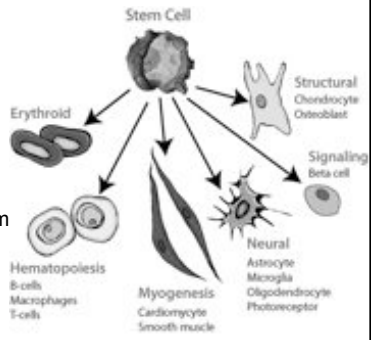
Topics

- Development and Differentiation
- Tissues
  - Epithelial
  - Connective
  - Muscle
  - Neural

4 key processes of development

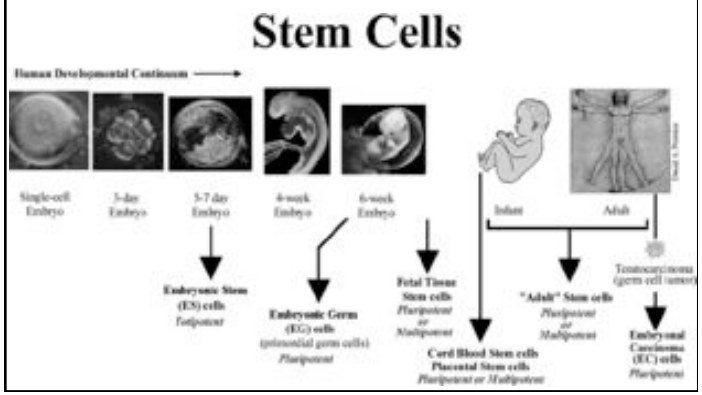
1) **Determination-** sets the developmental fate of a cell, even before the phenotype is visible

2) **Differentiation**- the process by which different cell types arise from less specialized cells



When is cell fate determined? Is it irreversible?

Cell differentiation **is not truly** irreversible.
Under the right conditions a determined cell can become undetermined.



Types of stem cells:

Totipotent- the ability of a single cell to divide and produce all the differentiated cells in an organism. The most versatile.

Pluripotent/Multipotent- the ability of a single cell to divide and differentiate into many cell types. Cannot give rise to an entire organism instead become a limited range of cells within a tissue.

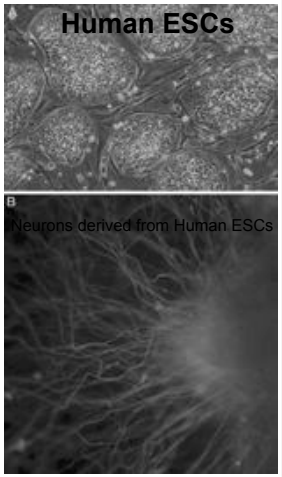
Adult- is a stem cell in adult humans that is used to replace cells that have died or lost function.

Stem Cells are extraordinary

- Can divide and make identical copies of themselves over and over again
- (Self-Renewal)

- Can remain unspecialized with no 'specific' function or become . . . .

- Specialized (Differentiated) w/ the potential to produce over 300 different types of cells



Diseases currently treated with stem cells:

Parkinson's Disease
Leukemia (Bone Marrow Transplants)
Skin Grafts resulting from severe burns

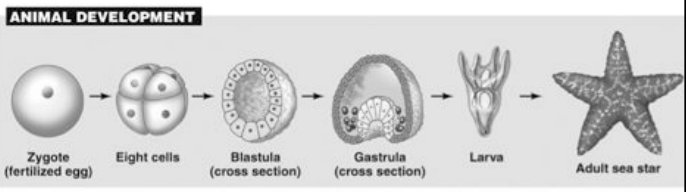
Controversial:

Cannot be isolated from most adult tissues, most successful from embryonic sources

4 key processes of development

3) **Growth**- increase in size of the body and its organs

4) **Morphogenesis-** organization and spatial distribution of differentiated cells into multicellular organs and organisms



Morphogenesis

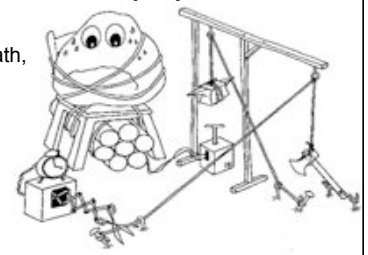
Pattern formation: developmental process that results in the spatial organization of a tissue/organism.

Cells in a tissue must "know" where they are in relation to the body.

The cells must activate the pattern of gene expression appropriate for their location.

Morphogenesis and Apoptosis

Apoptosis: programmed cell death, cell "suicide"



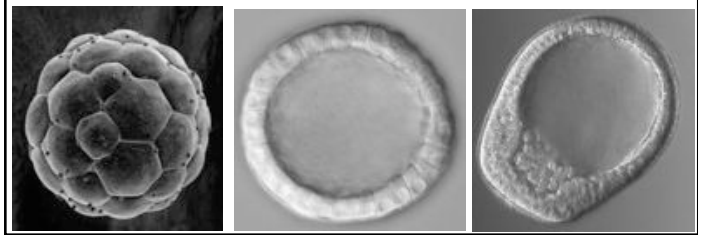
A normal component of the development and health of multicellular organisms. Apoptosis occurs in response to a variety of stimuli through a controlled, regulated fashion.

Other types of cell death: necrosis, autophagy

Let's go back:
What happens after fertilization?

The stages of development are: Fertilized ovum (zygote) → Morula (16, 32, 64) → Blastula → Gastrula

Morula → Blastula → Gastrula



Differentiation (Organogenesis)

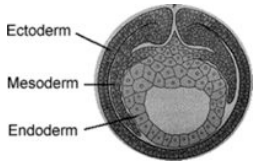
CELLS - TISSUES - ORGANS

Organogenesis; formation of the organs
(Organo = organs, genesis = creation)

Arises from layering of cells that occurs during the gastrula stage

The layers are **germ layers**;
have specific fates in the developing embryo:

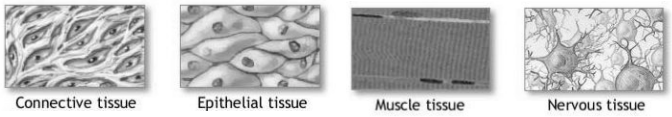
Endodzerm
The innermost layer
Mesoderm
In the middle
Ectoderm
The outermost



Differentiation of Primary Germ Layers (from the gastrula)

Ectoderm	**Mesoderm**	**Endoderm**
Nervous system	Skeleton	Digestive tract
Epidermis/skin	Muscles	Respiratory system
	Circulatory system	Liver
	Gonads	Bladder

What is a Tissue?



A **tissue** is a group of cells
Common embryonic origin
Function together to carry out specialized activities

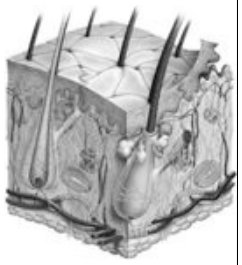
Histology is the science that deals with the study of tissues.

Pathologist specialized in laboratory studies of cells and tissue for diagnoses

Tissues

• Of the trillions of cells in your body, there are about 200 different "types"

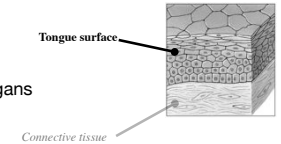
• To work efficiently several different types of cells must coordinate their efforts. The combination of cells and the *material between them* creates **tissues**.



Tissues

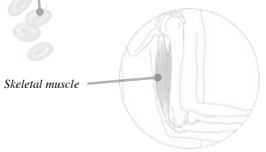
⁎1) **Epithelial** tissue

• Covers exposed surfaces, lines internal organs and cavities, and forms glands



2) **Connective** tissue

• Fills internal spaces, provides structural support for other tissues, transports materials within the body, and stores energy reserves.



3) **Muscle** tissue

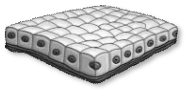
• Specialized for contraction - skeletal muscle, smooth (organ) muscle, and the heart.

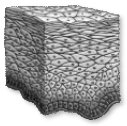
4) **Neural** tissue

• Carries information from one part of the body to another in the form of an electrical impulse.

Epithelial Tissue

Characteristics





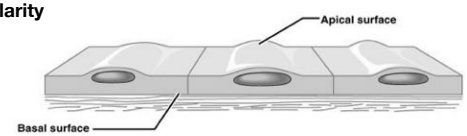
• Highly regenerative

Stem cells exist near the **basement membrane** to regenerate (through mitosis) new epithelial cells lost due to injury or other insults

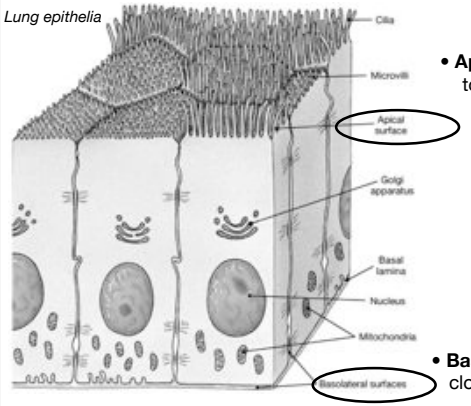
• Epithelia is **avascular** but highly **innervated**

• Always has one surface exposed to an external surface or passageway.

Epithelial cells have **polarity**



Epithelial Cells are Polarized



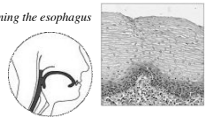
• **Apical** surface exposed to "external surface"

• **Basolateral** surface usually closer to the "blood side"

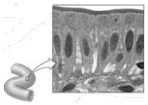
Epithelial Tissue

Functions

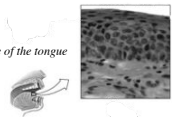
1) Provide physical protection



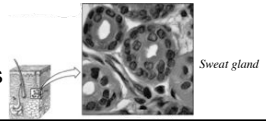
2) Control permeability



3) Provide sensation through neurons



4) Provide specialized secretions



Epithelial Classes

- Epithelia are classified by **three** cell shapes and **two** types of layers

Cell layers

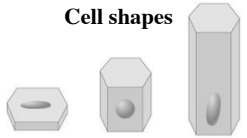
Simple

squamous epithelium

-Important for areas of transfer or absorption (e.g. lungs, kidney, blood vessels, etc.)

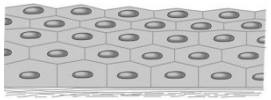
-Very fragile

Cell shapes



Squamous Cuboidal Columnar

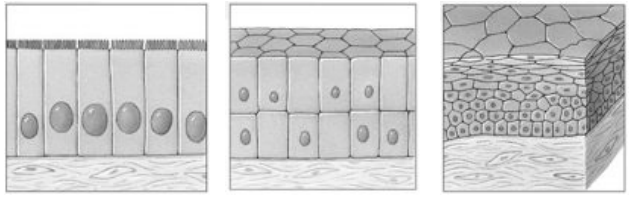
Stratified



squamous epithelium

-Important as a protective barrier to mechanical and chemical stress (e.g. skin, mouth)

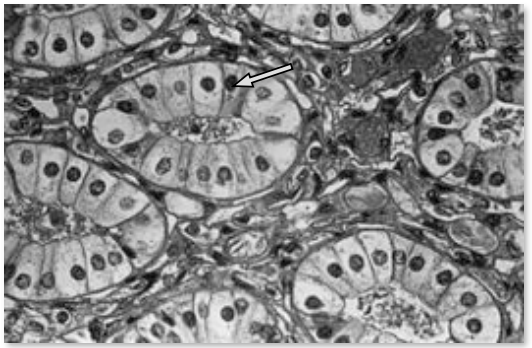
Epithelial Classification is Based on Surface Layer



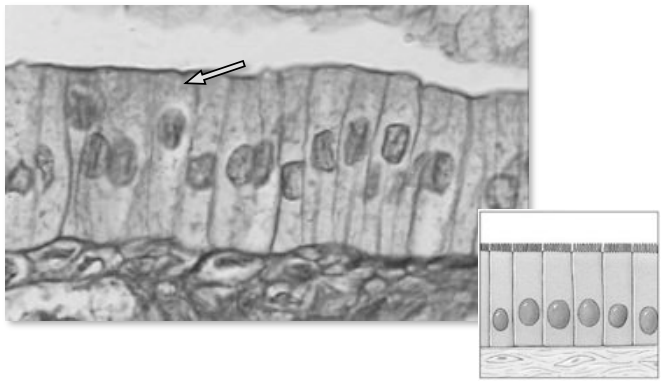
Simple columnar epithelia | Stratified cuboidal epithelia | Stratified squamous epithelia

- Each type is specialized for a different function

Simple Cuboidal Epithelium

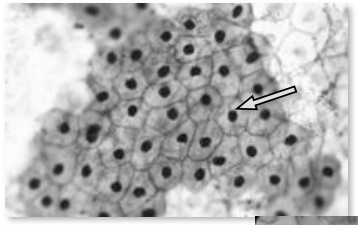


Simple Columnar Epilthelium



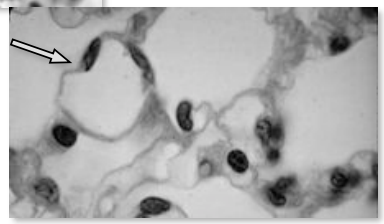
Ciliated, in lining of air passages

Simple Squamous Epithelium

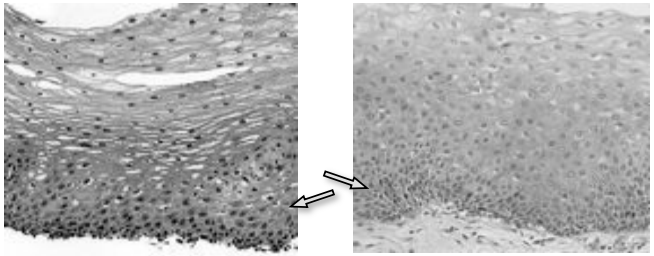


Frog skin

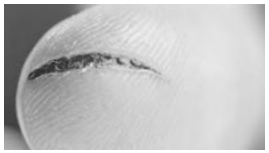
Lung alveoli



Stratified Squamous Epithelium

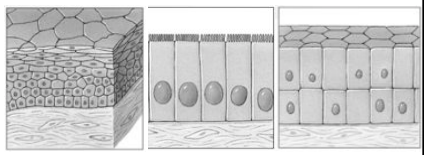


-Not all cells are flattened



Epithelial Classification is Based on Surface Layer

- *In general*,
  squamous= protection
  Columnar = absorbtion



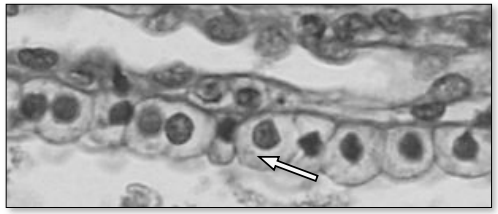
Stratified squamous epithelia | Simple columnar epithelia | Stratified cuboidal epithelia

- *In general*, cuboidal is involved in secretion from gland ducts

Endocrine vs. Exocrine glands

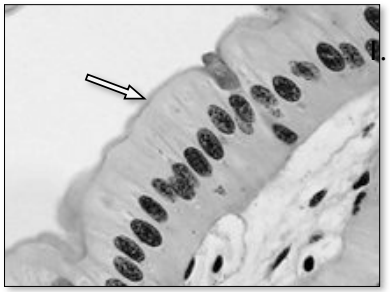
Endocrine glands - secrete substances inside the body
(e.g. hormones, enzymes, etc.)

Exocrine glands - secrete substances to outside the body
(e.g. milk, sweat, tears, etc.)



1. What tissue type?

2. Where might you find this in the human body?



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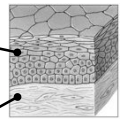
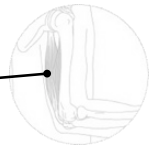


2) **Connective** tissue

- Fills internal spaces, provides structural support for other tissues, transports materials, stores energy reserves.

3) **Muscle** tissue

- Specialized for contraction - skeletal muscle, smooth (organ) muscle, and the heart.



4) **Neural** tissue

- Carries information from one part of the body to another in the form of an electrical impulse.

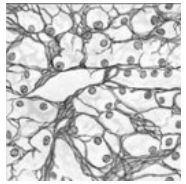
3 Types of Connective Tissue Fibers

1) Collagen Fibers

- strength and flexibility

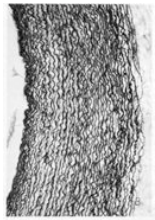
2) Reticular Fibers

- join CT to adjacent tissue



3) Elastic Fibers

- contain the protein **elastin** and are very branched and wavy



Connective Tissue

1) Loose Connective Tissue

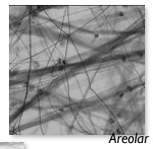
2) Supporting Connective Tissue

3) Fluid Connective Tissue

Categories of Connective Tissue

1) Loose Connective tissue

- Most widespread in body, includes:
  - A) All 3 types of fibers
  - B) Adipose



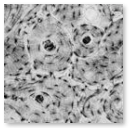
Areolar (loose)

2) Supportive connective tissue

Cartilage
- "*gristle*" strong yet flexible
- Full of **collagen** fibers

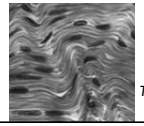
Cartilage

Bone
- Like cartilage, but even more collagen + salts
- Provide cavities for blood production



Bone

Dense Fibrous
- dense with collagen
- found in tendons and ligaments



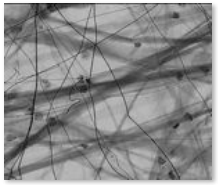
Tendon

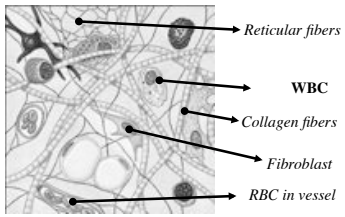
Loose Connective Tissue Proper

A) Loose connective tissue
-the tissue "between" cells

Fibroblasts: primary cell types that create **connective tissue proper**

Fibroblasts often involved in wound **repair**



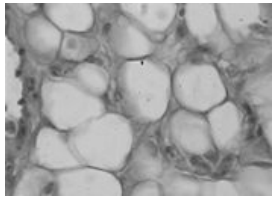


***Areolar* loose connective tissue**

Loose Connective Tissue Proper

B) Loose connective, Adipose tissue

- sometimes considered its own tissue
- provides cushion, insulation, energy storage
- **"brown fat"** vs. regular fat.



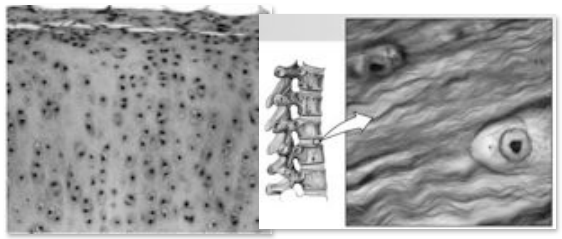
C) Reticular Tissue

- plays a supportive role only
- defines shape of organs

Supportive Connective Tissue - **Cartilage**

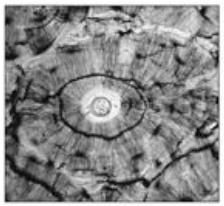
- Created by cells called **chondrocytes**, the only cells within cartilage.
- Composed mostly of collagen or elastin (or both)
- The only connective tissue that is **avascular**
- Often found near bones to prevent bone-bone contact (e.g. knee joint)

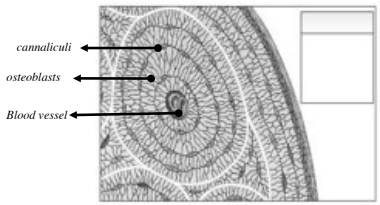
Supportive, but very flexible. Found in ears, nose, larynx...



Supportive Connective Tissue - **Bone**

- Provides incredible support
  - Calcium salts very strong, but brittle
  - 1/3 of bone is collagen
- The cells responsible for bone organization are **osteoblasts** and **osteoclasts**. Osteoblasts deposit bone minerals, osteoclasts break it down.
- Diffusion cannot occur through bone, so **cannaliculi** are used.





Categories of Connective Tissue

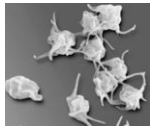
3) Fluid Connective Tissue

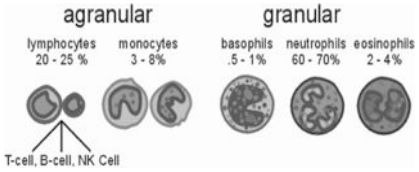
Blood
- The only CT that doesn't "connect" anything
- Liquid ECM (plasma)

• Carries nutrients and wastes
- Red Blood Cells (Erythrocytes)

• Components of the immune system
- White Blood Cells (Leukocytes)

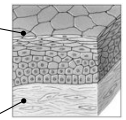
• Plasma
- Platelets, proteins





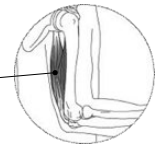
Tissues

1) **Epithelial** tissue
• Covers exposed surfaces, lines internal passageways and chambers, and forms glands



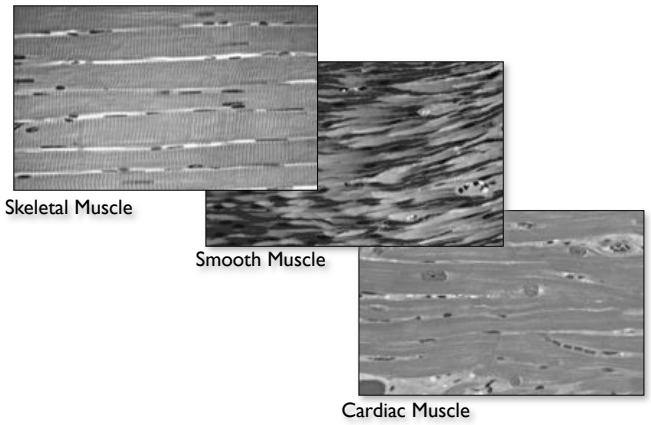
2) **Connective** tissue
• Fills internal spaces, provides structural support for other tissues, transports materials within the body, and stores energy reserves.

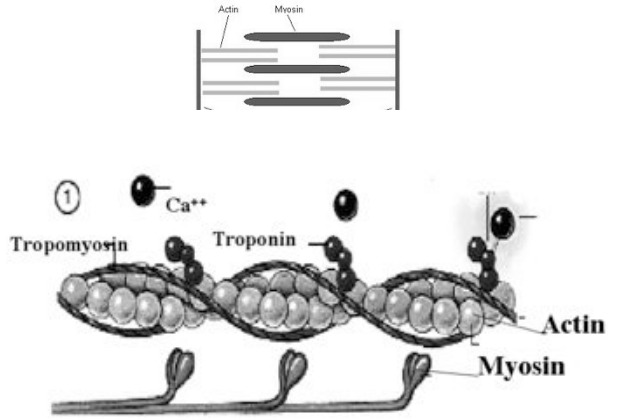
3) **Muscle** tissue
• Specialized for contraction - skeletal muscle, smooth (organ) muscle, and the heart.



4) **Neural** tissue
• Carries information from one part of the body to another in the form of an electrical impulse.

3 types of muscle tissue



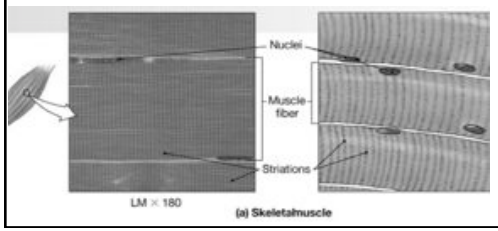


Muscle Tissue

3 Types

1) Skeletal Muscle- attached to bones by tendons

- Skeletal muscle cells (**myocytes)** are very long and have multiple nuclei
- Cells are bundled together into muscle fibers
- Skeletal muscle is **voluntary** and **striated**
- **Cannot** be regenerated, but can be partially repaired by "**satellite**" cells.

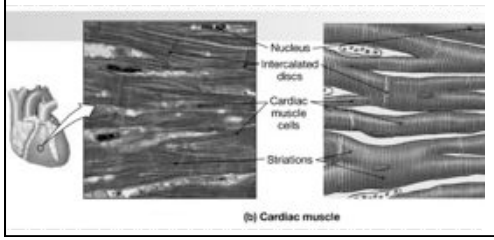


Muscle Tissue

2) Cardiac Muscle- forms contractile wall around heart

- C**ardiocytes** are found only in the heart
- Cardiac tissue resembles skeletal muscle, differs in several important characteristics

1. Cardiac muscle is branched (no bones in the heart)
2. Contraction not controlled by nerve impulses (**striated involuntary**)
3. Does have repair capabilities (but limited)
4. Presence of Intercalated disks

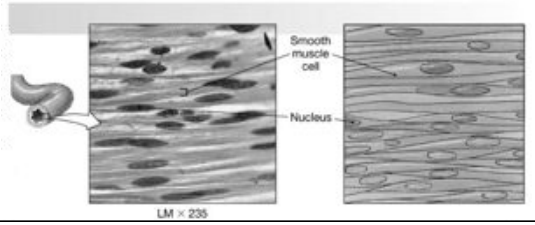


Muscle Tissue

3) Smooth muscle- responsible for involuntary body activities

- Organized differently than skeletal or cardiac muscle (e.g. **no striations**)
- Not branched, and single nucleus per cell
- Smooth muscle cells **can** reproduce after injury and regenerate
- "Most" smooth muscle is completely involuntary (**nonstriated involuntary**)

Blood vessels, GI tract, respiratory and reproductive systems

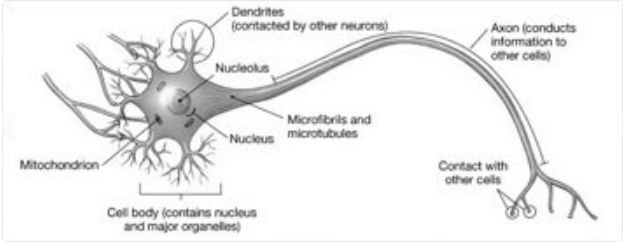


Neural Tissue

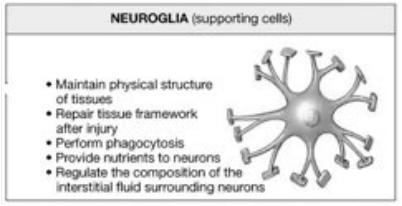
- Responsible for electrical impulse transmission throughout the body (communication)
- 98% of neural tissue located in the brain or spinal cord

2 Types of cells

1) Neurons- basic unit of the nervous system
- Propagate the electrical signals throughout the body
- Anatomy: cell body, dendrites, and axon



2) Neuroglia



Schwann (glial) cell - Form a sheath around peripheral neurons