4 Posted EMs

SUPPLEMENTAL MATERIAL:

HISTOLOGY IMAGE REVIEW - available on computers in HSL

Chapter 4. Epithelial Membrane Specializations
Frames: 201-220

SUPPLEMENTARY ELECTRON MICROGRAPHS

Rhodin, J. A.G., An Atlas of Histology Copies of this text are on reserve in the HSL.
Surface specializations pp. 9 - 13
Copies of this text are on reserve in the HSL.

V. CELLULAR SPECIALIZATIONS IN EPITHELIA

A. CELL ATTACHMENTS

1. CELL TO CELL CONTACT

a) JUNCTIONAL COMPLEX - (J. Figs. 4-4 to 4-7; R. Figs. 5.14 to 5.23). The junctional complex is a group of three types of cell junctions that occur at the apical perimeters of adjacent columnar and cuboidal cells. The structure of the complex is evident only by electron microscopy. Observe these junctions in EM 16: (1) zonula occludens, also called tight junctions, (2) zonula adherens, or adherens junctions, and (3) macula adherens, or desmosomes.

Functionally, the zonula occludens provides a seal that limits movement of material through the extracellular space between cells. In addition, it limits the passage of transmembrane proteins from the apical to the basolateral side of the cell, and vice-versa.
Both kinds of adherent junctions are mainly involved in holding cells together (i.e. resisting shear forces).

In the light microscope, the junctional complex is barely visible in sections stained with H and E. When observed by LM, the junctional complex is called the "terminal bar." (R. Fig. 5.13) What is the "terminal web"? (R. Fig. 5.3)

b) MACULA ADHERENS (DESMOSOMES), light microscopy. (J. Fig. 18-4; R. Plate 42)
(1) SL 026: (Thick Skin) (low, med, high). Individually, desmosomes cannot be resolved in the light microscope without special processing; however, their presence is indicated by "intercellular bridges" (fine lines crossing the space between pairs of blue lines), thin extensions of cells that are linked by desmosomes. During fixation, the cells shrink and separate from each other except where they are connected by desmosomes. As the cells pull apart, minute projections extend from adjacent cells to each cell junction. These numerous projections give the cells a "spiny" appearance in this layer of the skin (called the stratum spinosum). (What is the complete classification of this tissue?).

(2) EM 20-6: Desmosomes are frequent along membranes of adjacent skin cells. (J. Fig. 4-4, 4-5, 18-4; R. 5.14, 5.21).

c) GAP JUNCTION EM 22 – The description of gap junctions for EM 22 is extensive. You should appreciate that these junctions can be visualized with various electron micrographic techniques. In particular, freeze fracture has been used to visualize these junctions (J. Fig. 4-7; R. 5.22, 5.23). Functionally, gap junctions create channels that allow the passage of small molecules between the cytoplasm of adjacent cells.

d) INTERDIGITATION OF LATERAL MEMBRANES EM 9 (R 5.24) – These allow for an increase in the surface area of the plasma membrane, and, therefore, more transmembrane proteins such as transport channels.

2. The BASEMENT MEMBRANE (Basal attachment) (J. Figs. 4-1, 4-2, 4-3; R. 5.25, 5.26) is the interface between the epithelium and underlying tissue. It is composed of basal lamina (non-fibrillar collagen plus other material), secreted by epithelial cells, and a layer of reticular fibers and other fibrillar material, secreted by connective tissue cells. These two layers together can be seen in the light microscope.

a) SL 020 (low): (Bronchus). Beneath the pseudostratified ciliated columnar epithelium, the basement membrane appears as an acellular, pink band (e.g., between blue arrows). This basement membrane is thicker than most other basement membranes.

b) EM 19-2: fused basal laminae of 2 epithelial cells: In lung, endothelial cells of a capillary are separated from another epithelium by their fused basal laminae. A reticular layer is absent here.

c) HEMIDESMOSOMES (J. Fig. 4-3; R Fig. 5.29. 5.34, 5.36). These were termed "half desmosomes", because of their morphological similarity to the desmosome, though the molecular constituents are now known to be unrelated. Hemidesmosomes anchor the basal surface of cells to the basal lamina and are especially common in stratified squamous epithelia in areas that are subject to forces that could shear the epithelium from its underlying tissue (skin, gums).

B. SPECIALIZATIONS OF THE "FREE SURFACE"

1. MICROVILLI (J. Fig. 4-8; R. 5.2, 5.3). Most cells have a few microvilli on their apical surface, but microvilli are especially numerous on the apical surface of intestinal cells, whose main function is absorption. The microvilli form an even row of projections that appears as a "striated border."

a) SL 011: (Ileum). Observe the regular arrangement of numerous microvilli at the apical surface (J. Fig. 15-24, 15-25; R. Plate 60), often referred to as the "striated border". This simple columnar epithelium also has goblet cells, which are unicellular glands that secrete mucus.

b) SL 019: (Jejunum) (J. Fig. 15-24) (low, med). Stained with PAS. This stain is specific for glycoproteins, which are major constituents of the thick glycocalyx coating the microvilli, and of mucus, which fills the goblet cells (oil). All cells have a glycocalyx, which, however, is thicker in some cell types and on some surfaces than on others. In this slide, the glycocalyx on the lateral surfaces of the cells is evident (microvilli with glycocalyx, blue arrow; glycocalyx on lateral cell membranes, green arrows; goblet cell, red arrow).

c) EM 16 (J. Figs. 4-8, 15-24, 15-25; R. Figs. 5.2, 5.3) Electron micrographs of microvilli. Relate the glycocalyx with that in the PAS-stained section (SL 019) (oil). Notice the internal structure of the microvilli.

2. STEREOCILIA (J. Fig. 4-9; R. Fig. 5.4, 5.5). SL 156 (Testis): Locate the ducts of the epididymis (scan, low, high,). Cells in the pseudostratified columnar epithelium have elongated and branched projections, called stereocilia, that are a modified form of microvilli. (blue circle). Their function apparently is absorption.

3. CILIA (J. Figs. 4-10, 4-11; R. 5.6 to 5.9) SL 111: (Trachea). The structure with the largest lumen in this section is lined by ciliated pseudostratified columnar epithelium (low, high). Other ciliated epithelia are found in the uterine tube and uterus.

4. FLAGELLA are found in spermatozoa in humans. (J. Fig. 21-5; R. 22.12). Note their structure is similar to cilia, but they are longer and usually limited to 1 per cell.

SPECIFIC OBJECTIVES FOR EPITHELIAL SPECIALIZATIONS

1. Using the light microscope or digital slides, identify:

   Basement membrane
   Microvilli (seen as striated or brush border)
   Cilia
   Stereocilia
   Goblet cells (in H&E, and they are PAS positive)
   Glycocalyx (PAS positive)

   Recognize PAS stained slides (e.g. SL 19) and know which structures in the cell are PAS positive.

2. On electron micrographs, identify:

   Junctional complex
      Zonula occludens (tight junction)
      Zonula adherens (adherens junction)
      Macula adherens (spot desmosome, or just desmosome)
   Gap junction
   Hemidesmosome
   Interdigitation of lateral membranes
   Basal lamina
   Microvilli
      Microfilament core
   Stereocilia
      Microfilament core
   Cilia
      Microtubule core

   Glycocalyx