INTRODUCTION TO CELLS, TISSUES, AND MICROSCOPY
Part 2
OBJECTIVES

1. PREVIEW CELLULAR ULTRASTRUCTURE
2. PREVIEW CELLS, TISSUES, AND ORGANS
3. OVERVIEW OF LIGHT AND ELECTRON MICROSCOPY
4. PREPARATION OF SPECIMENS - TYPES OF VISIONS
5. ULTRASTRUCTURAL FEATURES OF THE CELL AND ORGANELLES
Introduction to HISTOLOGY

**PROTOPLASM** – 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

**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
Figure 3-1. Diagram showing a hypothetical eukaryotic cell, in the center, as seen with the light microscope. It is surrounded by its various structures as seen with the electron microscope. (Redrawn and reproduced, with permission, from Bloom W, Fawcett DW. A Textbook of Histology, 9th ed. Saunders, 1968.)
FOUR BASIC TYPES OF TISSUES IN THE BODY

EPITHELIUM

CONNECTIVE TISSUE

MUSCULAR TISSUE

NERVOUS TISSUE
Epithelium

- **FUNCTIONS:**
  - COVER ORGANS, LINE VISCERA AND BLOOD VESSELS, SECRETORY CELLS OF GLANDS
CONNECTIVE TISSUE

- FUNCTION: THE HISTOLOGICAL GLUE WHICH BINDS THE OTHER TISSUES TOGETHER TO FORM ORGANS, SPECIALIZATIONS INCLUDE BLOOD, CARTILAGE, AND BONE.
BLOOD CELLS
(CLASSIFIED AS CONNECTIVE TISSUE)

RED CELLS
- carry oxygen and carbon dioxide
- biconcave disks

WHITE CELLS
- defense against invaders
- granules and lobed or indented nuclei

PLATELETS
- blood clotting
- anucleate
Gunther von Hagens' Body Worlds: The Anatomical Exhibition of Real Human Bodies

Obesity Revealed, 2005

Fat

Muscle
MUSCLE

- **FUNCTION:**
  GENERATION OF CONTRACTILE FORCE
Muscleman with his Skeleton, 1996

This plastinate shows the skeleton and the muscular system of one and the same body. When standing next to one another, the two systems can be compared with one another and be put back together again in the mind’s eye. Plastination has first made this whole body plastinate possible. The reason for this is that cured and hardened plastic (here: silicone rubber) lends the muscles the necessary rigidity and independent stability to stand up straight without supports. It is the first of its kind.
NERVOUS TISSUE

FUNCTIONS: SPECIALIZED FOR THE TRANSMISSION, RECEPTION, AND INTEGRATION OF ELECTRICAL IMPULSES
Man at Leisure, 2002

All major nerves are shown. The raised arms completely expose the nerves of the upper extremities. Some nerves of the autonomic nervous system can be seen in front of the vertebral column. They pass their signals to the abdominal organs, which have been removed in this specimen.
Where are these basic tissues located?

- EPITHELIUM
- CONNECTIVE TISSUE
- MUSCULAR TISSUE
- NERVOUS TISSUE

Epithelium
Where are these basic tissues located?

EPITHELIUM
CONNECTIVE TISSUE
MUSCULAR TISSUE
NERVOUS TISSUE
Where are these basic tissues located?

EPITHELium
CONNECTIVE TISSUE
MUSCULAR TISSUE
NERVOUS TISSUE

Muscular tissue
Where are these basic tissues located?

EPITHELIUM
CONNECTIVE TISSUE
MUSCULAR TISSUE
NERVOUS TISSUE

NERVOUS TISSUE
Let’s enjoy some images

192 Eye

242 Esophagus and trachea, monkey
http://viewer.serenusview.com/Viewer.aspx?SlideId=ae5864df-d2ae-4fc4-814b-8e5e9956c39f

220 Fetal finger
http://viewer.serenusview.com/Viewer.aspx?SlideId=ec150f61-6449-43c0-8a4b-a07c110d2573
LYMPHOID TISSUE

- FUNCTIONS: RESPONSIBLE FOR THE "IMMUNE RESPONSE" TO FOREIGN INVADERS WHICH IS MEDIATED BY EITHER ANTIBODY PRODUCED BY THE CELLS OR BY THE CELLS THEMSELVES
BLOOD VESSELS
not one of the four tissues

HISTOLOGICAL IDENTIFICATION:
All vessels are lined with endothelium

ARTERY – THICK WALL COMPOSED OF SMOOTH MUSCLE PLUS SOME CONNECTIVE TISSUE CAPILLARY – NARROW TUBE LINED WITH A SINGLE ENDOTHELIAL CELL

VEIN – LARGE LUMEN RELATIVE TO THICKNESS OF CONNECTIVE TISSUE AND SMOOTH MUSCLE WALL

LYMPHATIC – SMALL THIN WALLED VESSELS WHICH CARRY LYMPH
196 Human spermatic cord

http://viewer.serenusview.com/Viewer.aspx?SlideId=652c6183-a5df-4790-b78f-e3f56eef3145

126 Vein and bile duct

http://viewer.serenusview.com/Viewer.aspx?SlideId=8f70a9e4-ad7b-4542-830d-11beb6596ebf

272 Human uterus

http://viewer.serenusview.com/Viewer.aspx?SlideId=a4e2a33a-6005-4831-aeb7-9e85dc8e204e
MAGNIFICATION VS. RESOLUTION

1. MAGNIFICATION - INCREASE IN IMAGE SIZE
2. RESOLUTION - SMALLEST DISTANCE BETWEEN TWO POINTS THAT CAN BE SEEN (DISTINGUISHED)

CALCULATED BY

0.61 (WAVELENGTH)/NUMERICAL APERTURE

0.25 um FOR LIGHT MICROSCOPE
0.1 nm FOR ELECTRON MICROSCOPE
SAMPLE PREPARATION

1. FIXATION

2. EMBEDDING
   A. PARAFFIN
   B. PLASTIC

3. SECTIONING
   A. 0.5 μm FOR LIGHT MICROSCOPY
   B. 60-80 NM FOR ELECTRON MICROSCOPY

Table 1–2. Typical sequence of procedures in preparing tissues for observation under the light microscope. Following embedding in paraffin blocks, the tissues can be sectioned with a microtome (Fig 1–1).

<table>
<thead>
<tr>
<th>Stage</th>
<th>Purpose</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Fixation in simple or compound fixatives (Bouin’s fluid, Zenker’s formalin)</td>
<td>To preserve tissue morphology and molecular composition</td>
<td>About 12 h, according to the fixative and the size of the piece of tissue</td>
</tr>
<tr>
<td>2. Dehydration in graded concentrated ethyl alcohol (70% up to 100% alcohol)</td>
<td>To replace tissue water with organic solvents</td>
<td>6–24 h</td>
</tr>
<tr>
<td>3. Clearing in benzene, xylene, or toluene</td>
<td>To impregnate the tissues with a paraffin or a plastic resin solvent</td>
<td>1–6 h</td>
</tr>
<tr>
<td>4. Embedding in melted paraffin at 60 °C or plastic resin at room temperature</td>
<td>Paraffin or resin penetrates all intercellular spaces and even into the cells, making the tissues more resistant to sectioning</td>
<td>1–3 h</td>
</tr>
</tbody>
</table>
STAINING

1. LIGHT MICROSCOPY
   A. HEMATOXYLIN AND EOSIN (H&E)
   B. PERIODIC ACID/SCHIFF (PAS)
   C. TOLUIDINE BLUE

2. ELECTRON MICROSCOPY (TEM)
   A. OSMIUM
   B. LEAD CITRATE
STAINING

1. LIGHT MICROSCOPY
   A. HEMATOXYLIN AND EOSIN (H&E)
   B. PERIODIC ACID/SIIF (PAS)

Color provides clues

C. TOLUIDINE BLUE

Shape
Size
Intensity of staining
STAINING

1. LIGHT MICROSCOPY
   A. HEMATOXYLIN AND EOSIN (H&E)
   B. PERIODIC ACID/SHIFF (PAS)
   C. TOLUIDINE BLUE

2. ELECTRON MICROSCOPY (TEM)
   A. OSMIUM
   B. LEAD CITRATE
Fundic stomach (H&E)
Fundic stomach, monkey (PAS)
Surface mucus cells of Fundic stomach, rabbit (toluidine blue)
Dead stained cells

BRIGHT FIELD

Live unstained cells

PHASE CONTRAST

NOMARSKI
differential interference contrast

DARK FIELD
OTHER LIGHT AND ELECTRON MICROSCOPE PROCEDURES

• IMMUNOFLUORESCENCE
• AUTORADIOGRAPHY
• IN SITU HYBRIDIZATION
• FREEZE FRACTURE
  – (MEMBRANE ANALYSIS)

Figure 2–9. Actin fibrils composed of aggregates of actin filaments in the cytoplasm of a cultured human fibroblast preincubated in fluorescent actin antibody. × 1767. (Reproduced, with permission, from E. Lazarides: J Cell Biol 1975; 65:549.)
AUTORADIOGRAPHY
self radioactive
(A) FRACTURE
the 2 fracture faces of the outer membrane of the nuclear envelope

(B) ETCH
intramembrane particle
outer surface of plasma membrane and of membrane-bounded organelle revealed by etching

Typical TEM

Carbon replica TEM
How Did Cells Get Its Name?

- Cells in cork
- walled boxes that are similar to tiny rooms, or *cellula*, occupied by monks = "cell."

Cells in a plant
Cell in an animal
Cells Contain Organelles

Organelles in cells are like organs in animal/human bodies.
Cells Contain Organelles

- **Cell Membrane**: Acts as the cell’s gatekeeper
- **Nucleus**: Acts as the cell’s computer
- **Mitochondrion**: Acts as the cell’s power plant
- **Endoplasmic Reticulum**: Acts as the cell’s construction team
- **Golgi Apparatus**: Acts as the cell’s packing department
Cells Contain Organelles

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Marks limit of cells/environment.
Cells Contain Organelles

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Archive of cell’s DNA

**Nucleus**
Cells Contain Organelles

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Mitochondria

Produces ATP (cell energy)
Cells Contain Organelles

- **Cell Membrane**: Acts as the cell's gatekeeper.
- **Nucleus**: Acts as the cell's computer.
- **Mitochondrion**: Acts as the cell's power plant.
- **Endoplasmic Reticulum**: Acts as the cell's construction team.
- **Golgi Apparatus**: Acts as the cell's packing department.

**Endoplasmic Reticulum**: Produces proteins and hormones and detoxifies.
Cells Contain Organelles

Cell Membrane
Acts as the cell's gatekeeper

Nucleus
Acts as the cell's computer

Mitochondrion
Acts as the cell's power plant

Endoplasmic Reticulum
Acts as the cell's construction team

Golgi Apparatus
Acts as the cell's packing department

Modifies (adds sugar to) and packages proteins

Golgi Apparatus
• Double layer of phospholipids
  • controls the flow of water
  • marks outer limit of cell
  • separates cell from environment
- Has a double membrane
- Holds DNA
  - Involved in cell division
  - Involved in directing protein production by ribosomes
Eukaryotic cell has a nucleus
- Make energy for the cell
- Can be different shapes
- Has a double membrane
Animal Cell

Plant Cell

Has a double membrane

(A) PROPOSED EVOLUTIONARY PATHWAY FOR MITOCHONDRIA

procaryotic cell

ancient eucaryotic cell
- Membrane bound sac
  - Intracellular digestion
  - Release of cellular waste
  - Generally small in animal cells
Electron Microscope Image of a Pancreatic Cell
Animal Cell

- Part of cytoskeleton of the cell
  - Ring of nine groups of fused microtubules
  - Groups of three microtubules
  - Involved in cell division
- Plants do not have centrioles
Electron Microscope Image of an Animal Cell
• Contain enzymes necessary for intracellular digestion
  • In white blood cells, these lysozymes digest bacteria
  • Cause cell death if improperly released into cytoplasm
Electron Microscope Image of a Nerve
Electron Microscope Image of a Nerve Lysosome
CELL COMPOSITION

THREE MAJOR CLASSES OF CYTOPLASMIC STRUCTURE

1. **MEMBRANOUS ORGANELLES** - COMMON STRUCTURES, METABOLIC FUNCTION, CELL MEMBRANE, RER, SER, GOLGI, MITOCHONDRIA, LYSOSOMES

2. **NON-MEMBRANOUS ORGANELLES** – CYTOSKELETAL COMPONENTS, MICROTUBULES, MICROFILAMENTS, INTERMEDIATE FILAMENTS, FREE RIBOSOMES

3. **INCLUSIONS** - EXPENDABLES
   a. NUTRIENT e.g., GLYCOGEN, LIPID
   b. PIGMENT e.g., MELANIN GRANULES
   c. SECRETORY GRANULE e.g., ZYMOMGEN GRANULE OF PANCREAS
In summary

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Castle Rock Big Bend National Park TX
The end of

VIBS 289
Larry Johnson

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