م.م.زينب وضاح قسم تقنيات البصريات

علم الاحياء

Lec 4

What Is Body Tissue?

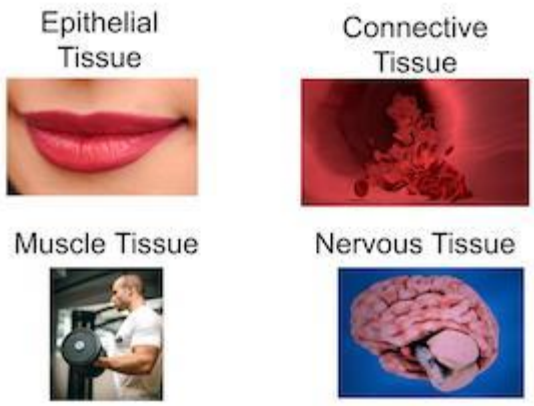
Body tissue is an intermediate level of organization of cells in multicellular organisms. In a tissue, cells from the same origin as well as extracellular matrix components work together to carry out a specific function in the body. Tissues are organized from cells, and further organize to create the additional levels of organization in the body, as shown in the table below.

Level of Organization	**Description**	**Example**
Cells	Basic units of life	Cardiomyocyte
Tissues	Cells from the same origin and extracellular matrix	Muscle tissue
Organs	Collections of tissues that perform a job in the body	Heart
Organ System	Collection of cells, tissues, and organs that work together to perform a function	Cardiovascular system
Organism	An entire multicellular living thing	Human

Types of Tissue in the Body

There are four main types of tissue in the body:

- Epithelial tissue
- Connective tissue
- Muscle tissue
- Nervous tissue



Tissues of the human body

Epithelial Tissue

Epithelial tissue is a body tissue made of cells connected together in sheets that form barriers within the body. Epithelial tissue can be found lining the entire body in the skin, covering all organs and lining the internal cavity of hollow organs. Epithelial tissue is specialized for functions including:

- Absorbing molecules
- Secreting molecules, such as hormones, oil or sweat

- Protecting the inner layers of the body
- Separating tissues and organs within the body
- Detecting and regulating sensations

Epithelial cells are polarized, meaning they have structurally and functionally different sides. The apical side is the side facing the outside of the organism, or the inside of a hollow organ. This side of the tissue is specialized for secretion or absorption if that is part of the function of the organ. The basal side of the tissue faces the internal organs. The lateral sides of the cells connect to other epithelial cells with cell junctions, allowing the tissue to be tightly connected and form a barrier for the organism.

Epithelial cells can be specialized for their function. For example, the epithelial tissue lining the small intestine is specialized for absorbing nutrients. The apical side contains protein channels and pumps that move nutrients into the cell. The basal side has a different selection of proteins that help these nutrients continue movement into the blood. The lateral sides are tightly connected to prevent nutrients from escaping into the interstitial fluid.

Epithelial tissue has different structures and shapes depending on its function. The different cellular structures of epithelial tissue include:

- Cuboidal - Cells are shaped like small cubes
- Columnar - Cells are shaped like tall columns
- Squamous - Cells are flattened

The different structures that these cell types can form include:

- Simple - Cells are arranged in a single flat layer
- Stratified - Cells are arranged in multiple layers

- Pseudostratified - Cells are a single layer but may be thicker or thinner to give the appearance of multiple layers.

Different combinations of cellular shapes and structures perform different functions in the body. The following table gives examples of different combinations and their function.

Shape and Structure	**Location**	**Function**
Simple squamous	Alveoli in the lungs, capillaries	Allows for simple diffusion of molecules
Simple cuboidal	Tubules in the kidneys, ducts and glands	Secretion and absorption
Simple columnar epithelium	Ciliated tissues like the bronchi	Secretion of mucus, protection
Pseudostratified columnar epithelium	Ciliated tissues in the upper respiratory tract	Secretes mucus, protects the tissue
Stratified squamous epithelium	Lines tissues like the mouth or vagina	Protects inner tissues
Stratified cuboidal epithelium	Glands like sweat glands and mammary glands	Secretes fluids, protects inner tissues
Stratified columnar epithelium	Male urethra, conjunctiva	Protection, secretion
Transitional epithelium	Lining of the bladder, urethra and ureters	Allows for stretch and protects tissues underneath

Epithelial tissue is formed in the embryo from all three germ layers. During fertilization, after the zygote is formed, it divides and forms a hollow ball of cells called a blastula. The blastula continues cell division and folds in on itself to form three distinct tissue layers, ectoderm, mesoderm and endoderm. Epithelial tissue is formed from all three of these germ layers.

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Connective Tissue

Connective tissue is a type of body tissue that binds organs and body parts together. Connective tissue is the most abundant tissue in the body and is widespread throughout the entire body. There are three main types of fibers that make up connective tissue:

- Collagen - Fibrous connective tissue that gives structure and strength to the extracellular matrix
- Reticular - Short connective tissue that branches
- Loose - Connective tissue that holds organs and other tissues in place

Connective tissues serve many important functions in the body, including:

- Supporting organs and holding them in place
- Transporting materials
- Storing energy reserves
- Insulating the body and maintaining temperature homeostasis
- Protecting underlying organs and tissues

There are four main classifications of connective tissue:

- Connective proper

- Bone
- Blood
- Cartilage

These types are specialized connective tissue and each has a unique function in the body.

Connective proper tissue can be further divided into dense connective tissue and loose connective tissue. Examples of the different classifications of connective tissue are explained in the table below.

Classification	**Example**	**Location**	**Function**
Connective Proper	Areolar Connective Tissue	All over the body	Packing material between other tissues and organs, protection
Connective Proper	Adipose Tissue or Body Fat	All over the body	Insulates the body, protection, thermoregulation
Connective Proper	Reticular Connective Tissue	Lymph nodes, spleen, bone marrow	Support and protection
Connective Proper	Dense Regular Connective Tissue	Tendons, ligaments, fascia	Supports and binds other tissue together

Connective Proper	Dense Irregular Tissue	Skin dermis and joint capsules	Regulates multidirectional stress and stretch
Connective Proper	Elastic Connective Tissue	Arterial blood vessels, bronchiole tubes	Regulates stretch
Bone	Compact bone tissue	Outer bone	Protects, offers structure and support
Bone	Trabecular bone tissue	Inner bone	Produces blood cells, allows bone to be lightweight
Blood	Blood	Within blood vessels	Specialized connective tissue that transports materials
Cartilage	Elastic Cartilage	External ear, epiglottis	Allows for flexible support
Cartilage	Hyaline Cartilage	Embryonic skeleton, ribs, nose, trachea, larynx	Shock absorption
Cartilage	Fibrocartilage	Vertebral discs, knees	Cushioning and withstanding pressure

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Muscle Tissue

Muscle tissue is a body tissue derived from the mesoderm that facilitates contraction in the body. All types of muscle tissue exhibit excitability, meaning they can transmit electricity, which allows for coordinated contraction in muscular organs.

Muscle tissue serves several functions in the body including:

- Digestion
- Reproduction
- Movement
- Structure and support

Muscle

Muscle allows for contraction and movement of tissues and organs. To accomplish this task, muscle tissue has actin filaments and myosin. There are two general types of muscle tissue:

- **Striated**: this type of muscle has a regular arrangement of actin and myosin. It is found in skeletal muscle and cardiac muscle.

- **Non-striated**: this muscle has an irregular arrangement of actin and myosin and is found in smooth muscle.

Striated muscle tissue is broken down further to skeletal muscle (can be whole muscle tissue or part of an organ) and cardiac muscle (the muscle that forms the heart). Collectively, the three types of muscle tissue regulate:

- Locomotion, including very complex movements, such as gymnastic moves, hurdling, pole vaulting, etc.
- Movement of organs, such as peristalsis (rhythmic) contractions of the gastrointestinal system that propel the food down the tract
- Pumping of blood as occurs in cardiac muscle within the heart

Nervous Tissue

Nervous tissue acts as the puppeteer to regulate muscle and glandular tissue. Such responses include breathing, coordination of locomotion, heart rate, blood vessel luminal size, peristalsis, urination, pupillary size, and other autonomic and non-autonomic responses. Nervous tissues perceive, transmit, and respond to external stimuli, such as if the lighting in the room is too bright, the retina in the eyes will perceive this light and transmit this information as an electrical charge (action potential) to the brain. The appropriate brain region will result in one to blink or close their eyes in response to the bright light. Nervous tissue thus includes a sensory and motor component. Nervous tissue is divided into:

- The central nervous system (CNS) - it includes the brain and spinal cord
- The peripheral nervous system (PNS) - it includes ganglia, myelinated nerve fibers (axons), and unmyelinated nerve fibers.

Some responses will be autonomic, indicating that they are done without voluntary control, such as breathing, pumping of the heart, movement of the gastrointestinal system, etc. This is a great benefit as this limits the amount of thought and work that would be required if we had to think about each of these vital processes.

Other responses are non-autonomous, such as general locomotion, movement associated with playing various sports, such as basketball, football, gymnastics, etc.

Embryonic Germ Layers

Three embryonic germ layers give rise to these basic types of tissue:

- Ectoderm
- Mesoderm
- Endoderm

Ectoderm

Ectoderm indicates the outermost germ layer, and it will give rise to certain epithelial tissues, such as:

- Epidermis of the skin
- Lips
- Oral cavity
- Nostrils
- Sweat and sebaceous glands
- Mammary glands
- Hair
- Nails

- Cells that produce the enamel of teeth
- Anterior pituitary gland
- Anus

Almost all cells of the nervous system are derived from ectoderm, except for microglial cells that are a type of macrophage. Neural tissues and cells derived from ectoderm include:

- Neurons in the CNS and PNS
- Glial cells (other than microglial cells) of the CNS and PNS
- Brain and spinal cord

Mesoderm

Mesoderm indicates the middle germ layer, and it will give rise to **mesenchymal cells**. These cells serve as a precursor for:

- Endothelium
- mesothelium
- Connective tissue cells
- Hematopoietic cells that give rise to red blood cells, white blood cells, and platelets
- Muscle cells (fibers)

Both endothelium and mesothelium are types of epithelial cells. Other organs derived from the mesoderm include the kidney and adrenal cortex that produces various steroid hormones, including mineralocorticoids (aldosterone), glucocorticoids (cortisol), and sex steroids.

Endoderm indicates the innermost layer, and it will give rise to epithelial tissue, such as the innermost lining of the gastrointestinal system, as well as:

- Thyroid follicular cells
- Pancreas cells
- Parathyroid chief cells
- Alveolar cells
- Lining of the trachea and bronchi
- Epithelium lining the auditory tube and tympanic cavity
- Lining of the urinary bladder and portion of the urethra

Based on the above, one of the key points is that epithelium can be derived from all three germ layers.

Tissue Membranes

Tissue membranes line the outermost regions of the body, internal body cavities, joints, and innermost portion of organs.