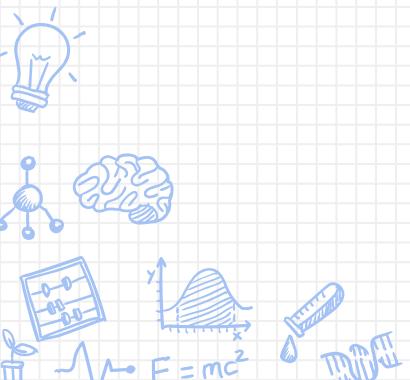




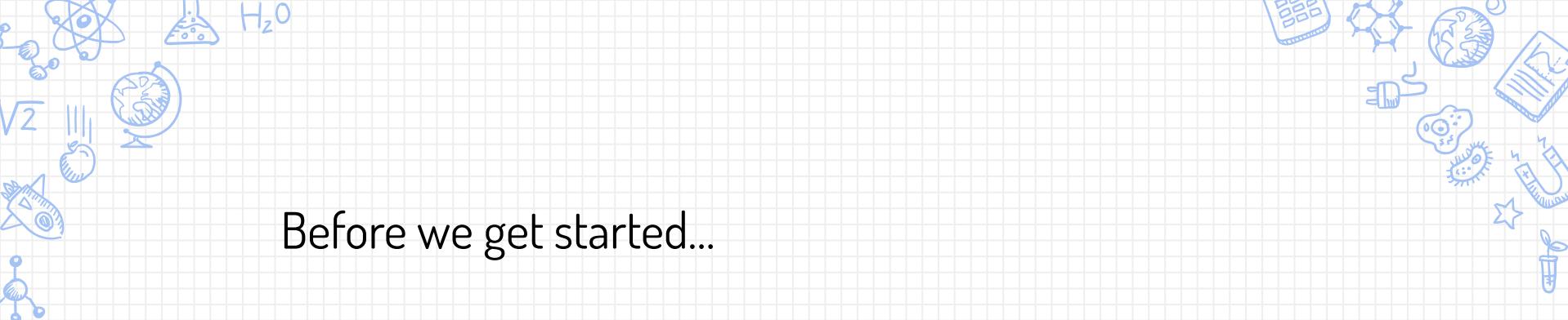
🏆 Let's Take Attendance 🏆

<http://sciovirtual.org/attendance>

Attendance code:
cardio49



H₂O

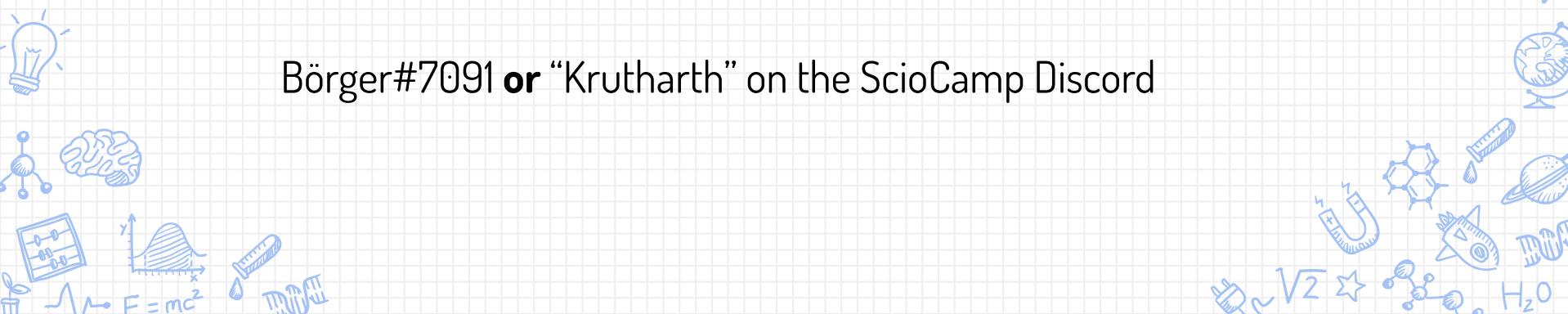


Before we get started...

Reach out to me here:

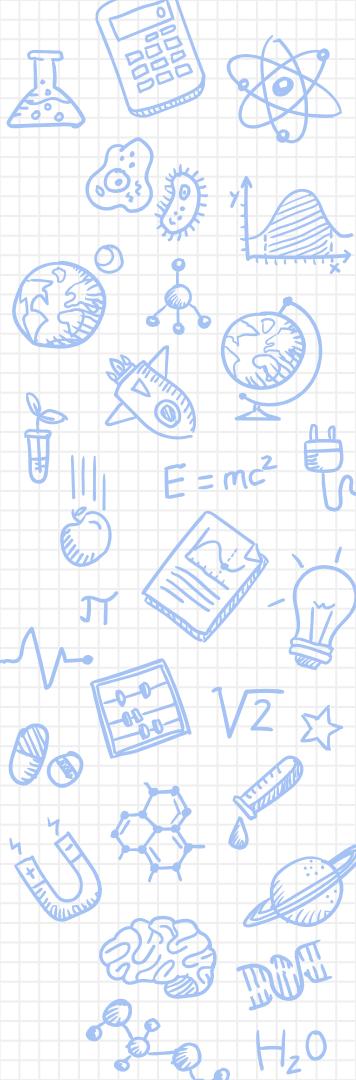
kittalu4u@gmail.com

Börger#7091 **or** “Krutharth” on the ScioCamp Discord



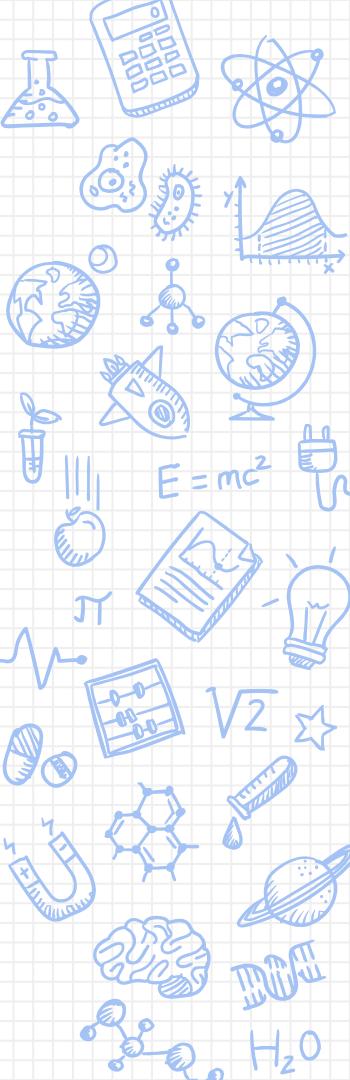
Absorption

Lesson 3



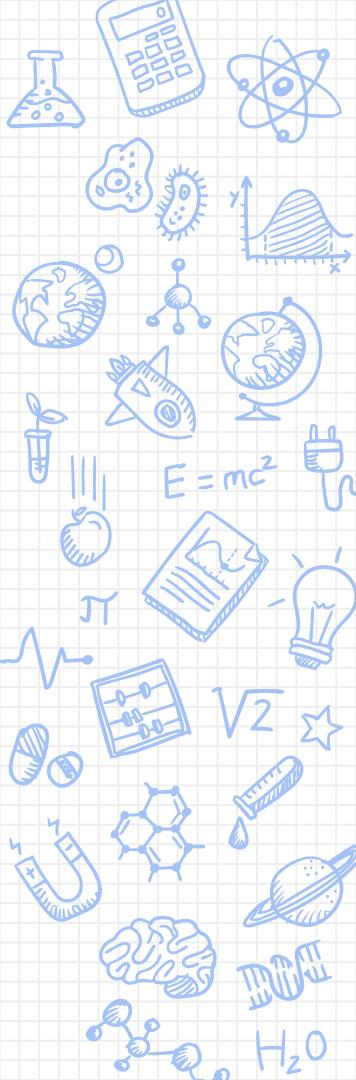
Homework and Course Challenge Posted

- ❖ Both are optional
 - Both can earn you points
 - ❖ Course challenge is pretty fun
 - ❖ Homework shouldn't take too long
 - Around 15 minutes
 - ❖ Course challenge will take as long as you want it to take
 - ❖ Course challenge + hw
 - https://docs.google.com/forms/d/e/1FAIpQLSc5LWJxGBAuUZ853SGfmZSowzd1PXPYAjFB9IpqE-NXyq_gHw/viewform



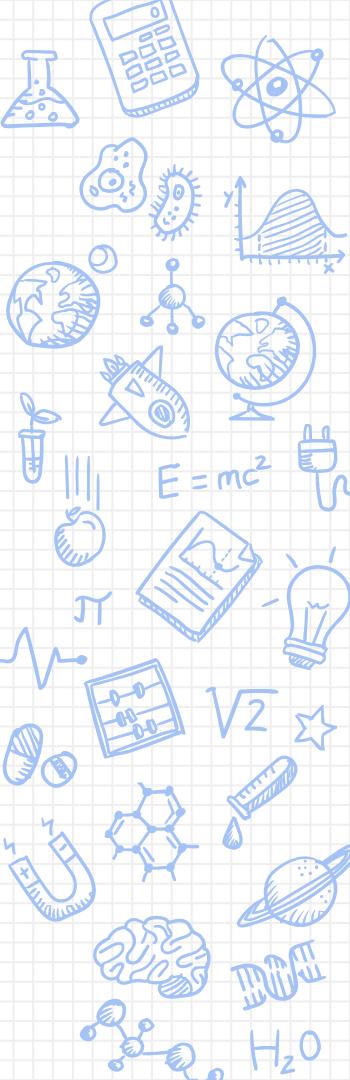
Pairing

- ❖ You can work alone or with groups in course challenge
- ❖ You can work with whoever you want
 - Even if they aren't in division 2
- ❖ Pairing form if you want to be paired
 - <https://docs.google.com/forms/d/e/1FAIpQLScZEK1TsPGK2P4vlHdNXPhlthYFWch31RhFOFJtRKSWmq7hDA/viewform>
- ❖ Points will not be split among team members if you work together (each person will get full points)



Breakout rooms starter

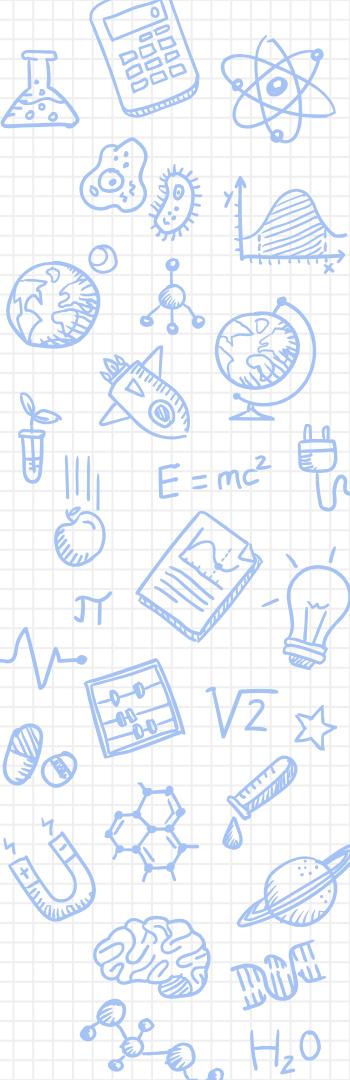
- ❖ Try and come up with as many similarities as you can between each other
 - ❖ Cannot include
 - Being from the same place
 - Have same amount of siblings
 - All being humans



Review from Last time!!!

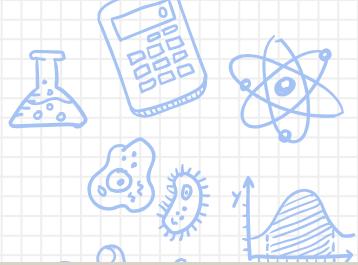
❖ Layers of GI tract

- Mucosa
 - Absorptive and secretory layer
- Submucosa
 - Vascular layer serving mucosa
- Muscularis
 - Smooth muscle layer allowing for peristalsis and contractions
- Serosa
 - Outer layer of GI tract



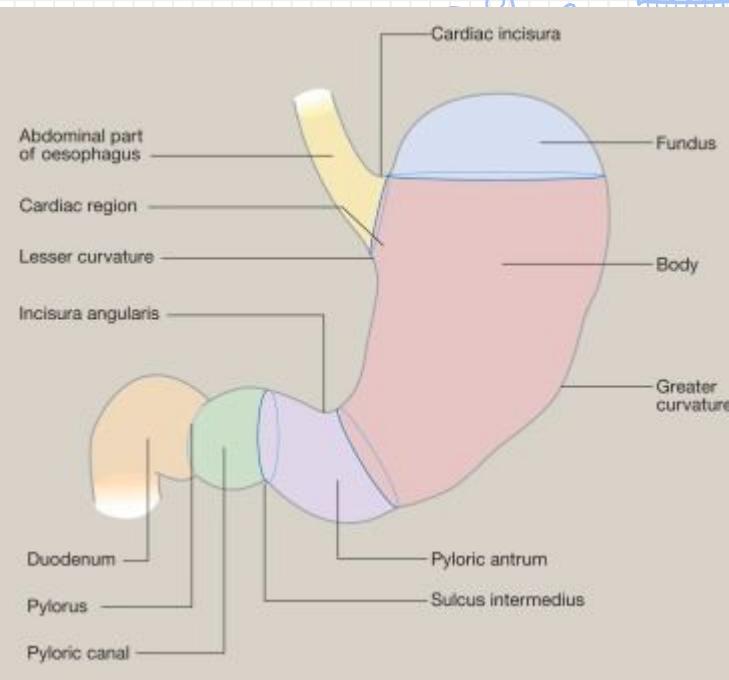
Review from Last time!!!

- ❖ Regulation
 - Parasympathetic
 - Promote digestive actions
 - Sympathetic
 - Inhibit digestive actions
 - Enteric Nervous system and paracrine regulators
 - Self-regulation
- ❖ Peristaltic contractions of esophagus push food from mouth to stomach
- ❖ Low pH of stomach aids digestion

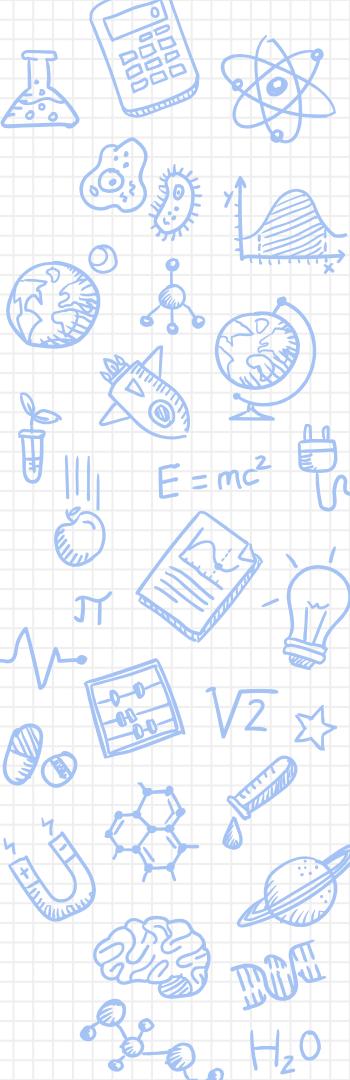


Review from Last time!!!

- ❖ Mucus/goblet cells
 - Secrete mucus
- ❖ Parietal cells
 - Secrete HCl
- ❖ Chief/zymogenic cells
 - Secrete pepsinogen
- ❖ Enterochromaffin-like cells
 - Secrete histamine and serotonin (paracrine regulators)
- ❖ G cells
 - Secrete gastrin into blood (hormone)
- ❖ D cells
 - Secrete somatostatin into blood (hormone)
- ❖ Stomach secretes ghrelin
 - P/D1 cells



Absorption



Absorption and Small Intestine

- ❖ Stomach partially digests foods
 - Mainly digests proteins only
- ❖ Small intestine completes digestion of other food macromolecules
 - Brush border enzymes
 - Enzymes from pancreas
- ❖ Small intestine absorbs monomers to build new things from them and generate energy
 - Generate ATP
 - Generate cell-specific polypeptides from absorbed amino acids for example

Regions of Small Intestine

❖ Duodenum

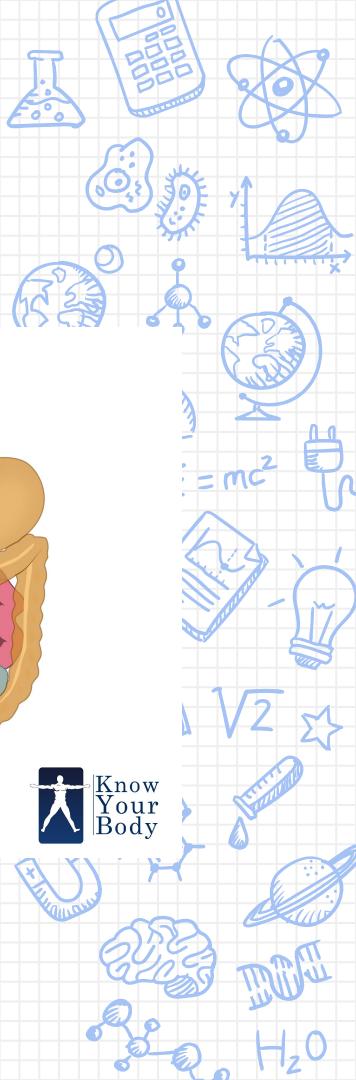
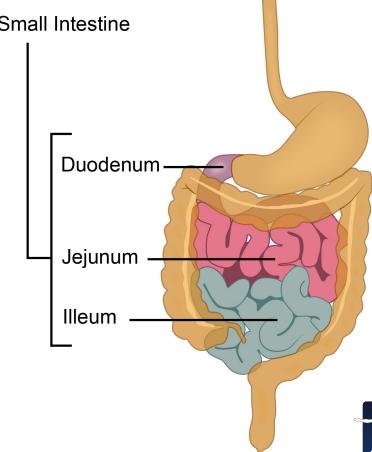
- Folate
- Iron
- Vitamin D3
- Sugars
- Amino acids
- Fatty acids

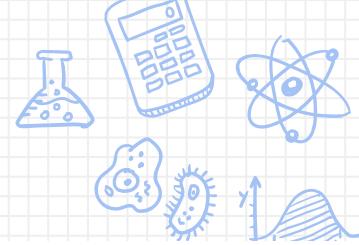
❖ Jejunum

- Sugars
- Amino acids
- Fatty acids

❖ Ileum

- Vitamin B12 (intrinsic factor needed)
- Bile acids

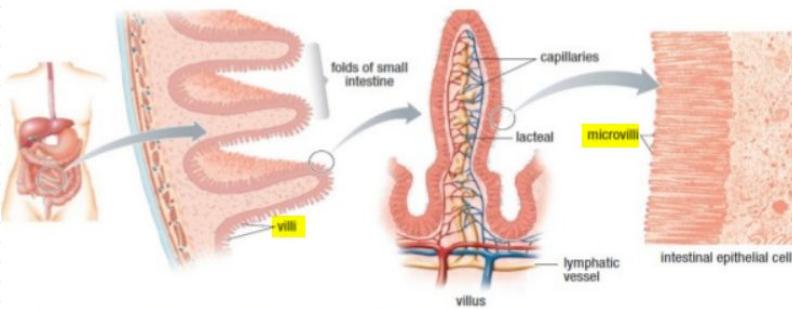




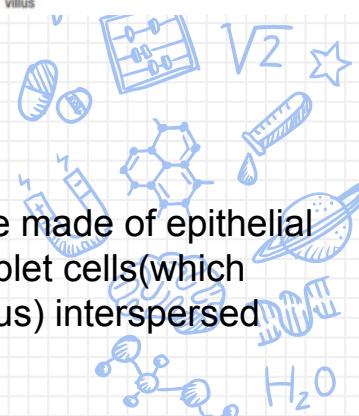
Structural adaptations

- ❖ Increases in surface area
 - Also seen in respiration and other organisms for a variety of functions!!
- ❖ More area for absorption of nutrients
- ❖ Villi made of multiple cells
- ❖ Each cell has many microvilli
 - Makes up brush border
- ❖ Contain blood vessels/capillaries
 - Carries nutrients
- ❖ Central lacteal
 - Carries fats

Villi and Microvilli

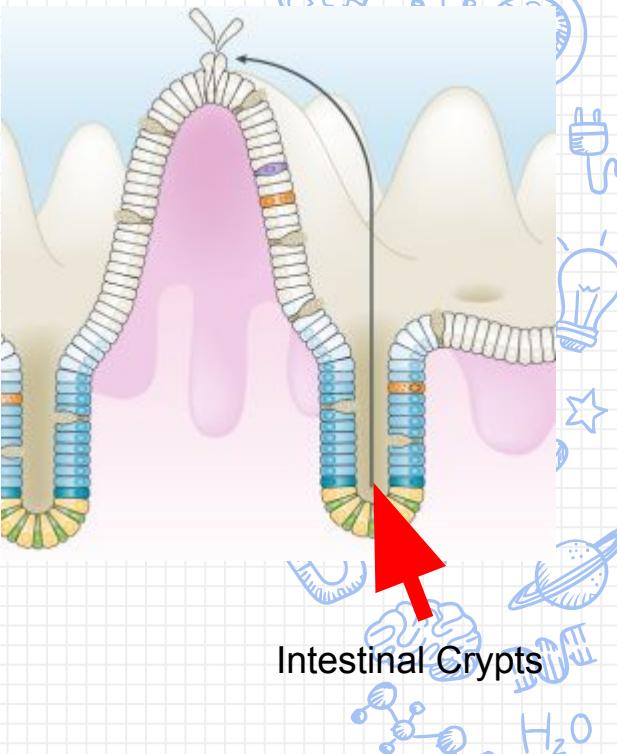


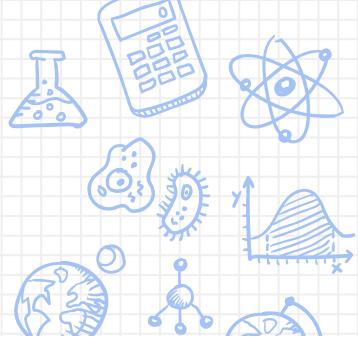
Note: Villi are made of epithelial cells with goblet cells (which secrete mucus) interspersed between



More on Villi!

- ❖ Epithelial cells shed at top and generated at bottom continuously
- ❖ Paneth cells located in crypts which regulate intestinal microbiota and maintain stem cells



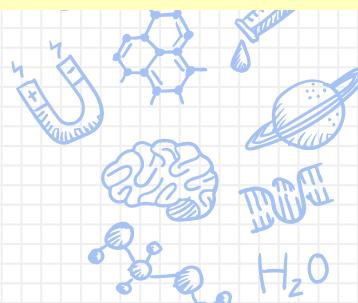
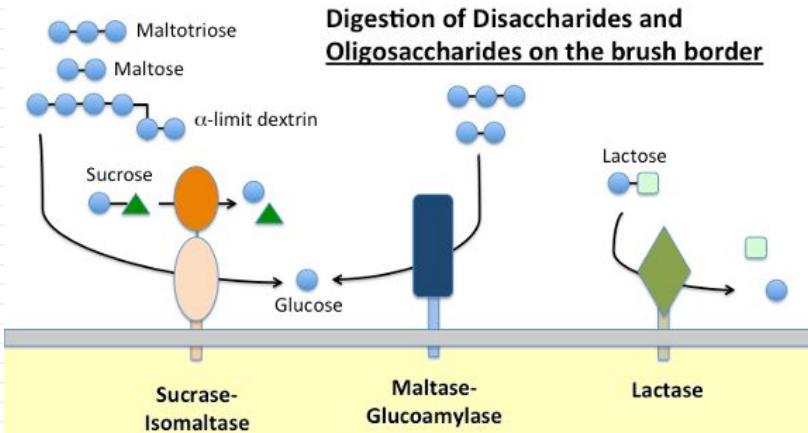


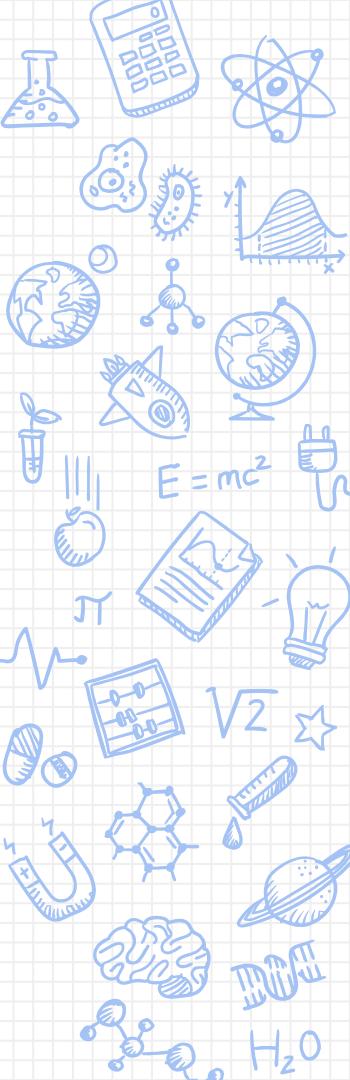
Intestinal Digestion: Intestinal enzymes

❖ Plasma membranes of microvilli contain digestive enzymes

➤ Brush Border enzymes

- Stay attached to microvilli membranes (not released into lumen)
- Examples:
 - Disaccharidases
 - Peptidase
 - Phosphatase



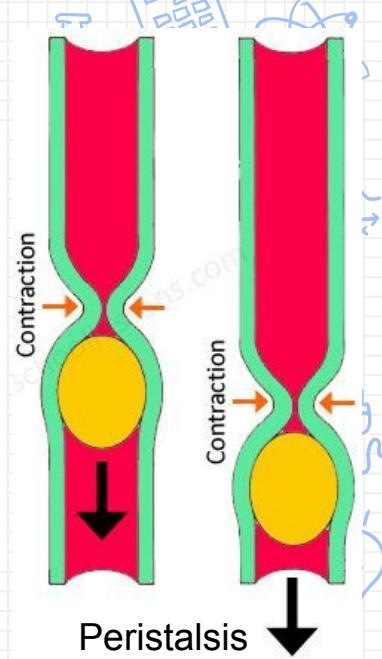
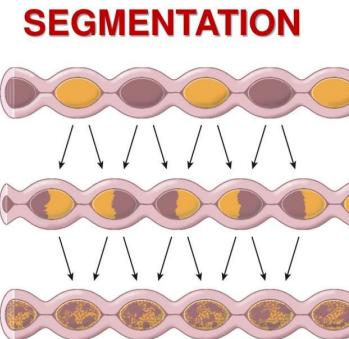


Pancreatic enzymes

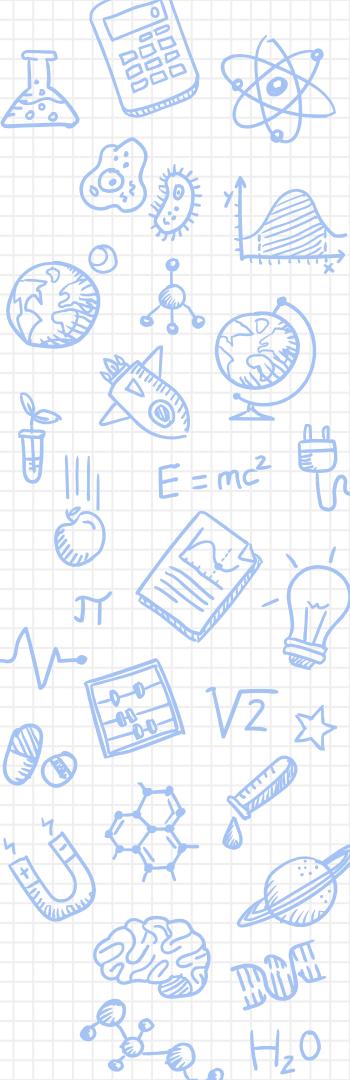
- ❖ Release of pancreatic juice into small intestine
 - Contains amylase(digests starch carbohydrates)
 - Contains trypsin(digests protein)
 - Contains lipase(digests fats)

Intestinal Movement: Peristalsis

- ❖ Two main types: peristalsis and segmentation
- ❖ Peristalsis controls muscle contraction and relaxation
 - Smooth muscle contraction behind food pushing it forward and relaxation in front of food, allowing to enter the next portion of intestine



Note: Peristalsis pushes food in one direction, allowing for net movement. Segmentation involves contraction at multiple sites and does not cause net movement.

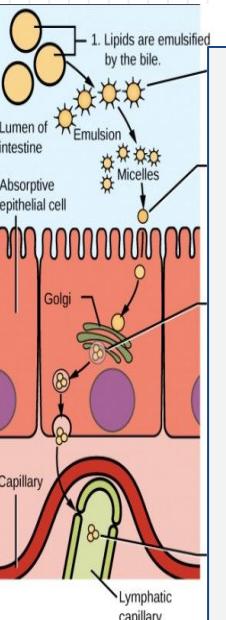


Intestinal Movement: Segmentation

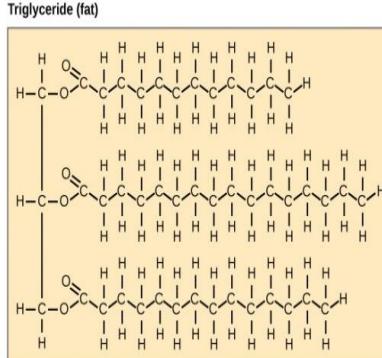
- ❖ Segmentation involves simultaneous constriction at different segments
 - Mixes chyme
 - Contractions paced by slow waves initiated by Interstitial cells of Cajal in muscularis
 - Cells depolarize, allow influx of calcium and initiate contraction
- ❖ Does anyone know why calcium is needed for muscle contraction?

Hepatic Portal Vein and Lacteal

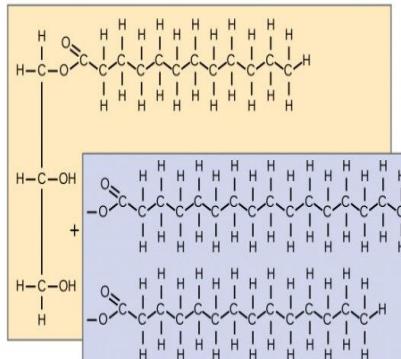
- ❖ Nutrients absorbed by villi are transported into capillaries in villi
 - ❖ Capillaries converge into Hepatic Portal Vein going to liver
 - Allows liver to regulate composition of blood
 - Allow liver to remove toxic ingested substances
 - ❖ Why would liver regulating blood composition be important?



1

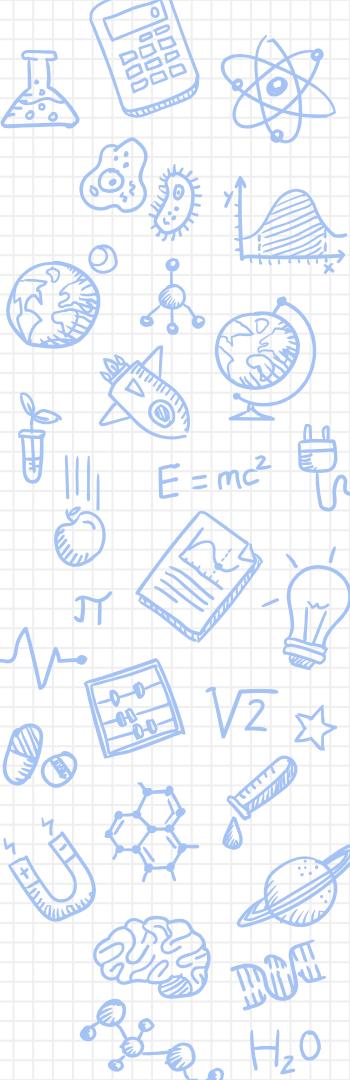


Monoallycerid



Fatty acid





Fat Absorption in Small Intestine

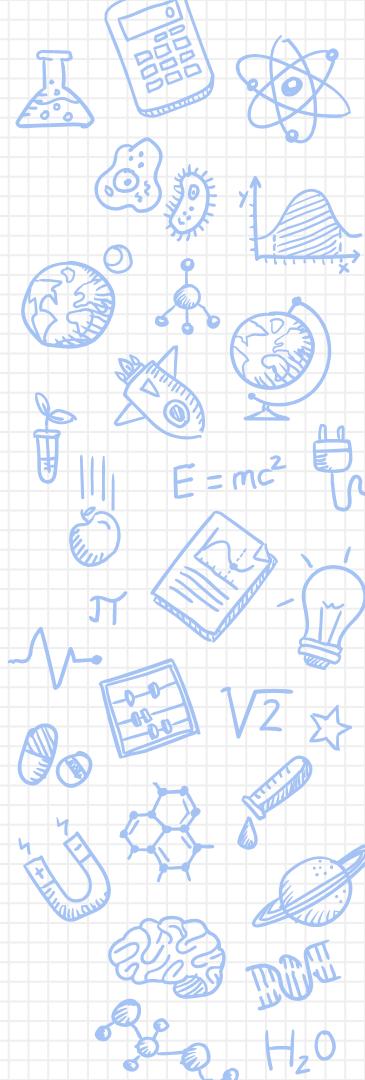
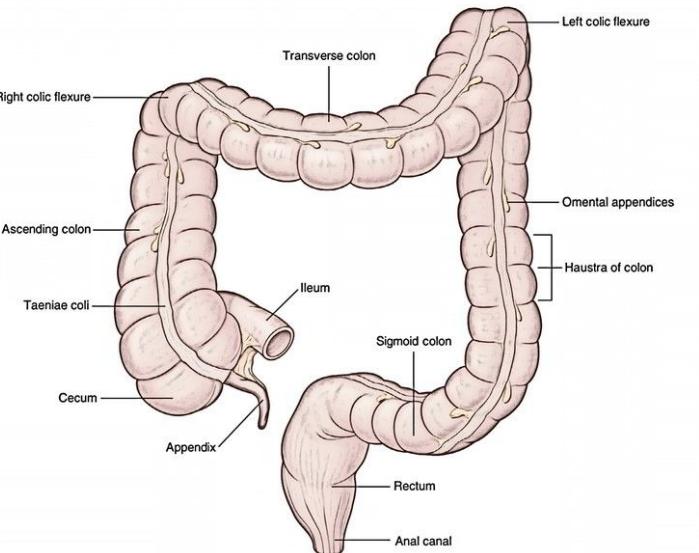
- ❖ Lipase breaks down triglyceride fats into monoglycerides and fatty acids
- ❖ Triglycerides are re-formed within villi and form chylomicrons
 - Triglycerides are combined with cholesterol, phospholipids, and proteins
 - Chylomicrons absorbed by lacteal in each villus, enter lymph and returned to heart
 - Lymph converges with blood at heart

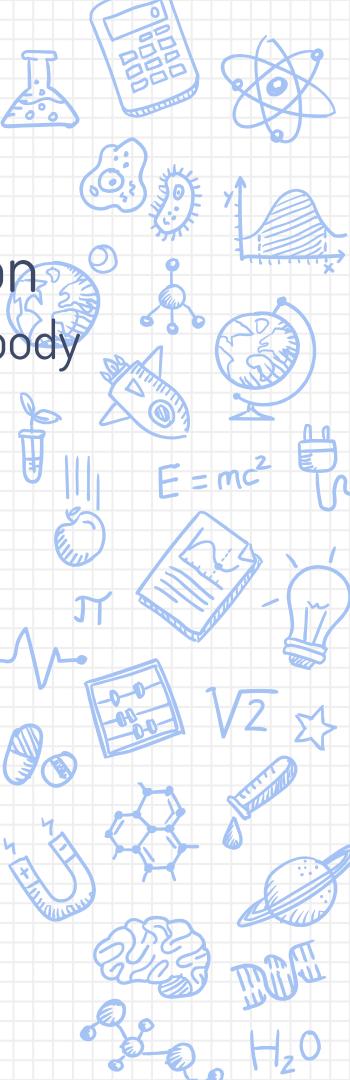


Large Intestine/Colon Anatomy

- ❖ Large Intestine absorbs water, mineral and vitamins and secretes the remains as feces
- ❖ Ileum passes chyme to large intestine and out of body
 - Ileum -> cecum -> ascending colon -> transverse colon -> descending colon -> sigmoid colon -> rectum -> anal canal -> anus -> toilet
- ❖ No villi
 - No brush border
- ❖ Outpocketings called haustra
- ❖ Cecum contains symbiotic bacteria helping in final digestion of chyme in large intestine

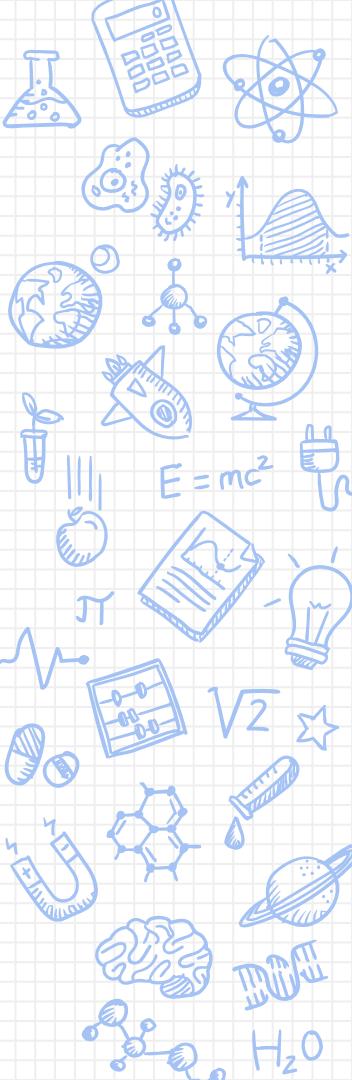
Large Intestine





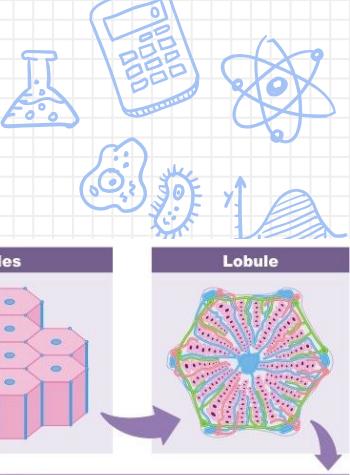
Intestinal Microbiota

- ❖ You may have heard bacteria in your gut help in digestion
 - Around 10x more microorganisms cells in large intestine than in body
 - Collectively called intestinal microbiota/microflora
- ❖ Microbiota is similar within families
 - Microbiota bacteria are derived from mother
- ❖ May play role in obesity and general health
- ❖ Microbiota provides nutrients
 - Vitamin K
 - B vitamins
 - Produce short-chain fatty acids
 - Also helps in water absorption



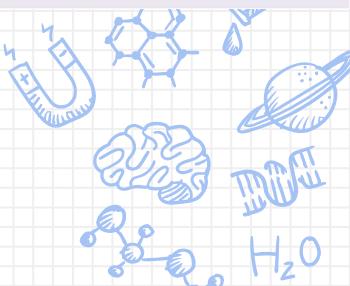
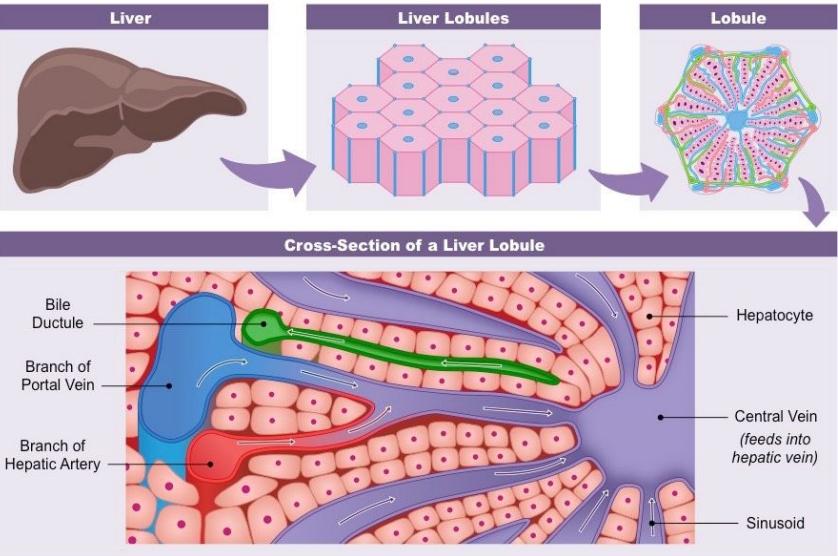
Accessory Organs of Digestive System

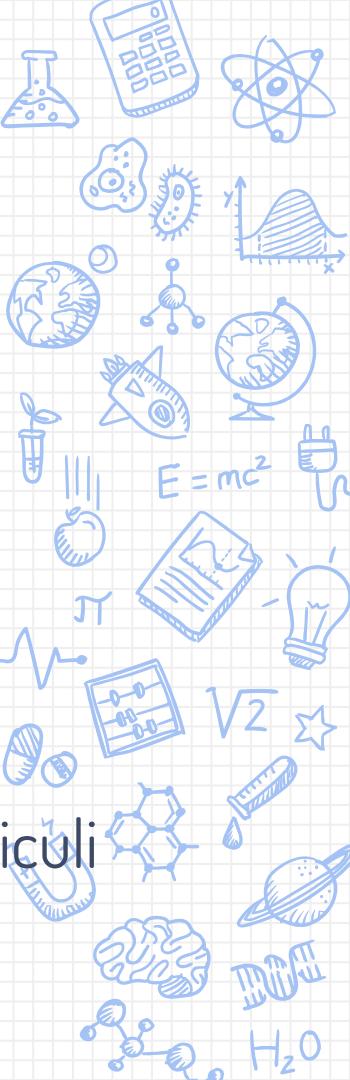
- ❖ Teeth
- ❖ Tongue
- ❖ Glandular organs
 - Salivary glands
 - Glands secreting digestive enzymes
- ❖ Liver
- ❖ Gallbladder
- ❖ Pancreas



Liver Structure

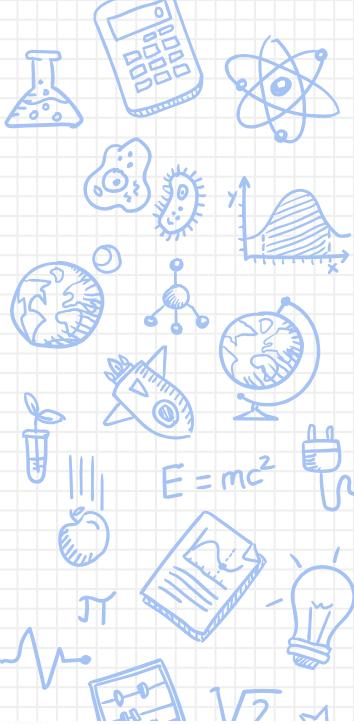
- ❖ Liver processes contents of hepatic portal vein
 - Detoxifies blood
 - Secretes glucose, fats and ketone bodies
 - Produces plasma proteins
- ❖ Liver is made of hepatocytes forming hepatic plates separated by sinusoids (capillary spaces)
- ❖ Liver is supplied with blood by hepatic portal vein and hepatic artery



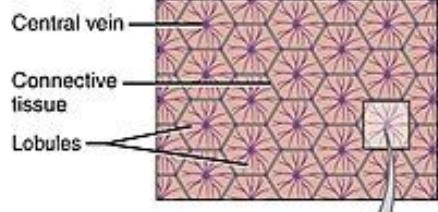
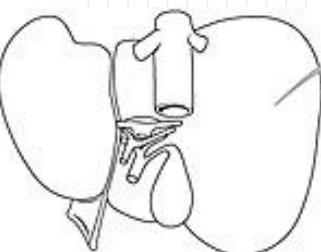
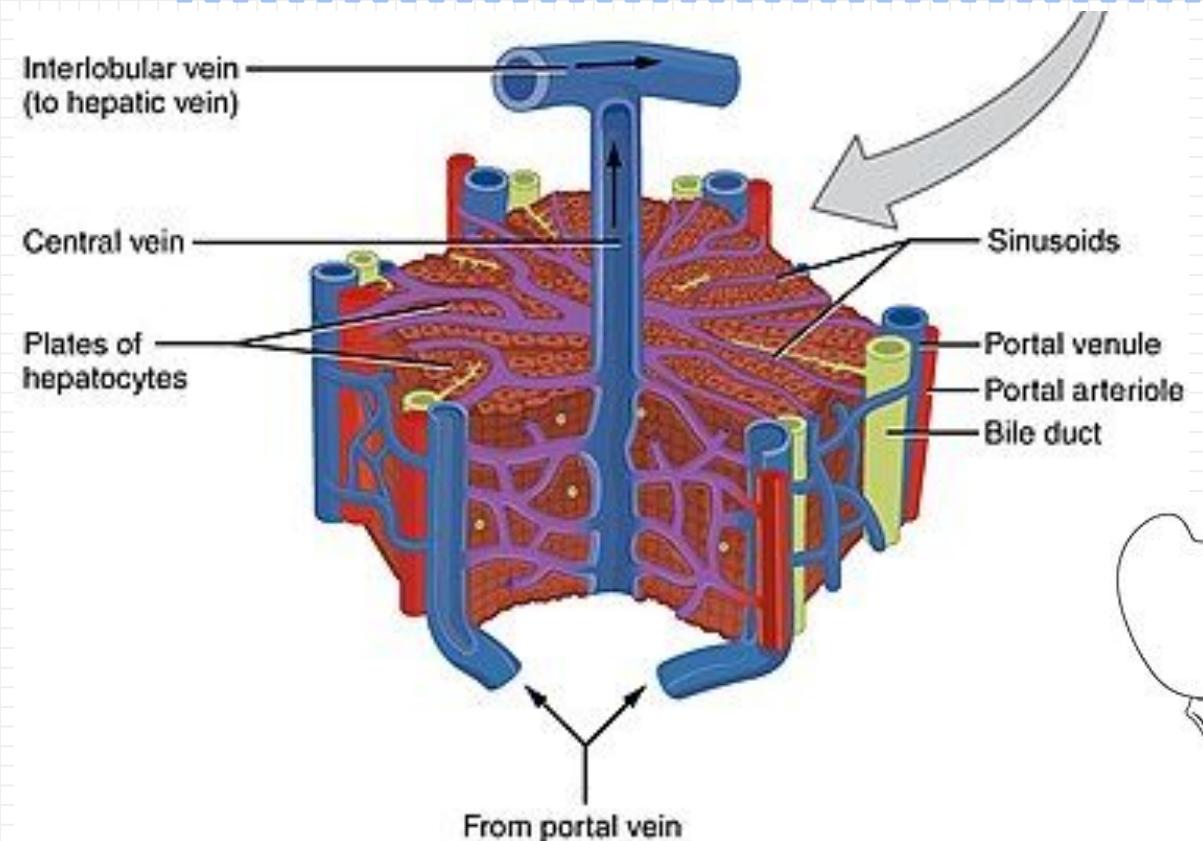


Liver Structure

- ❖ Hepatic plates organized into liver lobules
- ❖ Central vein in middle of each lobule
- ❖ Branches of hepatic portal vein and hepatic artery at periphery
 - Branches open into sinusoids which flow into central vein
 - Central vein converges to form hepatic vein
 - Returns blood to circulation
- ❖ Bile is made by hepatocytes and secreted into bile canaliculi in each hepatic plate
 - Bile canaliculi → bile ducts → hepatic ducts



Liver Structure



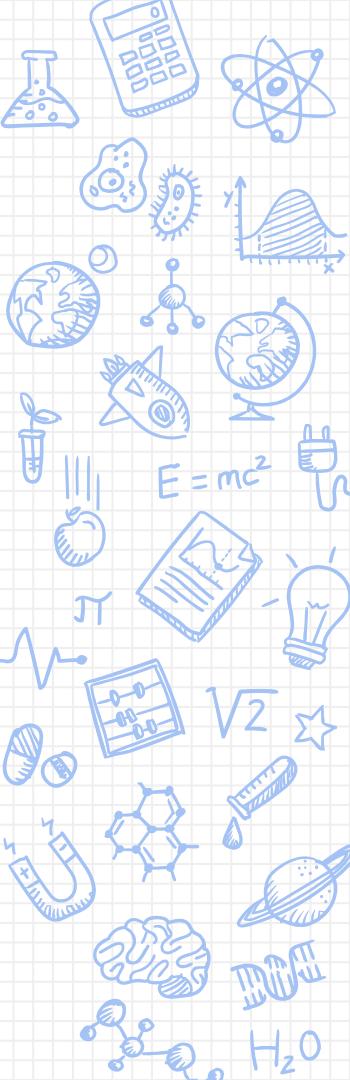
$$E=mc^2$$

1/5 ~

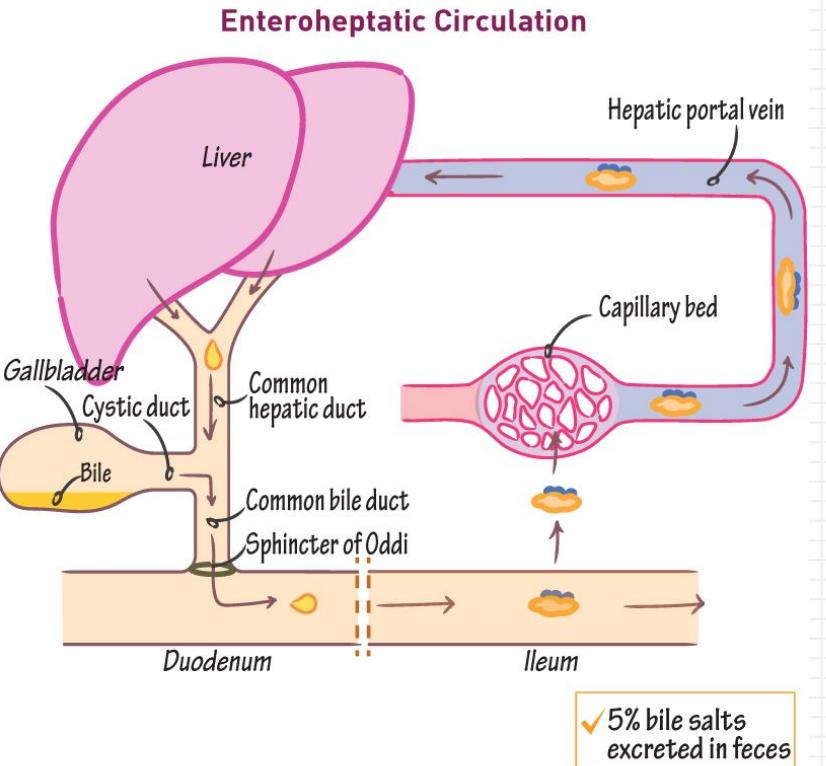


Liver Functionality

- ❖ Liver clears blood of certain compounds by removing them from blood and secretion into bile
 - Bile is released into intestines
- ❖ Some compounds released into bile enter enterohepatic circulation
 - Bile is secreted along with compounds into intestines
 - Compounds in bile are reabsorbed into hepatic portal vein
 - Compounds end up in liver which secretes them into bile again
 - Bile is secreted along with compounds into intestines
 - Some compounds circulate between intestines and liver (enterohepatic circulation)



Enter hepatic Circulation



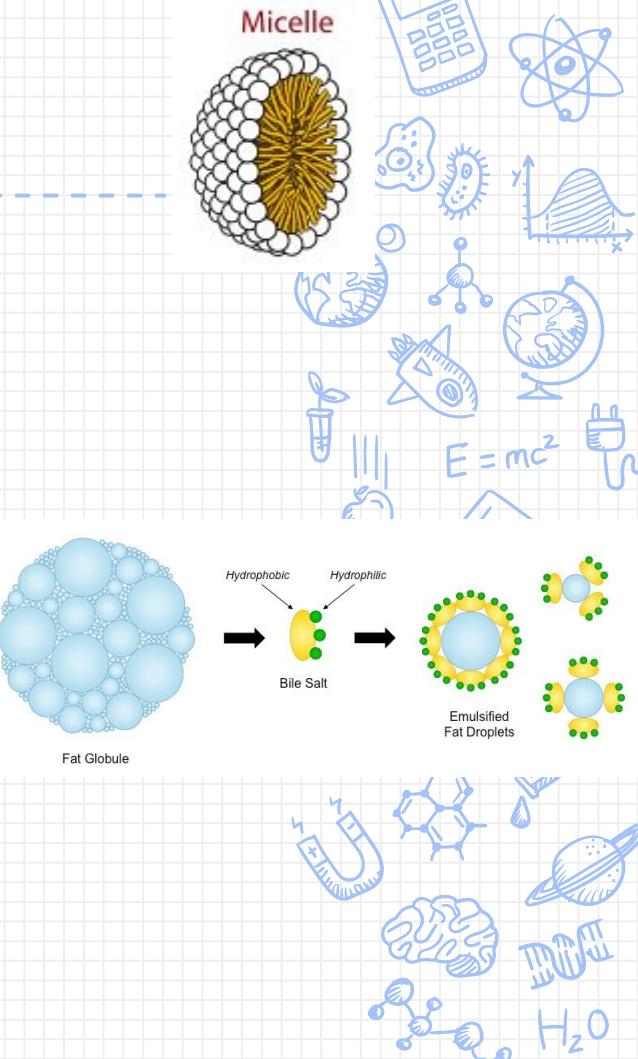


Bile Pigments

- ❖ Bile consists of bile pigment(bilirubin), bile salts, phospholipids, cholesterol, inorganic ions
- ❖ Liver processes bile pigment which is excreted or trapped in enterohepatic circulation
 - Liver combines bilirubin with glucuronic acid forming conjugated bilirubin
 - Bile goes into intestine where conjugated bilirubin is converted to urobilinogen
 - Some urobilinogen is excreted with feces
 - Other urobilinogen is taken up by hepatic portal vein and travels to liver
 - Some of urobilinogen is then secreted into bile again and trapped in enterohepatic circulation
 - Some other urobilinogen in liver enters blood circulation and exits via urine

Bile acids

- ❖ Bile acids are derivatives of cholesterol
 - Cholic acid
 - Chenodeoxycholic acid
- ❖ Bile acids combined with amino acids to form bile salts
- ❖ Bile salts form micelles due to amphiphilic properties
- ❖ Lipids in small intestine enter bile salts and become emulsified
 - Large fat globules split into smaller globules with greater surface area allowing for lipase to better break them down





Other Liver Functions

- ❖ Liver can remove drugs, hormones and biologically active compounds by:
 - Excretion of these molecules in bile from which they can then enter the feces
 - Kupffer cells lining the sinusoids may phagocytose/engulf these compounds
 - Chemically alter these molecules within hepatocytes
- ❖ Liver regulates blood glucose levels
 - Glycogenesis and lipogenesis when levels are high or after a meal
 - Glycogenolysis and gluconeogenesis when levels are low or during fasting
- ❖ Liver produces plasma albumin and plasma globulins
 - Albumin contributes most to the colloid osmotic pressure of blood
 - Globulins have transport and blood clotting functions
- ❖ What other body organs function in removing waste products?



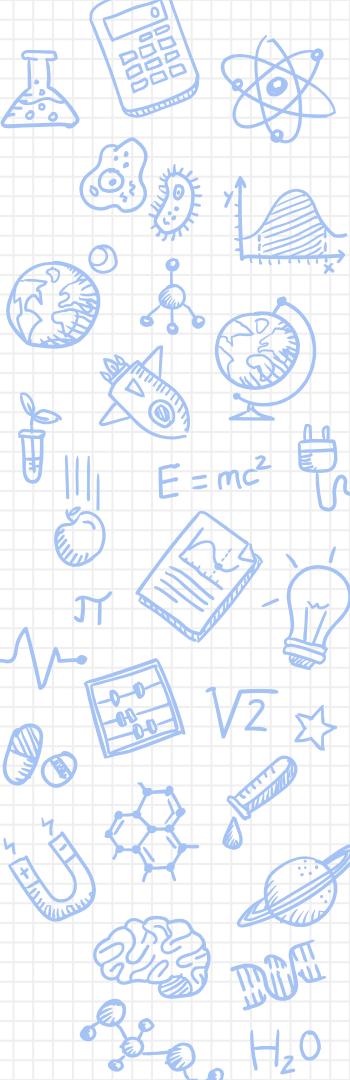
Gallbladder and Pancreas

- ❖ Gallbladder stores bile produced by liver
 - Located below liver
- ❖ Bile is released when chyme is in small intestine and stored in gallbladder
- ❖ Pancreas secretes pancreatic juice into duodenum containing digestive enzymes and bicarbonate
 - Digestive enzymes contribute to digestive function in conjunction with brush border enzymes
 - Bicarbonate neutralizes acidity of chyme



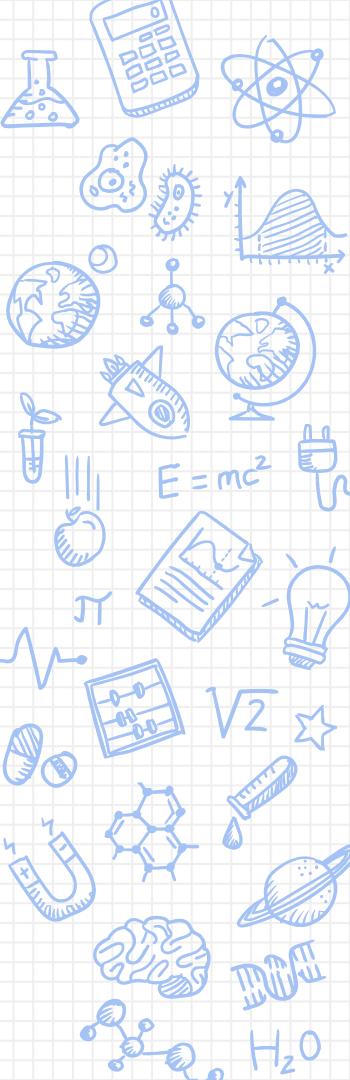
Final Review

- ❖ Small intestine split into 3 parts
 - Duodenum
 - Jejunum
 - Ileum
 - ❖ Villi and microvilli increase absorption in small intestine
 - ❖ Most nutrients(sugars, amino acids, nucleic acids) flow into hepatic portal vein to liver after absorption
 - ❖ Triglycerides flow into lymphatic system directly to heart after absorption as chylomicrons
 - ❖ Digestive enzymes from pancreas and brush border enzymes constitute small intestine digestive capabilities



Final Review

- ❖ Microbiome releases in large intestine produces vitamins and some nutrients from chyme
 - Essential for many aspects of good health
- ❖ Enterohepatic circulation is circulation of compounds between small intestine and liver
- ❖ Bile pigments derived from hemoglobin are excreted in urine, feces or trapped in enterohepatic circulation



-
- ❖ Bile salts emulsify fats in small intestine
 - ❖ Liver also detoxifies substances, regulates blood sugar and makes blood proteins
 - ❖ Gallbladder stores bile
 - ❖ Pancreas makes digestive enzymes and bicarbonate

More information

- Go read Fox Chapter 16(respiration) and 18(digestion):
 - <http://library.lol/main/80F5169D0BC997AD06EB67462C68485F>
- Science Olympiad Digestive Notes:
 - https://scioly.org/wiki/index.php/Anatomy/Digestive_System
- Campbell's Biology Chapter 41(digestive) and part of 42(respiratory):
 - <http://library.lol/main/EEDC6CFC9E0CE4439369C1AB7D3E3B63>



Any questions?

