1 Introduction to Vertebrates

Some **3.5 billion years ago** the beginning of life on Earth emerged when a sequence of reactions reached a climax to a molecule that could double. From 488 to 542 million years ago multicellular organisms began to explode in a period called the **Cambrian Period** which is the earliest of the **Paleozoic ("ancient life") Era,** a remarkably important era. With time through the increasing ecological complication, striking geological and climatic conditions of this era is what made the evolution of vertebrate species possible. From this commencement an immense variety of living organisms come forward; viruses, bacteria, fungi, protozoans, plants, and animals, from microscopic to macroscopic, and unicellular to multicellular. It is one of the most astonishing phenomena on earth studying the diversity of life and observing evidence that illustrate the ability of such organisms to adapt to seemingly countless environmental conditions. Life on Earth as we know it is truly breathtaking and yet with many more of it to discover. From new species, new drugs , novel systems and simply the way life progresses, should be discovered and better understood in order to take what we learn and process it in our intellectual way making life more efficient and exploit the resources around us in a more convenient way.

All forms of life are classified into major groups according to **a binomial nomenclature** further explained in the following chapters. In the kingdom Animalia, its members possess skeletal, muscular, digestive, respiratory, nervous, and reproductive systems. In this course you will be studying a group from kingdom **Animalia** which consists of **multicellular** animals that possess a combination of morphological characteristics, where these characteristics are not restricted to be present throughout the organism's life yet may show display during a certain stage of their life time.

This group of animals forms the phylum **Chordata** which will be further discussed in the coming chapters.

Histology: Animal Tissues 2

Before getting into the details of the phylum we shall begin our first chapter with the material required to build the most complex organs and systems forming diversely complex organisms.

In the study of **histology** it is a field that deals with the study of tissues their structures and their functions. Defining **tissues** they are a collection of similar cells with a characteristic organization and serving the same general function, which is part of an organism consisting of an aggregate of cells having a similar structure and function.

Tissues are divided into the following **four** types;

Epithelial tissue, Connective tissue, Muscular tissue and Nervous tissue.

1. Epithelial tissue:

- Made of **closely-packed** cells arranged in flat sheets.
- Have an **apical surface** and a lower attached **basal surface**.
- **Avascular** and **innervated**
- Epithelia form the surface of the skin, line the surfaces, both internal and external of various cavities and tubes of the body, and cover the internal organs.
- **Function:** protection, secretion, absorption, filtration.

Epithelial tissue are classified according to shape and number of layers.

- Classification by layer of cells is either **simple** (one layer of cells) or **stratified** (more than one layer of cells) as shown in figure 1.1.

- Classification by shape is either:

    a) **Squamous**: Flattened, plate-like cells, lining of blood vessels, peritoneum and epidermis.

    b) **Cuboidal**: is common in the lining of many glands, as in the lining of kidney tubules, or in the thyroid gland.

    c) **Columnar**: found in the lining of digestive tract, mucous membranes, excretory ducts and trachea. Cells are elongated, ciliated and may produce mucus. Also shown in Figure 1.1.

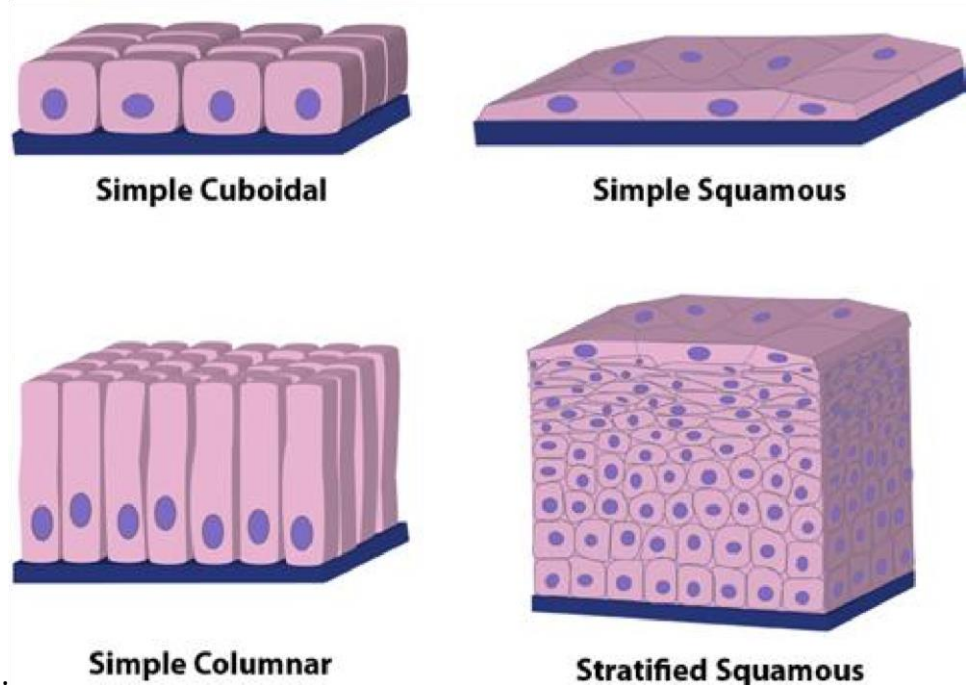


Figure 2.1 Different types of epithelial tissue.

2. Connective Tissue

- Consist of dispersed cells that are embedded in a **matrix** (extracellular material that is secreted by the cells **fibroblasts**).
- It consists of protein fibers embedded in an amorphous mixture of protein-polysaccharide ("proteoglycan") molecules.
- **Vascularized** (one exception is cartilage).
- They are generally classified into three large groups:

Table 2.1 Classification of connective tissues and types

General Classification	Further Classification	Name of tissue
Fluid Connective Tissues		Lymph
		Blood
Connective Tissues Proper	Loose Connective	Areolar
		Adipose
		Reticular
	Dense Connective	Collagen Regular Fiber
		Collagen Irregular Fiber
		Elastic Fiber
Supportive Connective Tissues	Bone	Compact
		Cancellous
	Cartilage	Hyaline
		Elastic
		Fibrocartilage

- The different types of tissues are further described in the coming pages followed by figures for the types that will also be seen in the lab.

A) Fluid Connective Tissues:

- The connective tissues blood and lymph are tissues contain a distinctive collection of cells in a liquid matrix.
- **Blood** being composed of red blood cells, platelets and white blood cells in a matrix of plasma.
- **Lymph** being composed largely of lymphocytes in a special fluid and is largely responsible for the immune system.

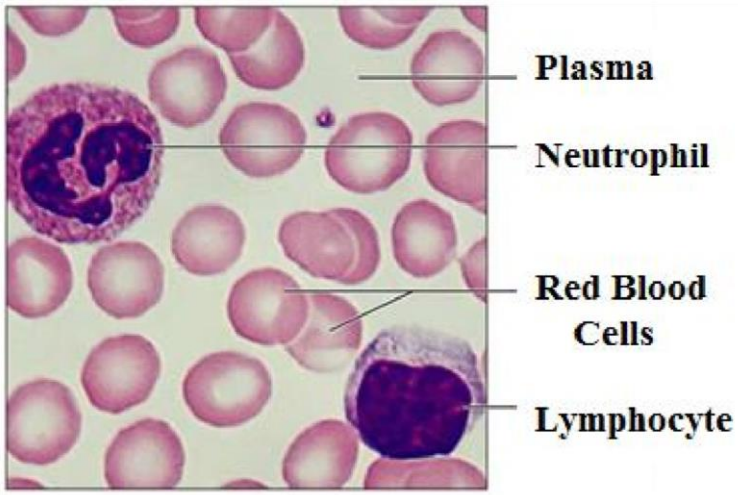


Figure 2.2 A photomicrograph of human blood smear

B) Connective Tissues Proper

- Possess visible protein fibers embedded in a fluid ground substance
- Type, abundance, and orientation of protein fibers determine the kind of connective tissue proper.
- The forming and mature cells of connective tissue proper are called **fibroblasts** or **fibrocytes** respectively.

a) Areolar tissue:

- underlying connective tissue to most epithelia
- forms much of the mesentery supporting organs within the abdominal cavity.
- supportive material for blood vessels and nerves

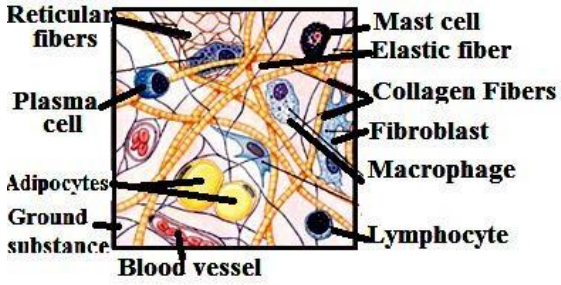


Figure 2.3 A diagram of areolar tissue

b) Adipose tissue

- Contains fat droplets that enlarge to push nuclei and cytoplasm to the **periphery**.
- Mature fat cells are called **adipocytes**

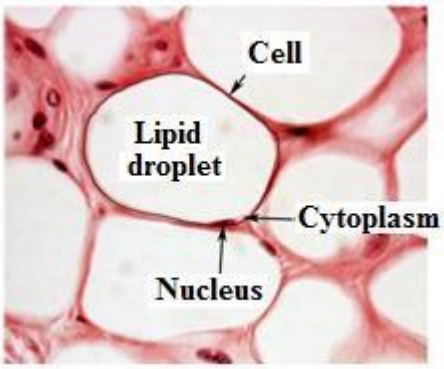


Figure 2.4 A photomicrograph of adipose tissue

c) Reticular Tissue

- Present as the supportive tissue of lymph nodes, glands, organs, and bone marrow

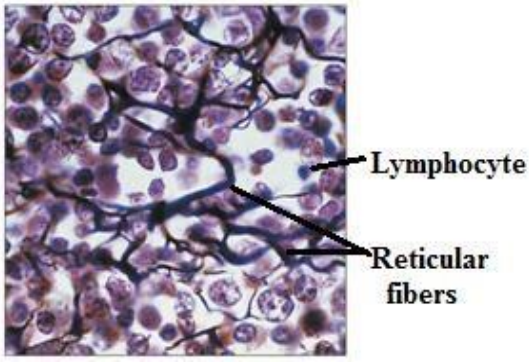


Figure 25 A photomicrograph of reticular tissue

d) Collagen Fibrous Tissue

- Include most tendons, ligaments
- **Tendons** connect muscle to bone. The matrix is principally collagen, and the fibers are all oriented parallel to each other. Tendons are strong but not elastic.
- **Ligaments** attach one bone to another. They contain both collagen and also the protein **elastin**.

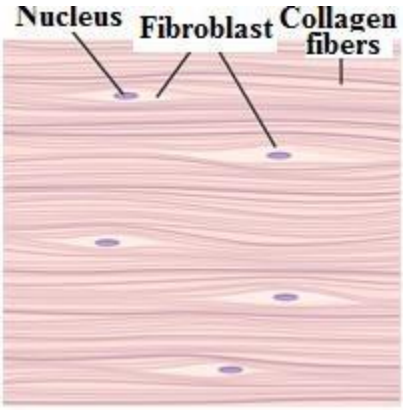


Figure 2.6 A diagram of collagen fibrous tissue

e) Compact Bone Tissue

- The **osteons** or **Haversian systems** of compact bone are what determine the strength
- Mature bone cells are called **osteocytes**

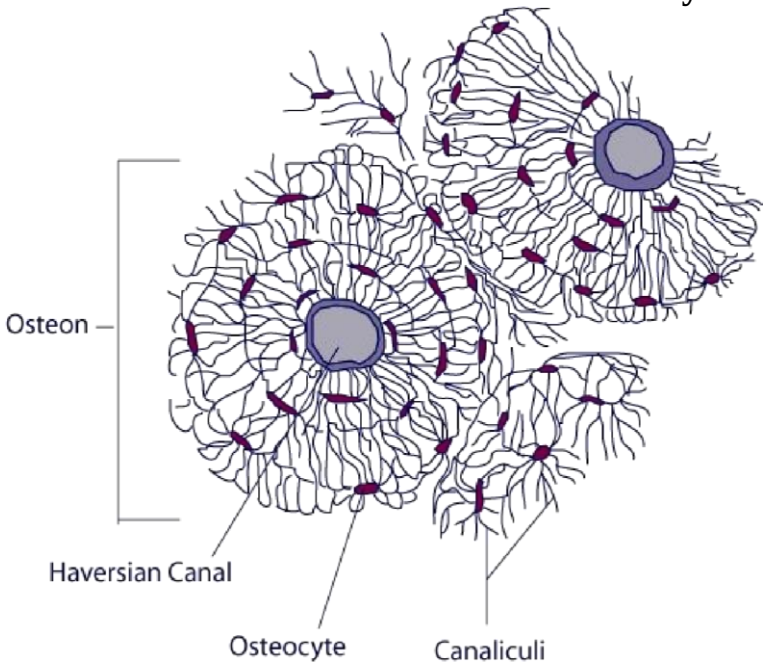


Figure 2.7 A Diagram of the cross section of compact bone tissue

f) Spongy Bone tissue

- Only found in compact bone
- Haversian Systems or Osteons are absent

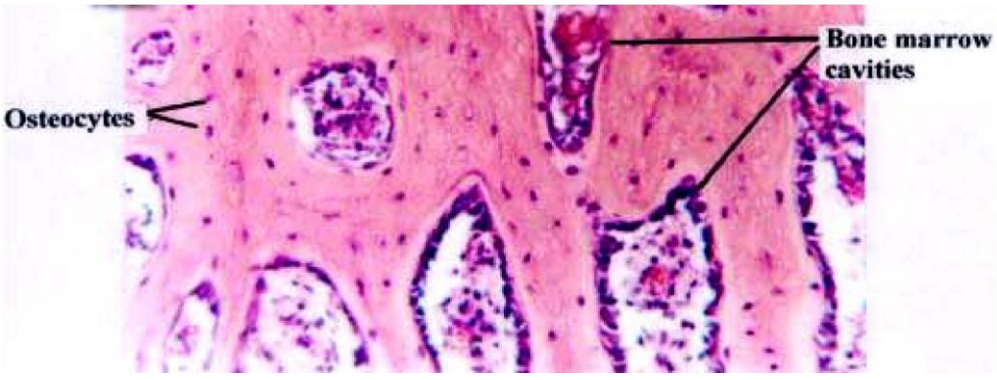


Figure 2.8 Photomicrograph of the cross section of a spongy bone tissue.

g) Hyaline Cartilage Tissue

- Most abundant type,
- Found in the nose, ears, trachea, larynx, and smaller respiratory tubes.
- Mature cartilage cells are called **chondrocytes** which are found inside a space called the **lacuna**.

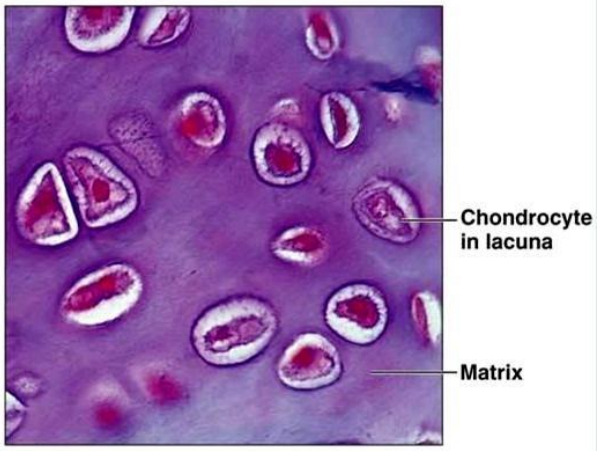
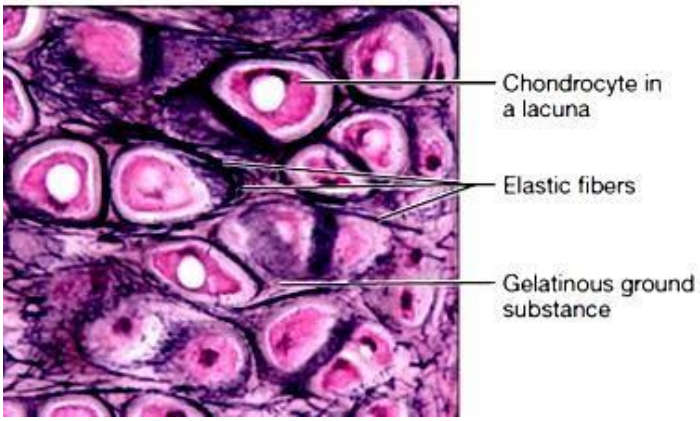


Figure 2.9: A photomicrograph of Hyaline



cartilage tissue.

h) Elastic Cartilage Tissue

- Elastic fibers embedded in matrix which differentiates it from hyaline cartilage.
- Found in epiglottis, and ear lobes

Figure 2.10: A Photomicrograph of elastic cartilage tissue

i) Fibrocartilage Tissue

- Intervertebral dics and discs of knee joints are of this type

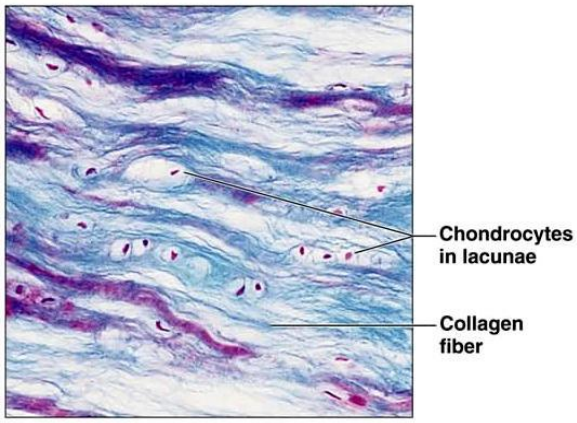


Figure 2.11: A Photomicrograph of elastic cartilage tissue

3. Muscular Tissue:

- Composed of microfilament of actin and myosin, which are contractile proteins
- Functions are: support and movement, propulsion of blood through vessels, movement of food or body secretions through tracts, thermoregulation.

Three kinds of muscle are found in vertebrates:

a) **Skeletal muscle (Striated muscle)**

- is made of long cylindrical fibers whose contraction provides the force of locomotion and other **voluntary** body movements.
- Striated (stripe-like pattern)

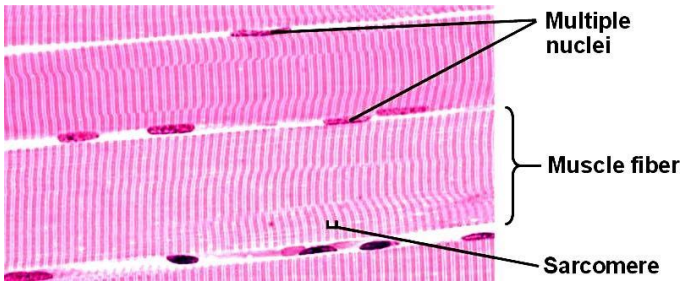


Figure 2.12: A photomicrograph of skeletal muscle tissue

- Multinucleated

b) **Smooth muscle**

- lines the walls of the hollow structures of the body, such as the intestine, urinary bladder, uterus, and blood vessels. Its contraction, which is **involuntary**.

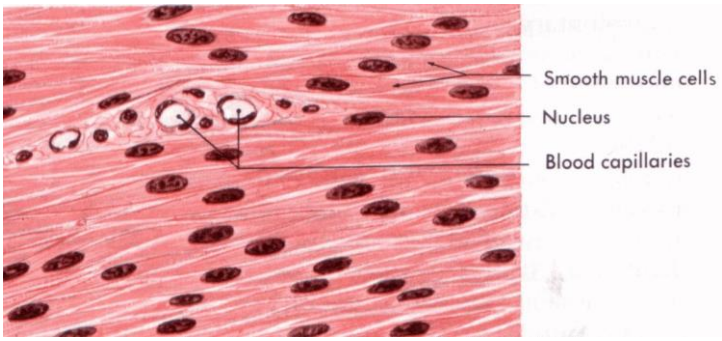


Figure 2.13: A diagram of skeletal muscle tissue

- One nucleus in each spindle- shaped cell.

c) **Cardiac muscle**

- Found only in the heart
- Under involuntary control
- Cells are attached to other cardiac muscle cells at **intercalated disks**
- **Striated**
- One nucleus per cell
- Branched fibers

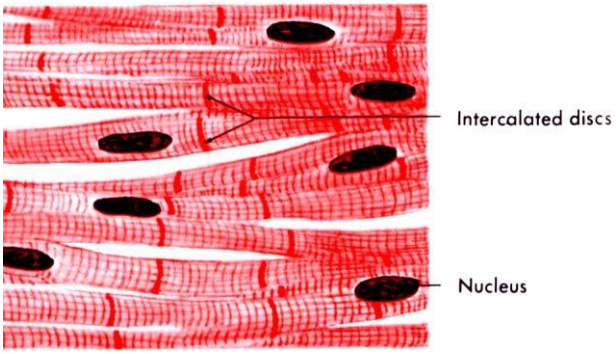


Figure 2.14: A diagram of cardiac muscle

4) Nervous Tissue

- Structural units are cells called neurons.
- Nervous tissue also contains **glial cells**, which are the various types of supporting cells in the nervous system.

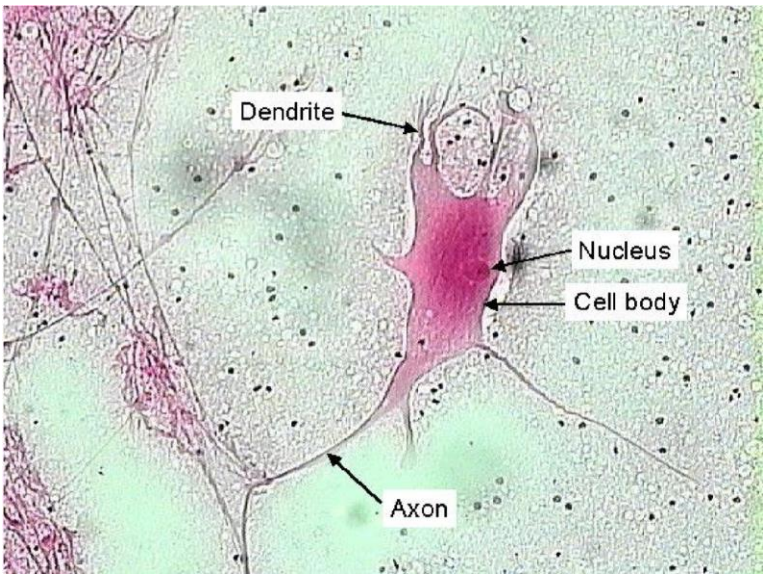


Figure 2.15: A photomicrograph of a neuron

Lab Work

- You should be able to identify each of the tissues relating form to function.
- Your instructor or TA will provide you with a sheet where you are to draw the assigned tissues.
- Make sure you write the type and name of the tissues indicating their magnification and labeled properly.