

# Human Physiology & Digestive System

Biology 12

# I. Human Organization

## Basic Biological Organization

### A. **Human body has several levels of organization:**

- 1. Cells of the same type joined together are called TISSUES**
- 2. Different Tissues are joined together to form ORGANS**
- 3. Various organs are arranged into an ORGAN SYSTEM**

[In a Nutshell: What are you?](#)

## II. Tissues

### A. Epithelial

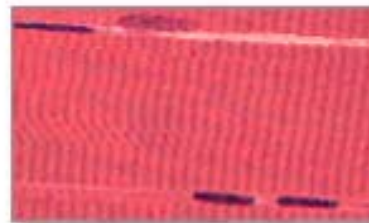
Four types of tissue



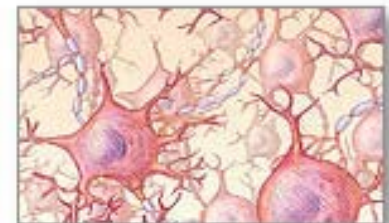
Connective tissue



Epithelial tissue



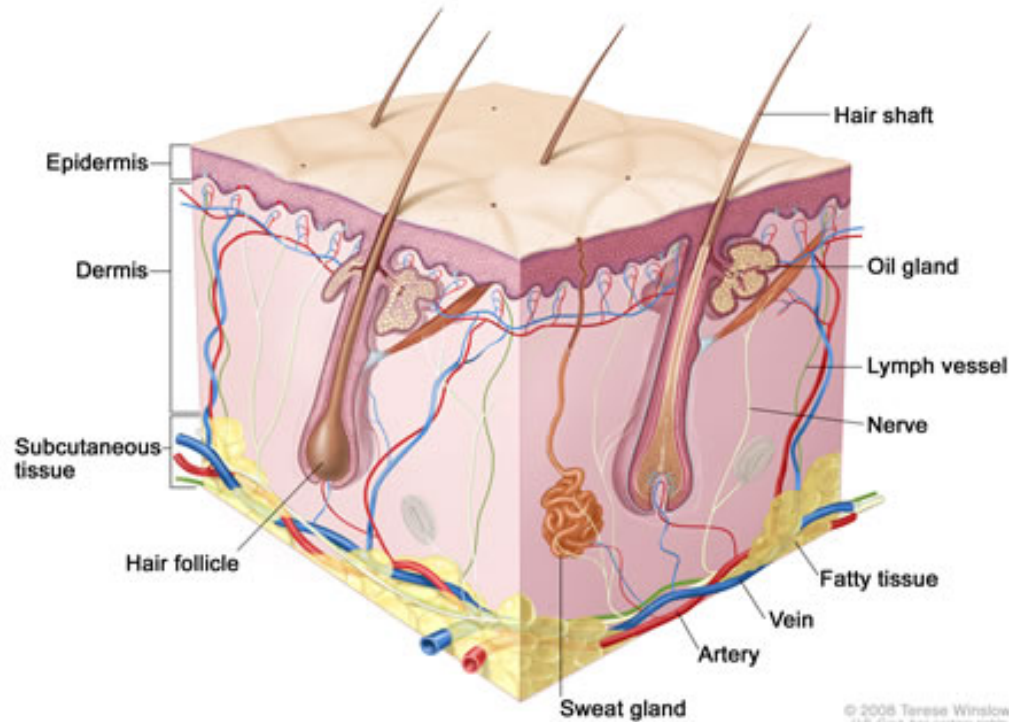
Muscle tissue



Nervous tissue

1. Covers body, lines cavities
2. Covers entire body surface and most of the body's inner cavities.

### 3. Outer epidermis (skin) protects from injury and drying out



### 4. In| and secretes mucus (e.g. along digestive tract)

## **5. Types:**

### **a. Squamous Epithelium**

**i. Function in protection, diffusion, filtration**

**ii. Made of flat cells**

**iii. e.g. lines alveoli and walls of capillaries, blood vessels**

### **b. Cuboid Epithelium**

**i. Function in secretion, absorption and protection**

**ii. Cube shaped cells**

**iii. e.g. line kidney tubules, surface of ovaries.**

## **c. Columnar Epithelium:**

**i. Column-shaped cells**

**ii. Often have microvilli or cilia to aid function**

**iii. e.g. lining of intestine, oviduct lining, lining of uterus**

**iv. Each type can exist as a single layer or be stratified (layers stacked on top of each other).**

**v. e.g. mouth, nose, vagina lined by stratified squamous epithelium.**

## **d. Pseudostratified Columnar:**

- i. Appear to be layered but is really just one layer of cells**
- ii. e.g. lining of respiratory tract.**



## **B. Connective**

### **1. Functions:**

- a. Bind structures together**
- b. Fill up spaces**
- c. Provide support and protection**
- d. Stores fat**

### **2. Structure:**

- a. Cells in connective tissue in matrix usually made up of either collagen or elastin**



### **3. Types:**

#### **a. Loose**

**i. Join tissues, hold organs in place, fat storage**

#### **b. Fibrous**

**i. Bundles of collagen fibers, very strong**

**ii. Used in tendons (connect muscle to bone) and ligaments (connect bones to other joints)**

**c. Cartilage**

**i. Flexible matrix rich in protein and fibers**

**ii. e.g. nose, ears, vertebrae, ends of bones**

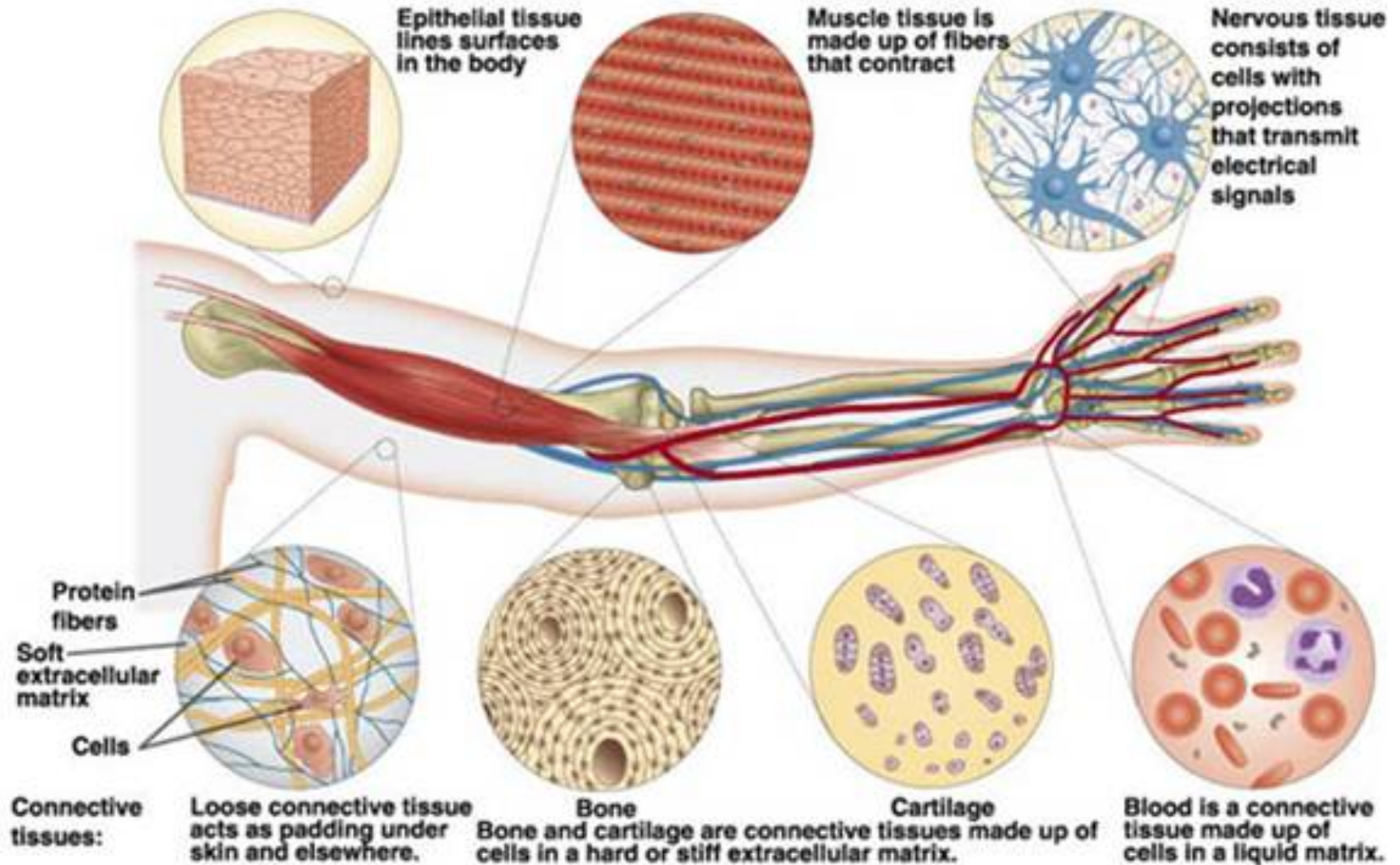
**d. Bone [TED-Ed Bone](#)**

**i. Rigid connective tissue**

**ii. Matrix of calcium salts**

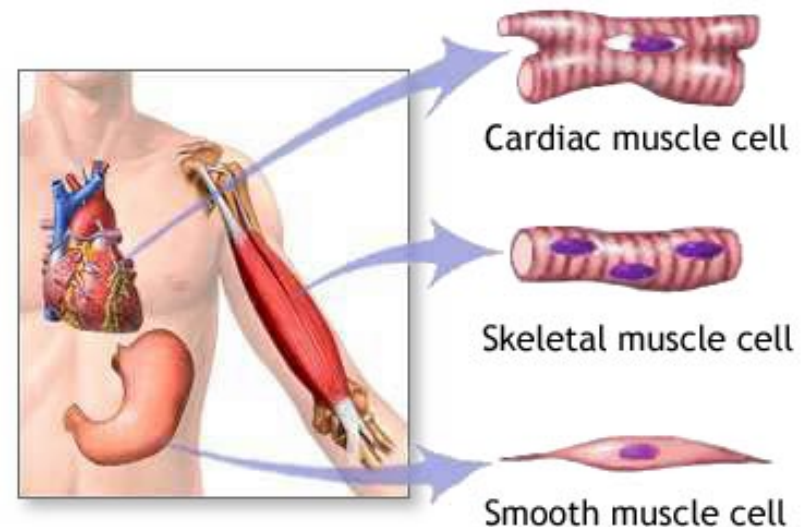
# e. Blood

## i. Matrix is liquid called plasma



## C. Muscle Tissue [Ted-Ed Mscle](#)

1. **Contracts for movement**
2. **Composed of fibers made of actin and myosin proteins whose interaction is responsible for movement.**



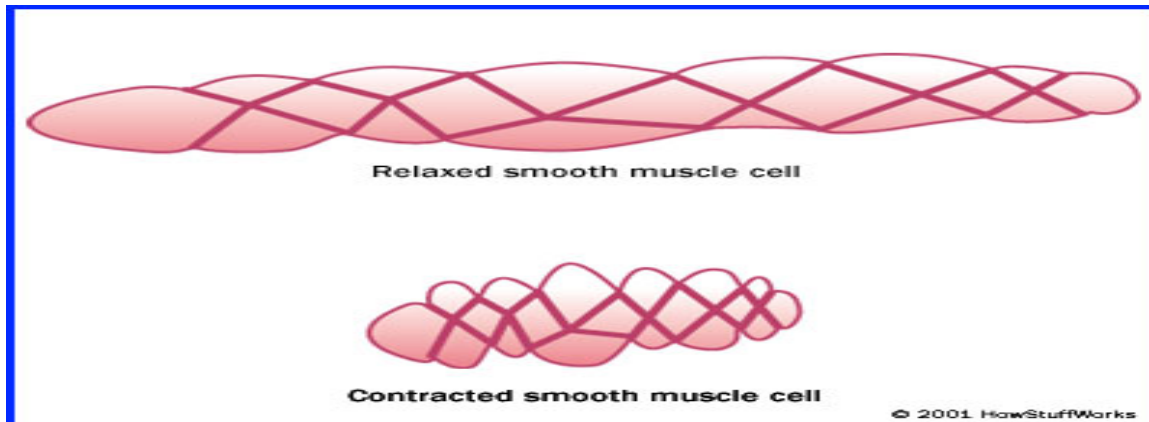
### **3. Types**

#### **a. Skeletal muscle**

- i. Striated (alternating light and dark bands)**
- ii. Attached to bones and used for movement**
- iii. Voluntary control**
- iv. Can contract quickly and strongly but will fatigue in time**

## **b. Smooth muscle**

- i. Non-striated**
- ii. Involuntary control**
- iii. Found in walls of internal organs (intestine, stomach, blood vessels)**
- iv. Contracts more slowly, but can contract over a longer period of time.**



## **c. Cardiac muscle**

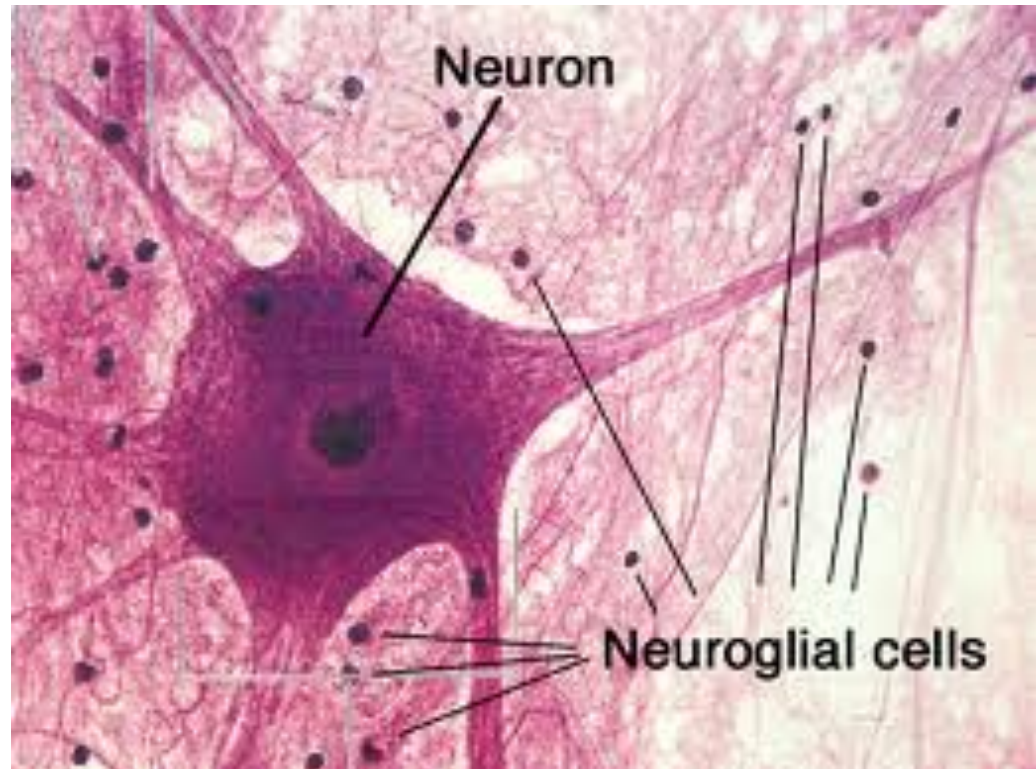
- i. Striated**
- ii. Involuntary**
- iii. Forms heart muscle**
- iv. Found only in the heart**
- v. Can contract quickly, and beats your whole life through**





## D. Nervous Tissue

1. Responds to stimuli and transmits impulses from one body part to another



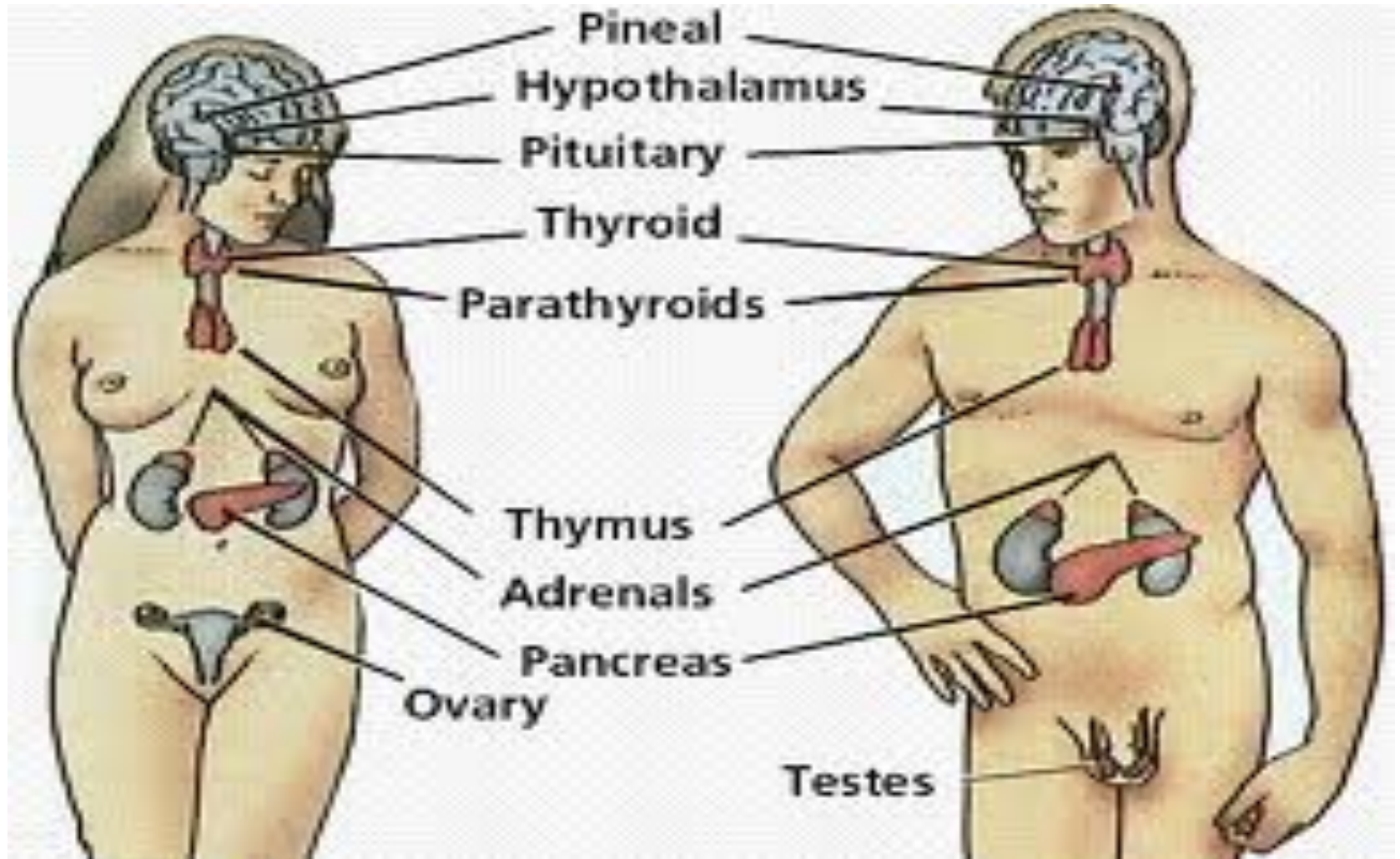


- 2. Conduct electrical and chemical messages along special cells called neurons**
  - a. Composed of:**
    - i. Cell body**
    - ii. Dendrites: conduct messages to cell body**
    - iii. Axon: send messages away from cell body**
    - iv. Axons and dendrites are nerve fibers**
  - b. Bundles of nerve fibers are called nerves.**

- 3. Nerves conduct messages to and from spinal cord, brain, and sense organs to register sensation and trigger muscle movement**
- 4. Glial cells surround nerve cells**
  - a. Help to support, protect, and nourish nerve cells**
  - b. Provide nutrients to the neurons and help keep the tissue free of debris**

# E. Glands

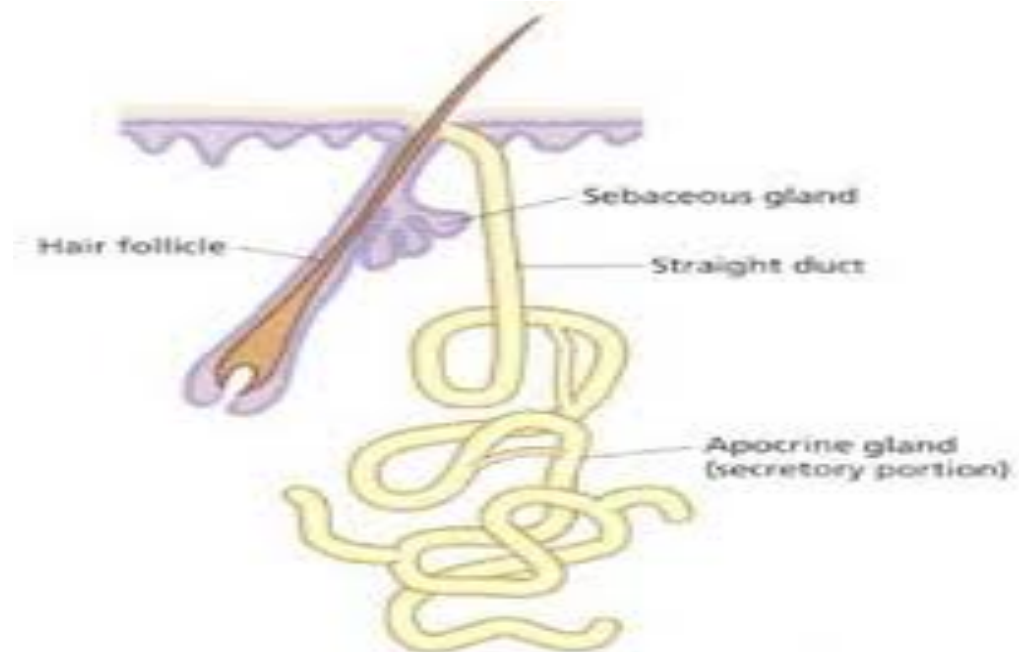
1. A single cell, or a collection of cells that secrete something



## 2. Types

### a. Exocrine glands

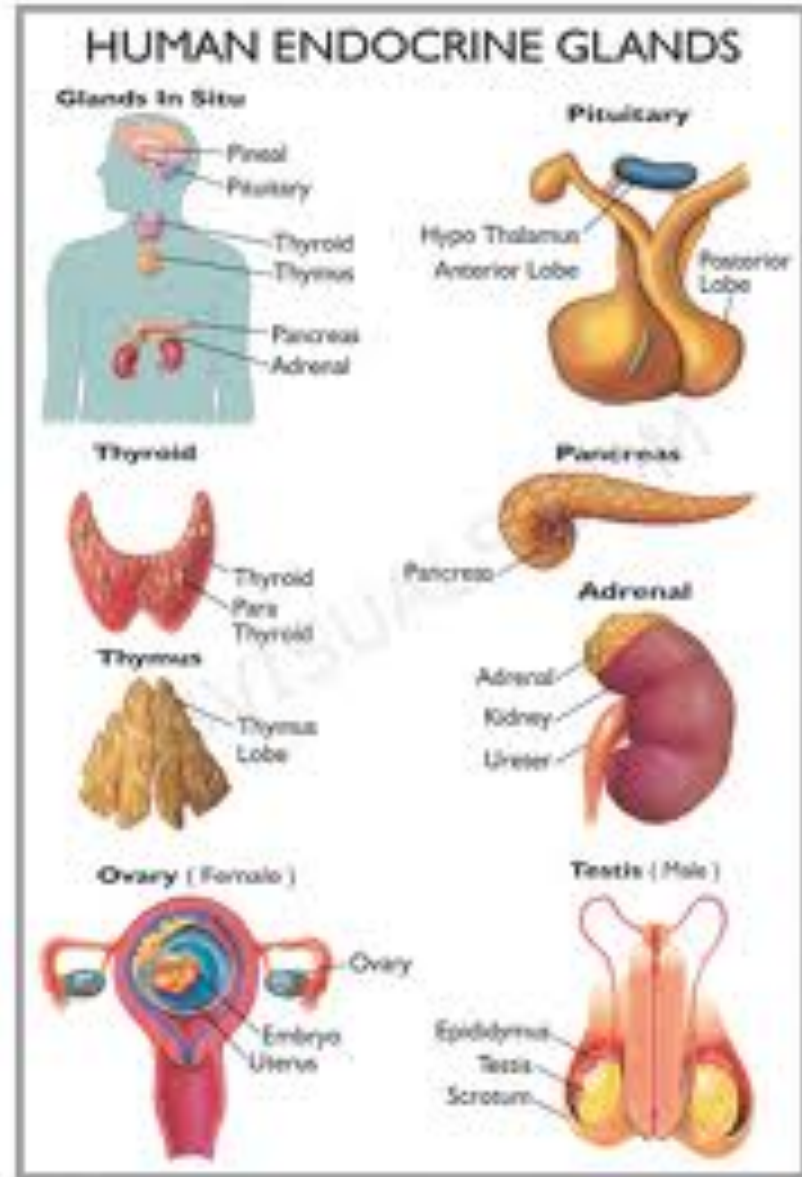
- i. Secrete into ducts
- ii. e.g. gall bladder is an exocrine gland because it secretes bile in a duct
- iii. e.g. sweat glands are exocrine glands



**b. Endocrine glands**

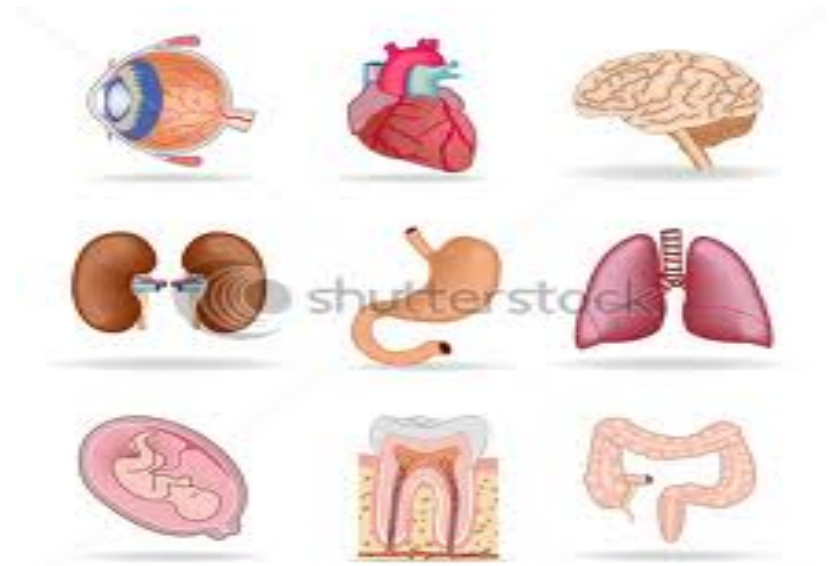
**i. Secrete chemicals (especially hormones) into bloodstream**

**ii. e.g. pancreas secretes insulin into the blood**



# III. Organs

- A. Tissues working together**
- B. Organs are made up of one or more types of tissues (usually more)**
- C. Each located in specific location, with specific functions**



## D. Human Organ Systems Overview:

### Amoeba Sisters Systems

<b>Digestive</b>	<b>convert food to usable nutrients</b>
<b>Circulatory</b>	<b>transport of necessary molecules to cells</b>
<b>Immune</b>	<b>defense against invading pathogens</b>
<b>Respiratory</b>	<b>gas exchange</b>
<b>Excretory</b>	<b>gets rid of metabolic wastes</b>
<b>Nervous &amp; Sensory</b>	<b>regulation and control, response to stimuli, processing information</b>
<b>Muscular &amp; Skeletal</b>	<b>support and movement</b>
<b>Hormonal</b>	<b>regulation of internal environment, development</b>
<b>Reproductive</b>	<b>producing offspring</b>

- E. Many internal organ systems enclosed within coelom, a cavity within the body**
- F. Organ systems contribute to maintaining a stable internal environment (homeostasis)**
- G. e.g. Temperature, pH, [glucose], blood pressure**



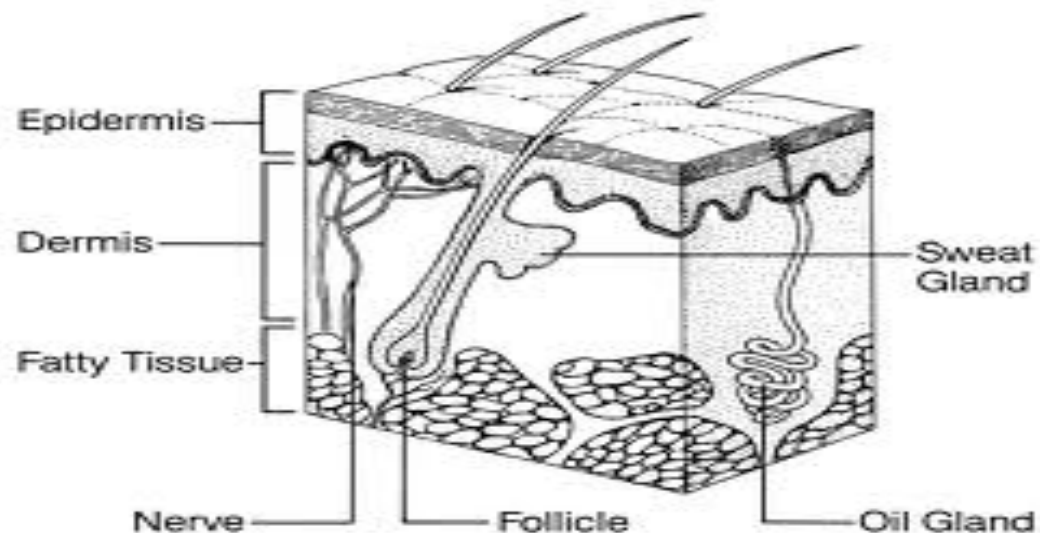
## IV. Skin

### A. An example of an organ [VIDEO](#)



[TED Ed: Skin](#)

- 1. Largest organ and has several tissue layers**
- 2. Skin covers body surfaces, gives protection from water loss and invasion by microorganisms, contains sense organs, helps to regulate body temperature**



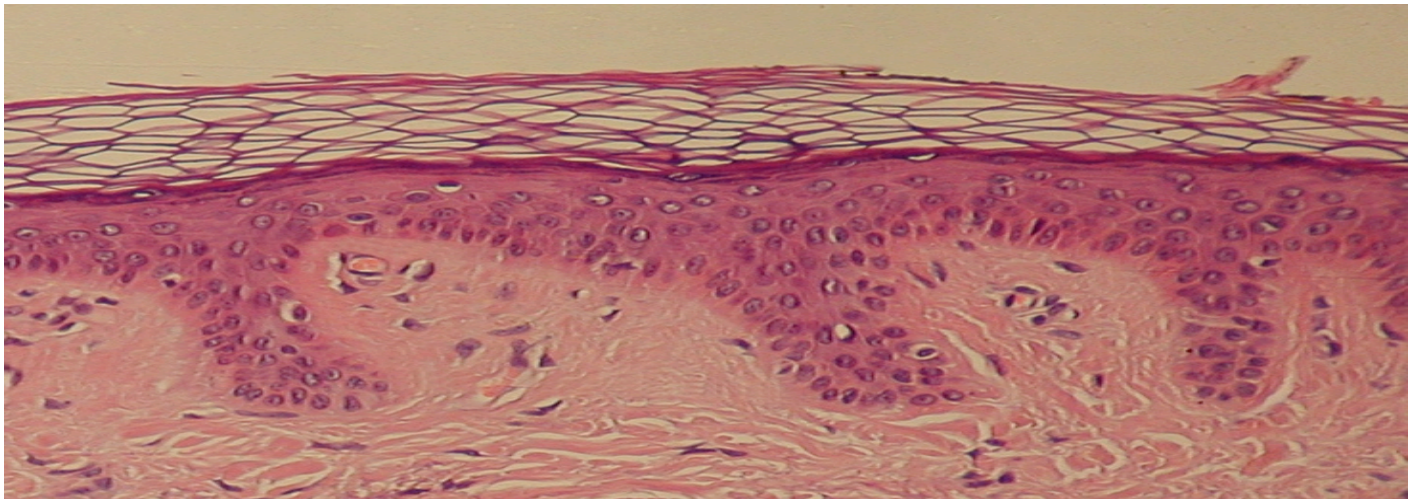
- 3. Skin is made up of three layers**
  - a. Epidermis**
    - i. Outer layer**
    - ii. Composed of stratified squamous epithelial cells**
    - iii. Basal cells at base of this layer produce new cells**
    - iv. Pigment cells (melanocytes) here produce melanin, responsible for skin colour**
    - v. Keratin protein hardens skin cells. (Hair & nails are made of tightly packed keratinized cells)**

## **b. Dermis**

**i. Middle layer**

**ii. Loose connective tissue with many elastic fibers**

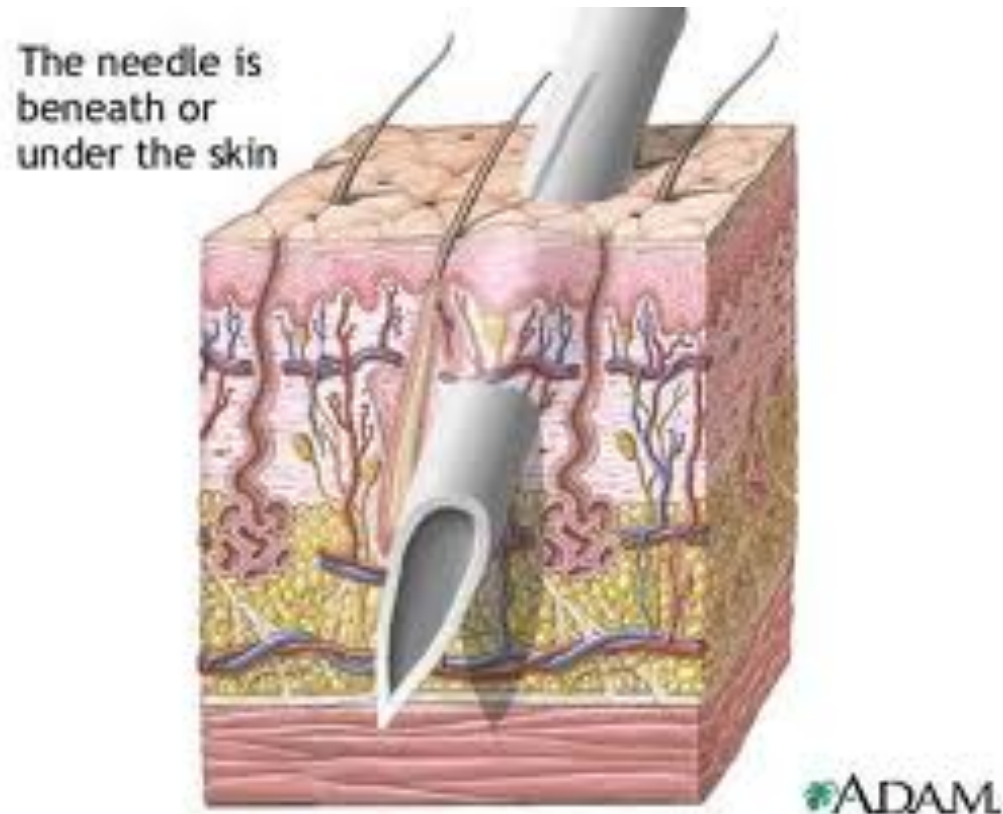
**iii. Sweat glands, nerve endings, blood vessels, and hair follicles located here**



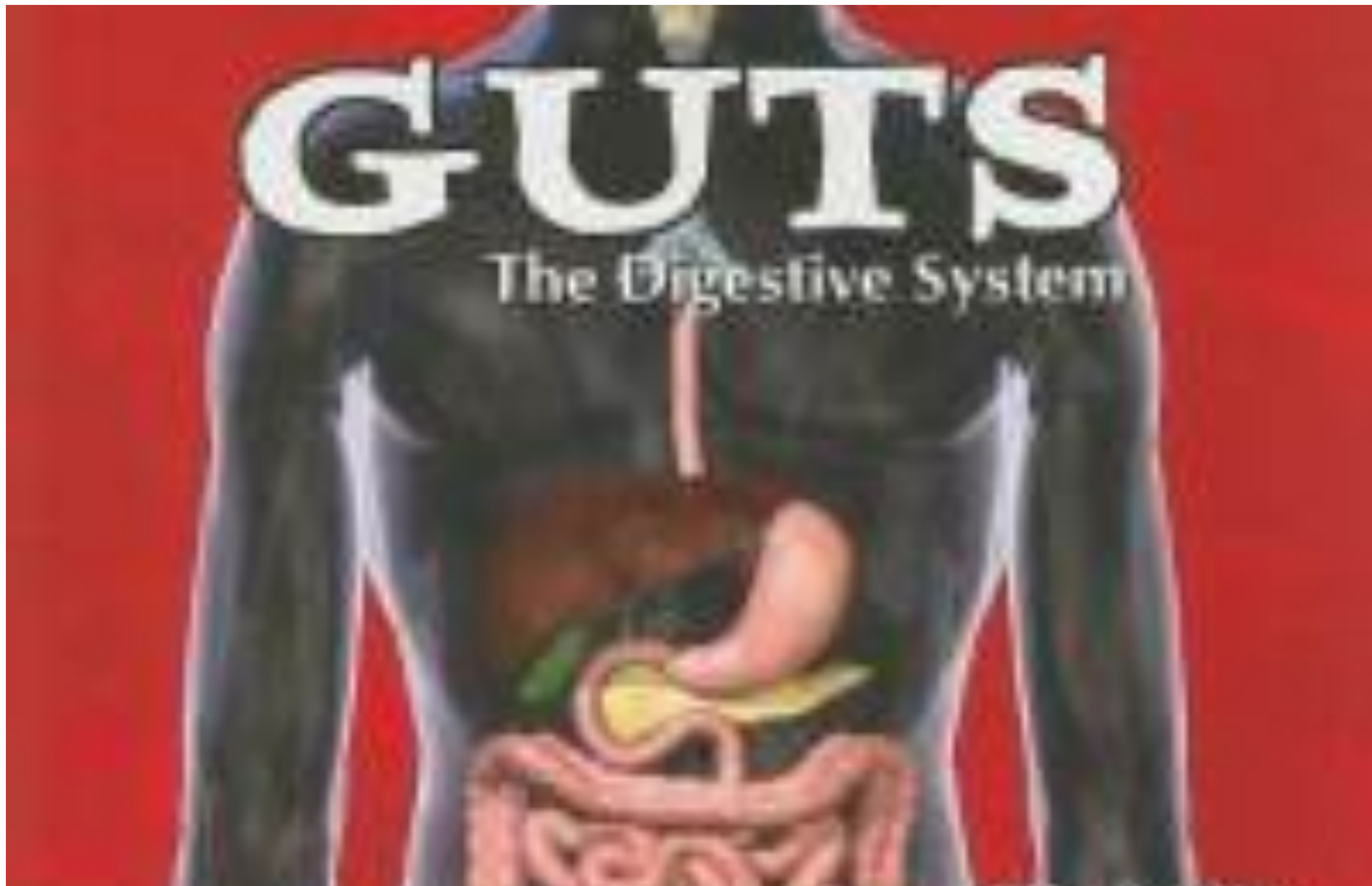
## c. Subcutaneous Layer

i. Bottom layer [Ted Ed Skin](#)

ii. Loose connective tissue containing adipose cells (fat)



# Digestive System



[VIDEO](#) Inside the Living Body

# **I. Introduction/Overview**

## **A. Digestion:**

- 1. Breakdown of food into small soluble molecules**
- 2. Occurs physically and chemically**

## **B. Absorption:**

- 1. Taking into the body of the specific compounds**

## **C. Elimination:**

- 1. Expulsion of materials not absorbed (taken into) the body**
- 2. Excretion**

## II. Location of Parts and Function

	oral cavity (mouth)	<ul style="list-style-type: none"><li>• physical digestion</li></ul>
8	pharynx	<ul style="list-style-type: none"><li>• common passage for digestion and respiration systems</li></ul>
	tongue	<ul style="list-style-type: none"><li>• tasting</li><li>• positions food for 'toothwork'</li></ul>
	teeth	<ul style="list-style-type: none"><li>• physical digestion of food</li></ul>
	salivary glands	<ul style="list-style-type: none"><li>• lubricate bolus, begin starch chemical digestion (salivary amylase)</li></ul>
9	epiglottis	<ul style="list-style-type: none"><li>• direct food ball into esophagus and not into trachea (the "wrong way")</li></ul>
7	esophagus	<ul style="list-style-type: none"><li>• tube through which food passes into stomach</li></ul>
6	stomach	<ul style="list-style-type: none"><li>• physical digestion (churns) and chemical digestion (protein)</li></ul>



10	cardiac sphincter	<ul style="list-style-type: none"> <li>• muscular ring acts as valve to contain food in stomach (top)</li> </ul>
3	duodenum	<ul style="list-style-type: none"> <li>• (top)1<sup>st</sup> 15 cm of sm. intestine</li> <li>• bile duct, pancreatic duct enter here</li> </ul>
11	pyloric sphincter	<ul style="list-style-type: none"> <li>• muscular ring; acts as valve to contain food in stomach</li> </ul>
14	small intestine	<ul style="list-style-type: none"> <li>• chemical digestion of all foods, absorption of monomers</li> </ul>
2	liver	<ul style="list-style-type: none"> <li>• produces bile and maintains blood glucose</li> </ul>
13	gall bladder	<ul style="list-style-type: none"> <li>• stores bile (←emulsifies fats)</li> </ul>
5	pancreas	<ul style="list-style-type: none"> <li>• neutralizes pH (<math>\text{NaHCO}_3</math>), secretes several enzymes</li> </ul>
4	large intestine	<ul style="list-style-type: none"> <li>• absorption of <math>\text{H}_2\text{O}</math></li> <li>• cultures <i>E. coli</i></li> </ul>
12	appendix	<ul style="list-style-type: none"> <li>• ? protection from pathogens</li> <li>• ? vestigial structure</li> </ul>
	rectum	<ul style="list-style-type: none"> <li>• last 20 cm of large intestine</li> </ul>
	anus	<ul style="list-style-type: none"> <li>• undigested material passes out here</li> </ul>

# A. Teeth

## 1. Type of teeth depends on food type:

a. Carnivores: teeth for grasping prey and severing meat from bones

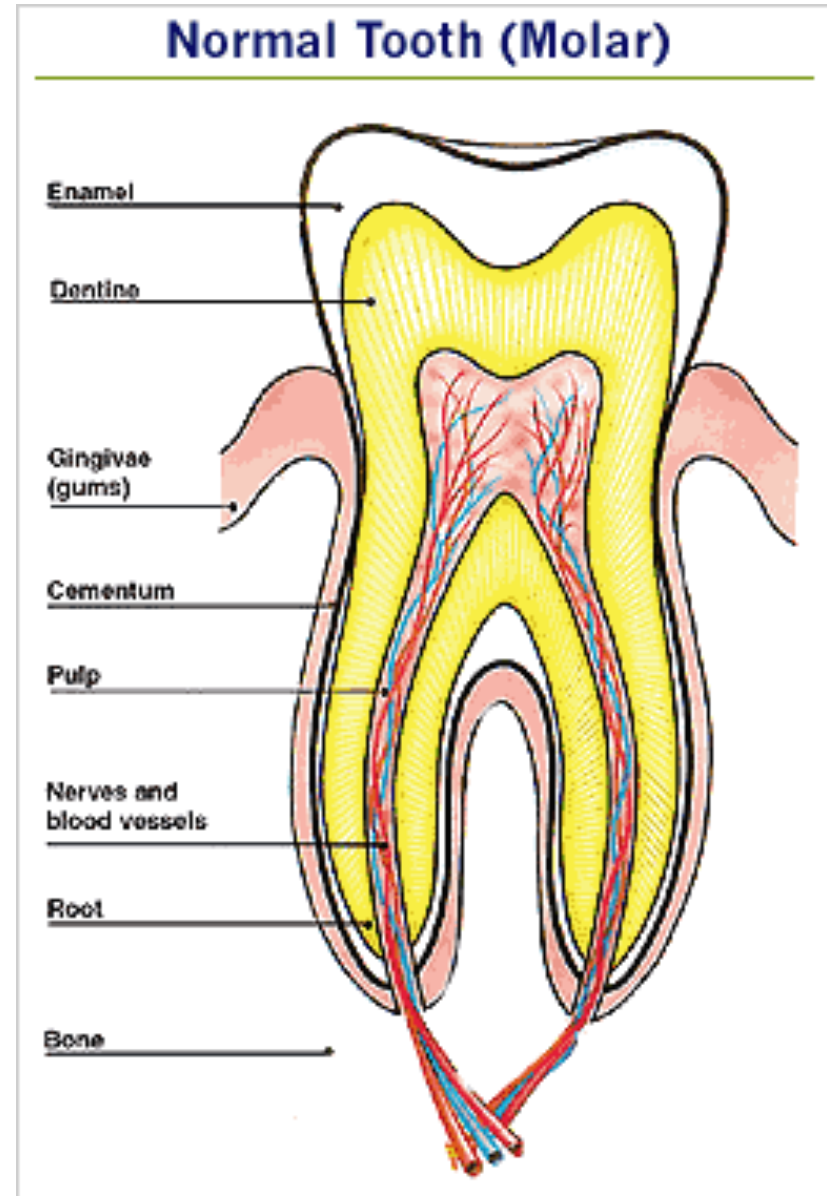
b. Herbivores: flat teeth surfaces for crushing plant fibres

c. Omnivores have a variety of tooth types for both flesh and vegetable matter [Ted-Ed](#)



## 2. Structure

- **a. Covered by a very hard substance called enamel**
- **b. under this: is the softer dentin (bony)**
- **c. Living part of the tooth is the pulp which contains nerves and blood vessels**
- **d. Teeth fit into sockets in the jaw**



## **B. Tongue**

### **1. Two functions:**

#### **a. Taste**

**i. Salt**

**ii. Sour**

**iii. Sweet**

**iv. Bitter**

#### **b. Help position food in the teeth**

## C. Salivary Glands

### 1. Three pairs:

a. **PAROTID** on side of face (swell with the mumps)

b. **SUBLINGUAL** (below tongue)  
and

c. **SUBMANDIBULAR** both in  
lower jaw

### 2. produce saliva

## D. Palates

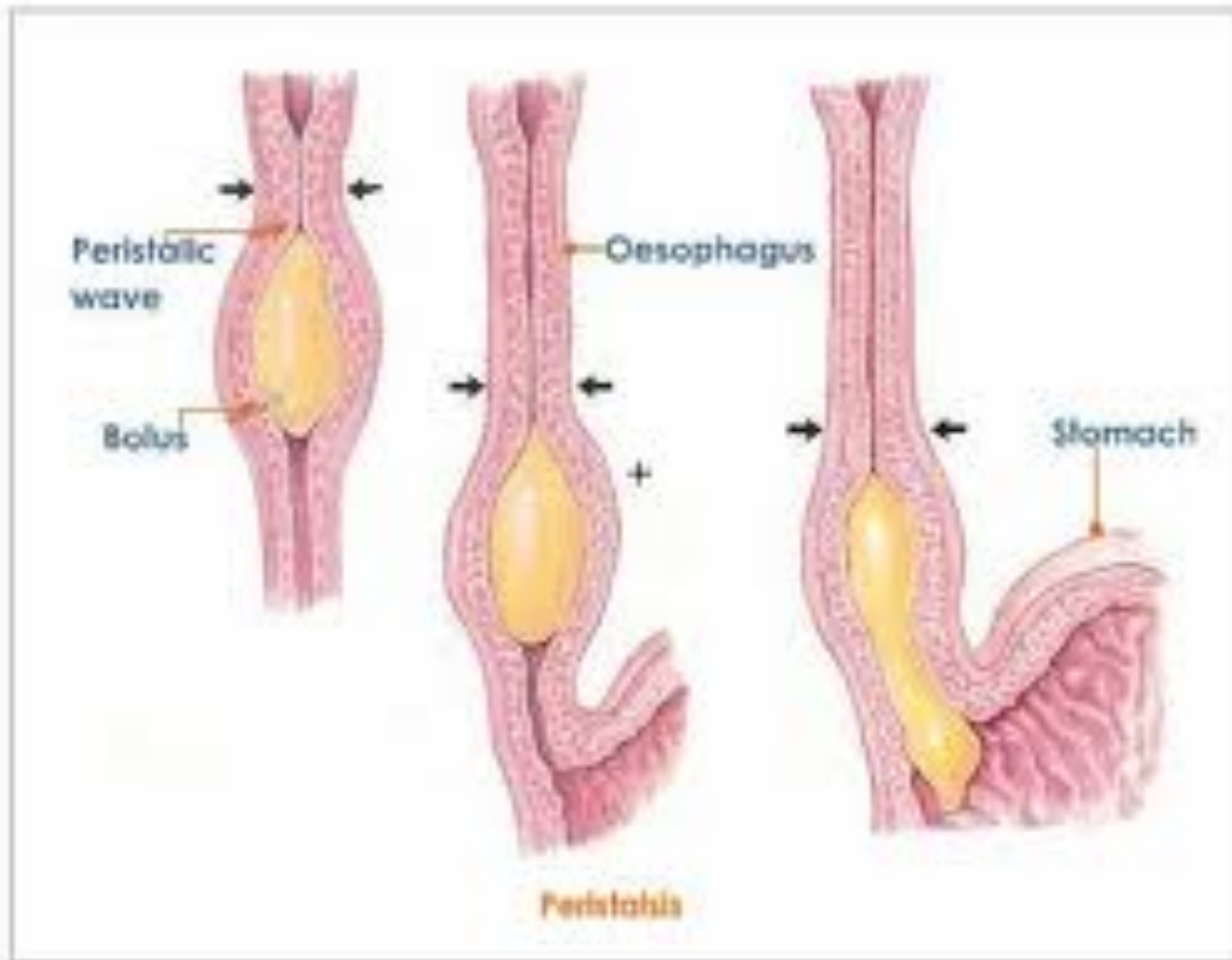
- 1. Locate at the top of the mouth**
- 2. Both soft (back) and hard (front)**
- 3. Separates the mouth from the nasal cavity**
- 4. End in a flap called the UVULA**

## **E. Pharynx**

- 1. Area between the mouth and the esophagus**
- 2. Pharynx is a tube used for breathing and eating**
- 3. EPIGLOTTIS closes off the opening to the glottis (larynx) when food is swallowed to prevent choking**

## F. Esophagus [Ted Ed Heartburn](#)

- 1. Muscular tube that pushes the food to the stomach by peristalsis**





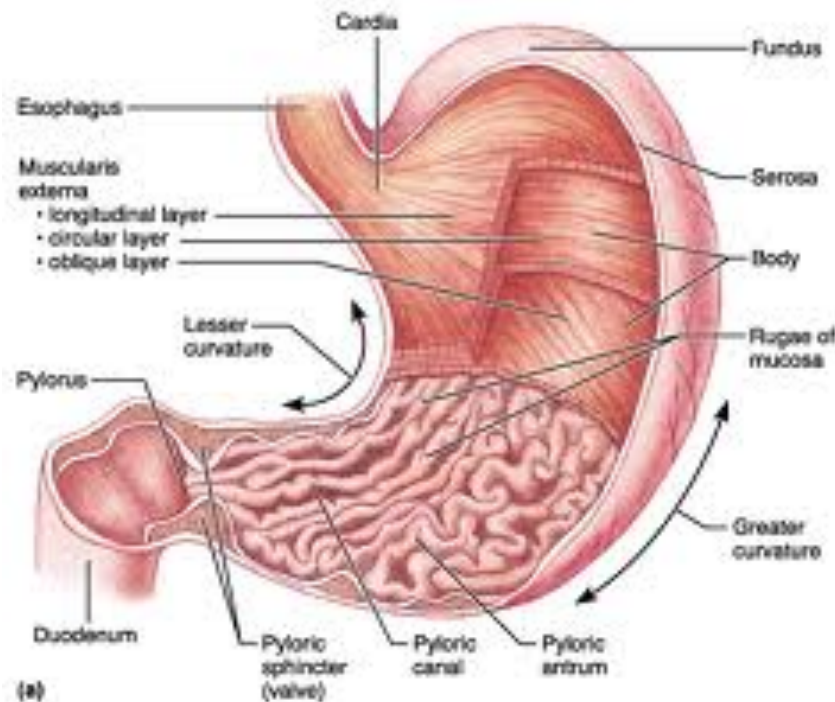
## 2. Five layers of tissue

- a. **MUCOSA is the epithelial lining**
- b. **SUBMUCOSA is the connective tissue**
- c. **MUSCULARIS are the 2 layers of muscles**
  - i) circular
  - ii) longitudinal
- d. **SEROSA outer epithelial layer; secretes a fluid to keep outer surface of tract moist so the organs slide when they contact each other**

## G. Cardiac Sphincter

**1. Muscle that surrounds the esophagus at its junction with the stomach**

**2. Opens to admit food into the stomach**



## H. Stomach

[Ted Ed Digestive System](#)

- 1. J-shaped pouch or enlargement of the gastrointestinal tract**
- 2. Located slightly left of center in the body**
- 3. Capacity: about 1 litre**

- 4. Inner epithelial lining contains gastric glands**
  - a. PARIETAL cells to produce HCl**
  - b. CHIEF cells produce pepsinogen, which is activated by HCl into enzyme pepsin**
  - c. Epithelial cells produce mucus to protect the stomach lining**

## 5. Function

- a. **Storage area for ingested food (empties in 2-6 hours)**
- b. **Place for digestive enzymes (pepsin and salivary amylase) to work**
- c. **Absorption of small molecules (e.g. H<sub>2</sub>O, ethanol)**
- d. **Regulates amount of pepsin produced:**
  - i. **Extra protein will stimulate lower stomach to secrete hormone called GASTRIN which will stimulate the upper stomach cells to produce more pepsinogen**

# I. Pyloric sphincter

- 1. Muscle that surrounds the stomach at its junction with the small intestine**
- 2. Opens to admit CHYME into the small intestine**

## J. Small Intestine

1. **3 meters or  $\approx$  10 feet in length**
2. **Walls highly convoluted to  $\uparrow$  S.A.**
3. **Interior folds covered with villi:  
tiny fingerlike projections that  
further  $\uparrow$  S.A.**
4. **Divided into 3 parts**
  - a. **Duodenum (first 25 cm)**

**Produces digestive enzymes:  
lactase, peptidase, maltase,  
nuclease**
  - b. **Jejunum**
  - c. **Ileum**

## **5. Functions:**

**a. Completes digestion**

**b. Absorption of nutrients**

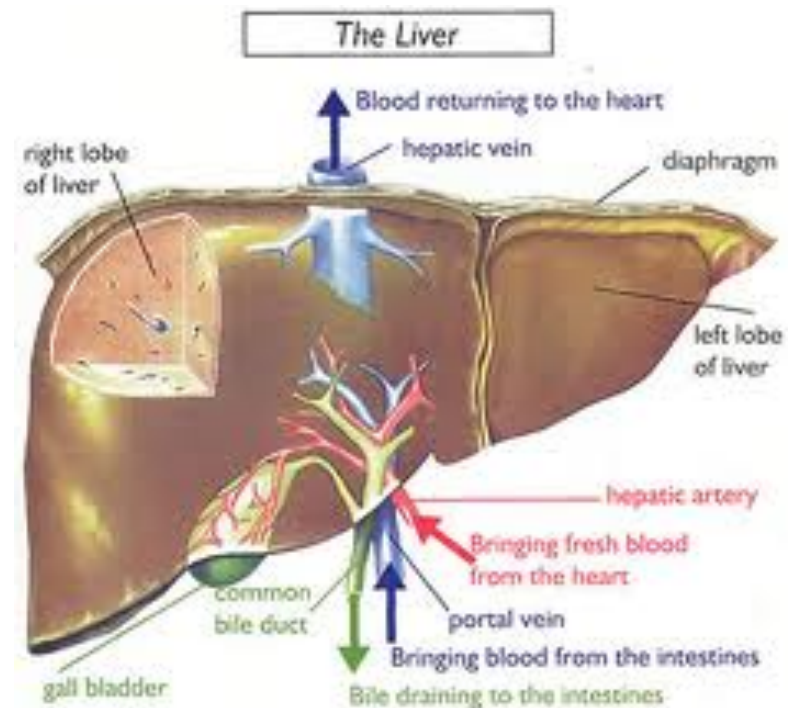
**i. monosaccharides, amino acids, short peptides, fatty acids are transported into intestinal cells, and diffuse into bloodstream**

**ii. Fats diffuse into intestinal cells and are deposited in the lacteal (lymph vessel in the villus)**



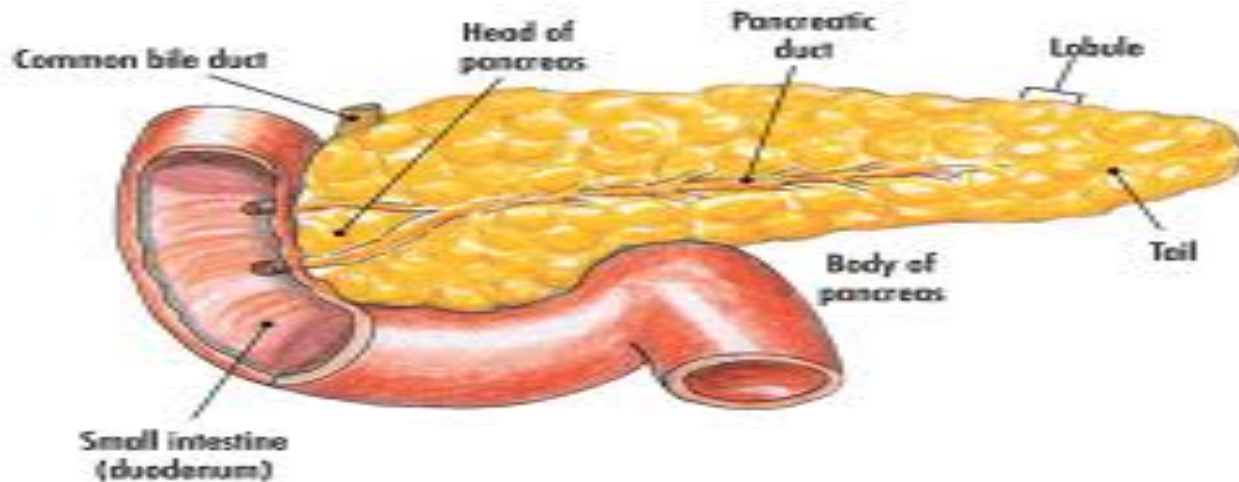
## K. Liver [Ted Ed Liver](#)

1. Largest organ in the body
2. Constant monitoring of the blood contents as the blood comes from the small intestine via the hepatic portal vein
3. Many functions  
... stay tuned!



## L. Pancreas [Ted Ed Pancreas](#)

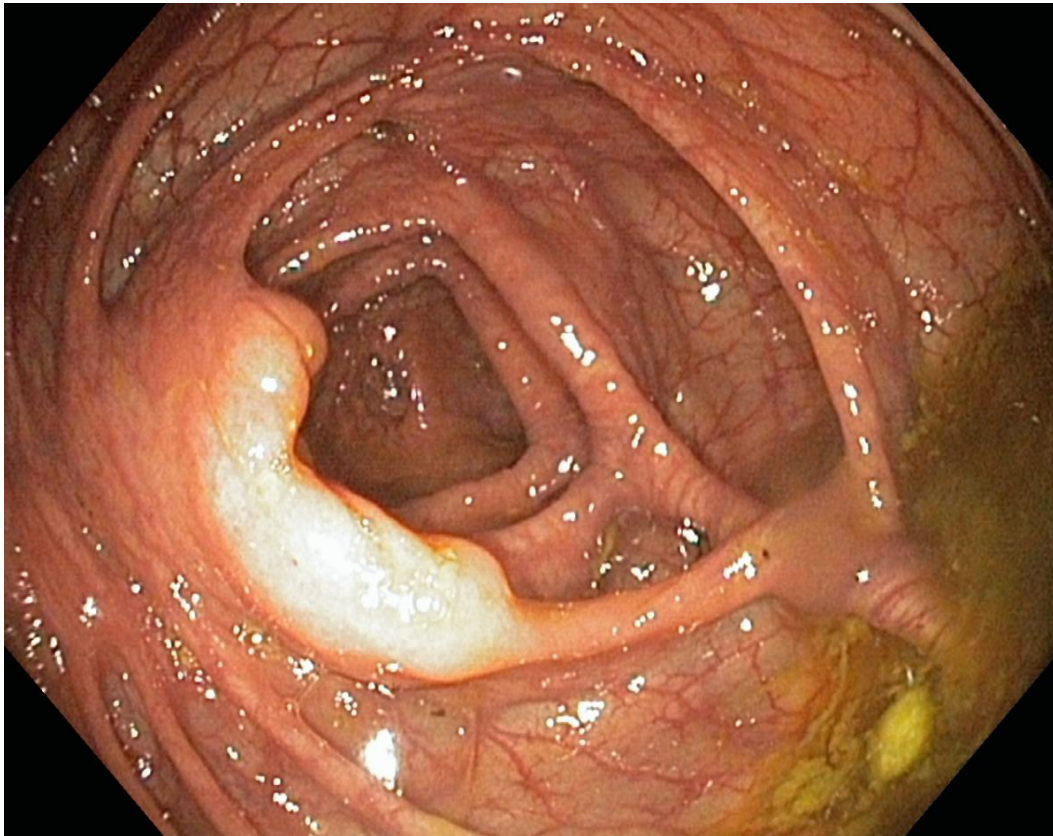
- 1. Produces pancreatic juice (digestive enzymes and sodium bicarbonate to neutralize acidic chyme)**
- 2. Produces insulin, a hormone that influences the cells' uptake of glucose from the bloodstream**



- 3. Pancreatic juice and bile are produced in response to the acid chyme from the stomach**
  - a. Chyme triggers the release of the hormones secretin and cholecystokinin (CCK) from the duodenum**
    - i. Secretin triggers release of pancreatic juice**
    - ii. CCK triggers release of bile**

# M. Ileo-caecal opening

- 1. Where the small intestine joins with the large intestine**



## **N. Caecum**

- 1. Blind pouch at the end of the small intestine**
- 2. No function in humans (vestigial)**
- 3. In herbivores, the cellulose is broken down here by microbes that live in the animal**
- 4. Appendix is a small finger-like growth off the end of the caecum**

# O. Large Intestine

1. 5 parts
  - a. Ascending colon
  - b. Transverse colon
  - c. Descending colon
  - d. Rectum - stores feces
  - e. Anus- muscles close the rectum until release of feces is appropriate [Ted-Ed Colon](#)

## 2. Functions

- a. Reabsorption of water
    - i. 95% of the daily 10 L of water is removed
  - b. Formation of feces
  - c. Manufacture of some amino acids, growth factors, vitamins B's and K by E.coli) Ted-Ed
- Microbes

### 3. E. coli bacteria

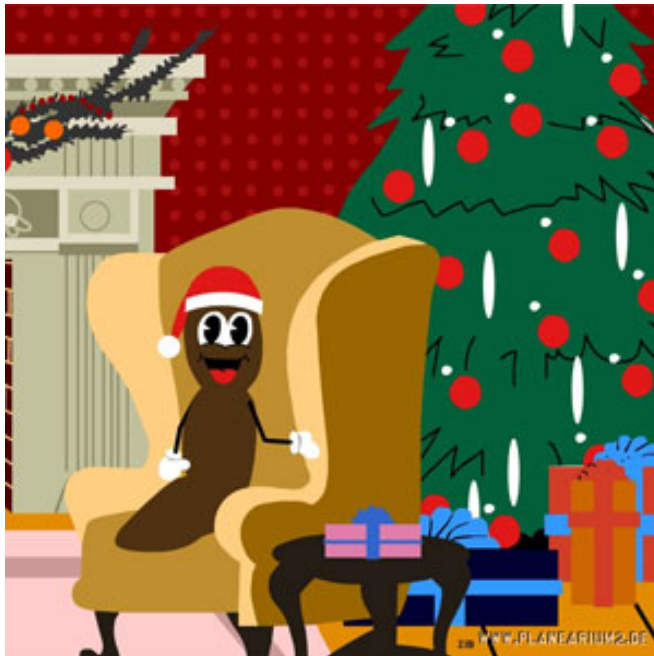
- a. Digest some undigestible material
- b. Produce gas (farts) [Ted-Ed Farts](#)
- c. Produce amino acids
- d. Produce vitamins
- e. Produce growth factors (proteins that stimulate cell growth)





#### 4. Feces is composed of:

- a. Undigested food (mainly cellulose)
- b. Dead bacteria [Ted-Ed Gut Microbes](#)
- c. Pigments



# III. Digestive Enzymes VIDEO

## Ted Ed Video

A. Enzymes break down food into small molecules which are then absorbed ANIMATION or ANIMATION (or next slide)

Fill out the following from your textbook:

- Source
- pH
- Food Digested
- Product

For: Salivary Amylase, Pepsin(ogen), Trypsin, Pancreatic Amylase, Lipase, Nuclease, Peptidase, Maltase

# Major digestive enzymes

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**TABLE 14.3** MAJOR DIGESTIVE ENZYMES

Enzyme	Produced By	Site of Action	Optimum pH	Digestion
Salivary amylase	Salivary glands	Mouth	Neutral	Starch + H <sub>2</sub> O → maltose
Pancreatic amylase	Pancreas	Small intestine	Basic	
Maltase	Small intestine	Small intestine	Basic	Maltose + H <sub>2</sub> O → glucose + glucose
Pepsin	Gastric glands	Stomach	Acidic	Protein + H <sub>2</sub> O → peptides
Trypsin	Pancreas	Small intestine	Basic	
Peptidases	Small intestine	Small intestine	Basic	Peptide + H <sub>2</sub> O → amino acids
Nuclease	Pancreas	Small intestine	Basic	RNA and DNA + H <sub>2</sub> O → nucleotides
Nucleosidases	Small intestine	Small intestine	Basic	Nucleotide + H <sub>2</sub> O → base + sugar + phosphate
Lipase	Pancreas	Small intestine	Basic	Fat droplet + H <sub>2</sub> O → glycerol + fatty acids

# IV. Swallowing and Peristalsis

- A. Swallowing involves the formation of a bolus (food ball)
  - 1. Formed by the mouth, teeth, tongue, and saliva from the salivary glands
- B. When swallowing the esophagus moves the bolus into the stomach by peristalsis
  - 1. Peristalsis is a rhythmic, wavelike contraction of the esophagus and intestine
  - 2. Muscle contractions (smooth muscle) run along the tube and push food material in one directionperistalsis [VIDEO](#) [VIDEO](#)

# **VI. The 7 Functions of the Liver**

- 1. Removes and metabolize toxic materials**
  - a. Example: alcohol detoxification**
- 2. Stores extra glucose in the form of glycogen**
  - a. Will also convert glycogen to glucose when blood sugar levels drop**
- 3. Destroys old red blood cells**
  - a. Broken into the heme segment which is recycled in new red blood cells**
  - b. Broken into bile which is stored in the gall bladder to be used for fat emulsification**

4. Produces urea from breakdown product of amino acids
  - a. Urea is nitrogenous waste
5. Makes blood proteins
6. Stores iron and the fat-soluble vitamins A, D, E and K
7. Converts amino acids to glucose if necessary (gluconeogenesis)

[VIDEO](#)

# V. Gastric, Pancreatic and Intestinal Juices

## A. Mouth: Salivary Glands:

### 1. Saliva

#### a. composed of

- i.  $H_2O$
- ii. mucus
- iii. salivary amalyse

#### b. function:

- i. Salivary amylase (digestive enzyme that breaks down starches)
- ii. Clean the mouth
- iii. Dissolve soluble particles
- iv. Soften food
- v. Moistens the lining of the mouth
- vi. Lubrication of food
- vii. Formation of a bolus (food ball)

## **B. Stomach: Gastric juice**

- 1. water (for hydrolysis)**
- 2. Pepsinogen [Ted-Ed Ulcers](#)**
  - a. inactive form of the enzyme Pepsin**
  - b. needs HCl to lower pH to activate Pepsin**
  - c. Pepsin digests large proteins to small amino acid chains (peptides)**
  - d. food becomes semi liquid mass called acid chyme**



## **C. Pancreas: Pancreatic juice**

### **1. Sodium Bicarbonate: ( $\text{NaHCO}_3$ , Baking Soda)**

**a. very important in neutralizing stomach acid to give a slightly basic pH in intestine. (pH 3.5 in stomach to pH 7.5 in intestine)**

### **2. Enzymes:**

**a. Pancreatic Amylase**

**b. Trypsin**

**c. Lipase**

**d. Nuclease (digests DNA & RNA to nucleotides)**

# VI. Insulin (and Glucagon)

[TED-Ed Diabetes](#)

## **A. Insulin**

**1. Hormone produced by cells in the Pancreas called islets of Langerhans**

**2. Acts upon the cell membranes of most cells and opens the protein gates in the membranes, allowing glucose to enter the cells from the blood**

**3. Lowering blood sugar**

**4. Stimulates the liver and muscles to convert glucose to glycogen, as well as promoting the formation of fats and proteins.**

**B. Glucagon**

**1. Second hormone produced by cells in the Pancreas called islets of Langerhans**

**2. Will increase blood glucose levels**

## **VII. Liver and Bile**

**A. Liver is connected to the intestines (villi) by the Hepatic portal vein which carries blood rich in foods to the liver**

**B. Liver acts as the gatekeeper to the blood by keeping levels of various foods in the blood (Hepatic vein) constant.**

## **C. Digestive function of the Liver**

### **1. Secretes bile**

**a. Green fluid**

**b. Stored in the gall bladder**

**c. Emulsifies fats**

**i. Breaks fat drops into tiny droplets which are homogeneous**

**ii. Stay in suspension**

**iii. Increases surface area of the fat droplets for Lipase to work on**

### **2. Breakdown fluid of hemoglobin**

# X. Control of Digestive Gland Secretions

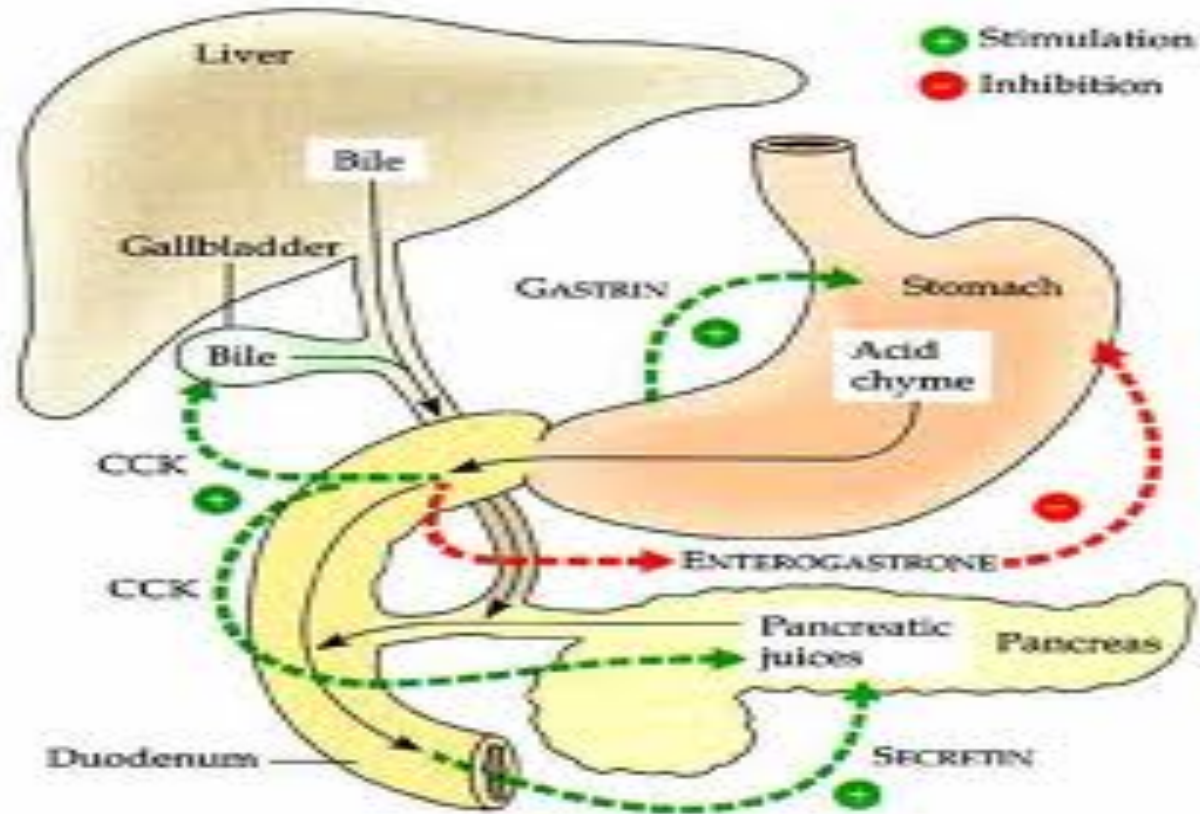
## A. Simple nervous reflex

1. Presence of food in the gut triggers nervous impulses to the brain which then sends nervous impulses to the digestive glands

## B. Conditioned reflex

1. Food is not present in the gut but some external stimulus causes glandular secretion to being
2. Example: Pavlovs dogs & bells

## C. Hormonal control



1. hormone released by some gland stimulated (via bloodstream) a digestive gland to begin secretion

2. Example: gastrin stimulates pepsinogen secretion