INTRODUCTION

- The first pages illustrate introductory concepts for those new to microscopy as well as definitions of commonly used histology terms.

- The drawings of histology images were originally designed to complement the histology component of the first year Medical course run prior to 2004.

- They are sketches from selected slides used in class from the teaching slide set.

- These labelled diagrams should closely follow the current Science courses in histology, anatomy and embryology and complement the virtual microscopy used in the current Medical course.
Do all microscope slides show 2-D slices of 3-D structures?

No, slides can also be smears, where entire cells lie on the surface of the slide, or whole tissue mounts of very thin structures, such as mesentery.

Do microscope images of 2-D slices represent a single plane of section of a 3-D structure?

No, 2-D slices have a thickness which can vary from a sliver of one cell to several cells deep. With the limited depth of field of high power lenses it is possible to focus through the various levels within a slice.

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LININGS, COVERINGS & TERMINOLOGY

KEY
- epithelium
- connective tissue beneath epithelium
- connective tissue, muscle, glands, etc

GENERALISED SECTION OF THE BODY

SKIN
Covers the external surface.

epidermis
(keratinised stratified squamous epithelium)
ORIGIN: ectoderm

MUCOSA or MUCOUS MEMBRANE
has a wet surface (mucus).
Lines organs that open to the outside.

ORIGIN: endoderm or mesoderm

MESOTHELIUM
(simple squamous epithelium)
ORIGIN: mesoderm

SEROSA or SEROUS MEMBRANE
has a wet surface (watery).
Lines body cavities.
Covers organs in body cavities.

ORIGIN: endoderm or mesoderm

ADVENTITIA
Connective tissue of one structure meets connective tissue of another structure.

lamina propria
lining epithelium
ORIGIN: endoderm or mesoderm

blood vessel lined by endothelium
(simple squamous epithelium)
ORIGIN: mesoderm

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COVERING AND LINING EPITHELIA

STRATIFIED EPITHELIA

**Tissue / Organ:**
- Bladder (relaxed)
- Bladder (stretched)
- Oesophagus
- Skin (epidermis)

**Epithelium:**
- Transitional
- Non-keratinised stratified squamous
- Keratinised stratified squamous
- Keratinised
- Keratinised stratified squamous

**Strata:**
- Corneum
- Granulosum
- Spinosum
- Germinativum
- Lamina propria
- Mitotic figure
- Squames
- Squamous
- Spinosum
- Germinativum
- Dermis
- Mitotic figure
- Vacuoles (folded plasma membrane)
- Binucleate cell
- Adluminal or facet cell

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SIMPLE EPITHELIA

**EPITHELIUM:**
- simple cuboidal

**TISSUE / ORGAN:**
- thyroid

**EPITHELIUM:**
- simple squamous

**TISSUES / ORGANS:**
1. endothelium lining blood vessel
2. mesothelium of serosa covering lung

**EPITHELIUM:**
- simple columnar or pseudostratified columnar

**TISSUE / ORGAN:**
- seminal vesicle (ox)

**EPITHELIUM:**
- pseudostratified columnar (respiratory epithelium)

**MORE FULLY:** pseudostratified ciliated columnar epithelium with goblet cells

**TISSUE / ORGAN:**
- trachea

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**FEATURE:** sebaceous gland
**TISSUE / ORGAN:** around hair follicle in dermis of skin

**FEATURE:** eccrine sweat gland
**TISSUE / ORGAN:** dermis of skin (also in hypodermis)

**FEATURE:** duct and secretory portions, myoepithelial cells
**TISSUE / ORGAN:** eccrine sweat gland

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Are myoepithelial cells only present around sweat glands and what is their function?

*They are found around the secretory acini and some ducts of many glands. They contract under autonomic nervous control to expel the glandular secretions.*
**FEATURE:** lobe, lobules and ducts  
**TISSUE / ORGAN:** compound tubulo-alveolar (tubulo-acinar) gland

- interlobular duct = excretory duct [drains the lobes of a gland]
- interlobular duct = intralobular duct [drains many lobules in a lobe]
- intralobular duct (e.g. striated duct) [drains many acini in a lobule]
- intercalated duct [drains each acinus]

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**FEATURE:** lobe, lobules and ducts (TS)  
**TISSUE / ORGAN:** part of a lobe of salivary gland

- mucous secretory tube
- intercalated ducts
- small lumen
- serous demilune

**mucous acinus**  
Wedge-shaped cells filled with pale staining remnant of mucous secretion and flattened basal nuclei

**serous acinus**  
Wedge-shaped cells packed with zymogen granules and round nucleus

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**FEATURE:** serous and mucous acini and ducts  
**TISSUE / ORGAN:** submandibular salivary gland

- Do all compound glands have striated ducts?

*No, they all have intralobular ducts but these have a characteristic appearance in the salivary gland and so have a different name.*
CONNECTIVE TISSUE

DENSE CONNECTIVE TISSUE

CLASSIFICATION: dense regular connective tissue (showing crimp pattern)
TISSUE / ORGAN: tendon or ligament fascicle

What is the difference between this specimen and the one before?

It is stained to show elastic fibres. These were always present but not seen without the special stain.

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SPECIFIC TISSUES & FIBRES

CLASSIFICATION: brown and white adipose tissue
TISSUE / ORGAN: fat stored in body

brown fat cell (brown adipocyte)
centrally located round nucleus
lipid droplet (one of many -- multilocular)
collagenous septum separating fat lobules
fibroblast nucleus
white fat cell (white adipocyte)
flattened nucleus
single large lipid droplet (unilocular)
blood vessel

CLASSIFICATION: reticular fibres
TISSUE / ORGAN: lymph node

capsule with collagen and reticular fibres
reticular fibre
collagen fibre
macrophage
mast cell
fibroblast nucleus

CLASSIFICATION: elastic fibres
TISSUE / ORGAN: elastic artery (brachial artery)

colagen fibre
myofibroblast
collagen fibre
elastic fibres
endothelium
lymphocyte
fenestration
crenated elastic fibre (TS)
collagen fibre
elastic fibre (TS)

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**FEATURE:** blood cell types
**TISSUE / ORGAN:** peripheral blood

**ERYTHROCYTE**
- biconcave disc with pale centre
- rouleaux formation
- stack of erythrocytes

**SMALL LYMPHOCYTE**
- with a large, round nucleus and blue cytoplasmic rim

**MONONUCLEAR LEUKOCYTES or AGRANULOCYTES**

**NEUTROPHIL**
- with multi-lobed nucleus and many small granules

**EOSINOPHIL**
- with bi-lobed nucleus and many large red granules of similar size

**BASOPHIL**
- with many blue granules of different size that obscure the nucleus

**MONOCYTE**
- with a single nucleus that may be irregular or bean shaped and blue cytoplasm which may have tiny granules or vacuoles
- Indentation of the nucleus (monocyte or lymphocyte) is caused by proximity to the Golgi apparatus.

**MONONUCLEAR LEUKOCYTES or AGRANULOCYTES**

**PLATELETS**
- cytoplasmic fragments with a dark chromomere and pale hyalomere

**POLYMPHONUCLEAR LEUKOCYTES or GRANULOCYTES**

**FEATURE:** tissue eosinophil (and plasma cells)
**TISSUE / ORGAN:** lamina propria of glands of stomach mucosa

**FEATURE:** plasma cell
**TISSUE / ORGAN:** lamina propria of salivary gland secretory acini

**BLOOD CELLS (SMEAR)**

**BLOOD-RELATED CELLS (SECTION)**

**MONONUCLEAR LEUKOCYTES or AGRANULOCYTES**

**MONONUCLEAR LEUKOCYTES or AGRANULOCYTES**

**FEATURE:** megakaryocyte
**TISSUE / ORGAN:** bone marrow

**FEATURE:** osteoclast
**TISSUE / ORGAN:** bone trabecula

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CARTILAGE AND BONE

FEATURE: hyaline cartilage
TISSUE / ORGAN: trachea

attachment side

FEATURE: elastic cartilage
TISSUE / ORGAN: pinna of ear

external ear side
COMPACT BONE

FEATURE: Haversian systems (= osteons) with lamellae (TS)
TISSUE / ORGAN: diaphysis (shaft) of femur

FEATURE: Haversian systems (= osteons) with lamellae (LS)
TISSUE / ORGAN: diaphysis of femur
BONE / MUSCLE FORMATION & JOINTS

INTRAMEMBRANOUS OSSIFICATION

FEATURE: intramembranous ossification examples

TISSUE / ORGAN:
1. dura mater and calvaria
2. Meckel’s cartilage and mandible

STRIATED MUSCLE DEVELOPMENT

FEATURE: myoblasts and myotubes (developing striated muscle cells)

TISSUE / ORGAN: fetal tongue

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**ENDOCHONDRAL OSSIFICATION**

**FEATURE:** stages in long bone development  
**TISSUE / ORGAN:** fetal rat tail

**TISSUE / ORGAN:** intervertebral disc  
endochondral ossification  
marrow cavity

**JOINTS**

**DISTAL**  
hyaline cartilage  
"model" of bone

collar of intramembranous bone in perichondrium  
swelling, dying chondrocytes  
ingrowth of blood vessels, marrow cells and periosteal osteoprogenitor cells

**PROXIMAL**  
fibrous periosteum  
cellular periosteum with osteoprogenitor cells

**FEATURE:** developing symphysis joint  
**TISSUE / ORGAN:** intervertebral disc

**JOINTS**

nucleus pulposus  
annulus fibrosus  
collagen fibres and matrix

chondrocytes and cartilage matrix  
trabecula  
marrow cell  
forming Haversian canal  
marrow

**FEATUE:** bone growth and remodelling  
**TISSUE / ORGAN:** periosteal collar of vertebra

**ENDOCHONDRAL OSSIFICATION**

**ZONES**  
resting chondrocytes  
proliferating chondrocytes  
chondrocyte hypertrophy  
calcifying matrix  
resorption

perichondrial-lined perforating channels with blood vessels (cartilage canals)  
perichondrium  
perioSteum  
aponeurosis  
tendon or striated muscle

articular cartilage  
synovial cavity  
articulating surface  
hyaline cartilage  
articular disc

bone trabeculae  
blood vessels  
bone growth

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Why is there a large variation in smooth muscle nuclei (TS) from absent to small to large? The cells are so long that sections cut the ovoid nucleus from centre to edge or even miss it.
CLASSIFICATION: single smooth muscle cells
TISSUE / ORGAN: intestinal villus

CLASSIFICATION: cardiac muscle fascicles
TISSUE / ORGAN: heart (interventricular septum)
**NERVOUS TISSUE**

**CENTRAL NERVOUS SYSTEM (CNS)**

- **dura mater**
- **arachnoid**
- **pia mater**
- **septum of pia mater**
- **grey matter**
- **white matter**
- **dorsal nerve rootlet**
- **small neuron of dorsal horn**
- **ependymal cells around central canal**
- **motor neuron of ventral horn**
- **myelin sheath**
- **Nodes of Ranvier**
- **paranodal swelling**
- **node of Ranvier**
- **axon hillock**
- **Nissl granules**
- **ventral nerve rootlet**

**FEATURE:** white matter and cells of grey matter  
**TISSUE / ORGAN:** spinal cord and meninges

**PERIPHERAL NERVOUS SYSTEM (PNS)**

- **endoneurium**
- **perineurium**
- **epineurium**
- **blood vessel (vasa nervorum)**
- **myelinated nerve fibre**
- **Schmidt-Lanternman cleft**
- **myelin sheath**
- **axon hillock**
- **axon**
- **dendrite**

**FEATURE:** myelin sheath  
**TISSUE / ORGAN:** peripheral nerve (TS)

**FEATURE:** Nodes of Ranvier  
**TISSUE / ORGAN:** peripheral nerve (LS)
**FEATURE:** Schwann cells
**TISSUE / ORGAN:** sciatic nerve

**FEATURE:** pseudounipolar neurons and myelin
**TISSUE / ORGAN:** trigeminal sensory ganglion

**FEATURE:** peripheral nerve fascicles
**TISSUE / ORGAN:** connective tissue (tongue)
FETAL MEMBRANES

PLACENTA

FEATURE: chorionic plate, villi, uterine wall
TISSUE / ORGAN: placenta (3 months)

UMBILICAL CORD

FEATURE: vessels and Wharton’s jelly
TISSUE / ORGAN: umbilical cord (TS)

Warton’s jelly is an artefact of “dead” umbilical cord. What should “living” cord look like and why is this different?

Before birth the cord has three large vessels and very little connective tissue. After birth the blood flow stops and without blood pressure the vessels collapse. The connective tissue swells with fluid that leaks from the vessels.