



# 🏆 Let's Take Attendance 🏆

<http://sciovirtual.org/attendance>

Attendance code: brain31



# 🏆 ScioCamp Feedback 🏆

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# Updates on HW and course challenge

- ❖ Due date will be pushed to end of day Wednesday to allow those who haven't been paired to work together and get it done
- ❖ Do you all want homework 3+4 to be posted today?
- ❖ Homework 5+6 along with Course Challenge 2 will be posted on Thursday and you will have until Monday to do it

# **Regulation and Disease**

Lesson 4

# Review from last time!!!

- ❖ Duodenum, Jejunum and Ileum parts of small intestine absorb different compounds
- ❖ Microvilli and Villi stud the intestinal surface
- ❖ Nutrients(except triglycerides) are absorbed and enter hepatic portal vein -> liver -> general blood circulation
- ❖ Triglycerides are absorbed and enter lacteals(as chylomicrons) -> lymphatic system -> heart -> general blood circulation
- ❖ Pancreatic enzymes and brush border enzymes aid in digestion in small intestine

# Review from last time!!!

- ❖ Large intestine harbors diverse microbiota
  - Produce short-chain fatty acids
  - Aid in vitamin and mineral absorption
- ❖ Large intestine absorbs vitamin K, B vitamins, water and electrolytes
- ❖ Liver can take substances from hepatic portal vein and blood and secrete them in bile for excretion through feces
- ❖ Compounds in bile can also circulate between small intestine and liver called enterohepatic circulation
- ❖ **Does anyone remember what enterohepatic circulation is?**
- ❖ Bile pigment is derived from degraded hemoglobin and is excreted via urine, feces or trapped in enterohepatic circulation

# Review from last time!!!

- ❖ Bile salts emulsify fats
- ❖ Liver in summary:
  - Detoxifies substances
  - Regulates glucose levels
  - Produces plasma proteins
- ❖ Gallbladder stores bile
- ❖ Pancreas secretes digestive enzymes and bicarbonate
  - Bicarbonate neutralizes acidity of chyme in duodenum

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# Blooket game!!!

# Regulation of Gastric (stomach) Function

- ❖ Does anyone remember what part of the nervous system is related to self regulation of digestion?
- ❖ Gastric functions is automatic to some extent
  - Stomach itself controls pushing chyme through pyloric sphincter
  - Partially digested protein in stomach can stimulate HCL release(from parietal cells) and pepsinogen release(from chief cells)
- ❖ Autonomic nerves and hormones(extrinsic) work in conjunction with this automatic activity
- ❖ Extrinsic control of stomach function is divided into 3 phases
  - Cephalic Phase
  - Gastric Phase
  - Intestinal Phase

# Cephalic Phase

- ❖ Control by the brain via vagus nerves
- ❖ Variety of stimuli related to food can trigger the brain to activate vagus nerve which stimulates chief cells and parietal cells
  - Chief cells secrete pepsinogen
  - Parietal cells secrete HCL
- ❖ Vagus nerve stimulates parietal cells indirectly
  - Vagus nerve stimulates G-cells to secrete gastrin
  - Gastrin acts as a hormone and stimulates ECL cells to secrete histamine
  - Histamine acts as a paracrine regulator and stimulates parietal cells to secrete HCL

# Gastric Phase

- ❖ Arrival of food in stomach stimulates gastric phase
- ❖ There is already some HCL and pepsin in stomach due to cephalic phase
- ❖ Partial digestion of protein occurs and stimulates more acid secretion
  - HCL and pepsin already present from cephalic phase partially digest some proteins
  - Partially digested proteins stimulate chief cells to secrete pepsinogen and G cells to secrete gastrin
  - Gastrin stimulates secretion of pepsinogen from chief cells and HCL indirectly from parietal cells
  - Positive feedback loop occurs as more protein digestion stimulates more HCL and pepsinogen secretion which in turn facilitate more protein digestion
- ❖ One HCL secretion lowers pH sufficiently, D cells are stimulated to secrete somatostatin
  - Somatostatin prevents further gastrin release and acid release

# Intestinal Phase

- ❖ Inhibition of gastric activity when chyme enters small intestine
- ❖ Presence of stretch in duodenum and increase in concentration inhibits gastric activity through neural reflex
  - Vagus nerves
- ❖ Fat in chyme also inhibits gastric activity through hormones
  - Enterogastrones
    - Cholecystokinin
    - Glucagon-like peptide-1
- ❖ Give small intestine time to digest and absorb food after receiving chyme

# Enteric Nervous System

- ❖ A collection of around 100 million nerve cells along the GI tract which are involved in self-regulation of digestive processes
  - Extrinsic afferents from ENS deliver sensory information to CNS via vagus nerves
  - Intrinsic afferents deliver sensory information to interneurons with ENS and help in self-regulating activity
- ❖ Examples of self-regulation by ENS include peristalsis in esophagus
  - Intrinsic afferents detect the entry of chyme into esophagus
  - Interneurons are activated which in turn activate motor neurons
  - Motor neurons stimulate contraction of smooth muscle behind the bolus and relaxation of smooth muscle in front of bolus
    - Drives bolus down the esophagus

# Regulation of Pancreatic Juice and Bile Secretion

- ❖ Vagus nerve input to pancreas and cholecystokinin hormone secreted by duodenum stimulates secretion of pancreatic enzymes
  - Cholecystokinin is stimulated by protein and fat in chyme
    - There is need to digest protein and fat
- ❖ Duodenum secretes secretin hormone when there is fall of duodenal pH
  - Bicarbonate from pancreatic juice then neutralizes acidity and stabilizes pH
- ❖ Bile is continuously produced by liver is stimulated to secrete more after a meal
  - CCK and secretin enhance bile secretion
  - Arrival of chyme in duodenum stimulates contractions of gallbladder allowing more bile to be secreted into duodenum

# Digestive enzymes

- ❖ Digestive enzymes are released in mouth, stomach and small intestine
- ❖ Small intestine derives enzymes from brush border and pancreas
- ❖ **Does anyone remember the difference between pancreatic and brush border enzymes?**
- ❖ Common enzymes
  - Salivary amylase - Enzyme breaking down starch(carbohydrates) in saliva
  - Lingual lipase - Enzyme breaking down fats in saliva
  - Pepsinogen -> pepsin - Enzyme breaking down peptides(proteins) in stomach
  - Trypsin - Pancreatic enzyme breaking down proteins(cleavage at basic amino acids)
  - Chymotrypsin - Pancreatic enzyme breaking down proteins(cleavage at aromatic amino acids)
  - Aminopeptidase - Brush border enzyme breaking down amino acids from amino terminal
  - Carboxypeptidase - Pancreatic enzyme breaking down amino acids from carboxyl-terminal

# More Digestive Enzymes!!

- Pancreatic nuclease - Pancreatic enzyme breaking down nucleic acids into individual nucleotides
- Nucleotidase - Brush border enzyme breaking down nucleotides into nucleosides(nitrogenous base and sugar)
- Nucleosidase - Brush border enzyme breaking down nucleosides
- Lactase - Enzyme breaking down lactose in small intestine(disaccharidase)
- Pancreatic lipase - Pancreatic enzyme breaking down fats
- Dipeptidase - Brush border enzyme breaking down dipeptides(two linked amino acids)

# Disease!!!

- ❖ A variety of ailments result from misregulation, infection and destruction of the digestive system including:
  - Crohn's Disease
  - Peptic Ulcers
  - Diabetes
  - Diarrhea
  - Lactose intolerance
  - Hepatitis
  - Appendicitis
  - Diverticular Disease
  - Gastroesophageal reflux disease(GERD)
  - Celiac Disease

# Crohn's Disease

- ❖ Disease causing inflammation of digestive tract
  - Usually affects small and large intestine
- ❖ Causes are unknown but may involve autoimmune reaction and genetics may be involved
  - Eating certain foods and stress can make symptoms worse
- ❖ Family history, smoking, certain medications(antibiotics and NSAIDs), and a high-fat diet can increase chance of developing Crohn's
- ❖ Common symptoms include diarrhea, cramping/pain in abdomen, and weight loss
  - Other possible symptoms are anemia, eye redness/pain, fatigue, fever, joint pain, nausea and red bumps under skin
- ❖ Diagnosis involves medical history(symptoms), family history, physical exam(checking for sounds, pain or bloating from abdomen), colonoscopy, blood tests, stool tests, upper GI endoscopy, image tests(such as CT scans)
- ❖ Treatments include medicines decreasing inflammation and diarrhea, bowel rest(drinking only certain liquids or not drinking or eating anything), or surgery to remove a damaged part of digestive tract

# Peptic ulcers

- ❖ A sore in the lining of the stomach or duodenum
- ❖ Caused by erosions of the mucosa of the stomach or duodenum due to the acidity of HCl  
**(hydrochloric acid)**
  - often caused by the bacteria ***Helicobacter pylori***
- ❖ Also caused by long-term use of NSAIDs such as aspirin and ibuprofen
- ❖ Symptoms include burning stomach pain
  - Pain occurs between meals or during night
  - Briefly stops if you take antacids
  - Comes and goes for many days or weeks
- ❖ Blood, stool and breathing tests are used to test for *H. pylori* infection
  - Endoscopy or x-ray may be needed
- ❖ Treatment often includes medicines to reduce secretion of stomach acids and antibiotics to treat *H. pylori* infection
  - Surgery may be needed if the peptic ulcers don't heal

# Diabetes

- ❖ Disease involving high blood glucose levels
- ❖ Insulin stimulates glucose uptake from blood
  - Insulin not produced in type 1 diabetes
  - Body doesn't respond to insulin in type 2 diabetes
- ❖ Type 1 diabetes is usually an autoimmune cell destroying insulin-producing beta cells of pancreas
- ❖ Type 2 diabetes is caused by decreased responsiveness to insulin and lowered synthesis of insulin
- ❖ Symptoms include excessive urination and thirst, weight loss, increased hunger, blurry vision, numbness in limbs, fatigue, slower healing wounds and having more infections than usual
- ❖ Several types of blood tests measuring glucose can usually diagnose diabetes
- ❖ In type 1 diabetes, taking insulin is required while in type 2 diabetes, lifestyle changes and medications which lower glucose production in liver, increase insulin sensitivity and increase insulin synthesis

# Diarrhea

- ❖ Disease involving loose, watery stools
  - May be an acute or chronic problem(acute diarrhea is common)
- ❖ Causes include bacteria from contaminated food or water, viruses(such as flu, norovirus, or rotavirus), parasites, medicines(antibiotics, cancer drugs, antacids), food intolerances(problems digesting certain ingredients of food such as in lactose intolerance) and problems with colon function
  - May also be caused as a result of another disease in GI tract such as Crohn's Disease
- ❖ Other symptoms include cramps/pain in abdomen, urgent needs to use bathrooms and loss of bowel control
- ❖ Diagnosed through physical exams, blood test, and stool test
- ❖ Treatment includes replacing lost fluids(prevents dehydration), medications(used to treat an infection), and drinking more fluids

# Lactose Intolerance

- ❖ The inability to digest foods with lactose(milk sugar) in them
- ❖ Brush border enzyme *lactase* becomes inactive in some adults
  - Deficiency of lactase results in lactose intolerance
- ❖ Symptoms include feeling sick, pain in stomach, gas, diarrhea, and swelling of stomach after ingesting lactose
- ❖ Tests include blood, breath or stool test for diagnosis
- ❖ Treatment just includes avoiding foods with lactose or taking pills to help digest lactose
  - Calcium supplements may be needed since milk products are the most common sources of calcium in diet

# Hepatitis

- ❖ Inflammation of the liver
  - Swelling that occurs when infected or injured and affects liver function
- ❖ Types include viral hepatitis(caused by viruses), alcoholic hepatitis(alcohol causes cirrhosis and liver damage), toxic hepatitis(caused by chemicals or medicines), autoimmune hepatitis(immune system attacks liver)
- ❖ People may be asymptomatic but symptoms include fever, fatigue, loss of appetite, nausea, abdominal pain, dark urine, bowel movements, joint pain, and jaundice
- ❖ Hepatitis can lead to liver scarring, failure and cancer
- ❖ Diagnosis involves medical history, physical exam, blood tests(tests for viral hepatitis), imaging tests(CT, MRI, etc.), and liver biopsy
- ❖ Treatments include medicines(antiviral drugs), surgery, and liver transplant

# Appendicitis

- ❖ Blockage of the **appendix**
  - Leads to increased pressure, inflammation and problems with blood flow
- ❖ Appendix can burst and spread infection if not treated
- ❖ Causes include infection(bacteria, viruses, or parasites), tumors, and blockage of tube joining large intestine and appendix
- ❖ Symptoms include pain in abdomen(right side), vomiting, upset stomach, loss of appetite, fever, chills, swollen belly and constipation
- ❖ Diagnosed through medical history, physical exam, blood tests(check for infection), urine tests(check for urinary infection) and imaging tests
- ❖ Treatment involves surgery to remove appendix and possibly antibiotics if there is an infection involved

# Diverticular Disease

- ❖ Outer surface of the colon bulges to create pouches called *haustra*
- ❖ The muscularis externa of the haustra becomes weakened so that the wall forms a more elongated outpouching, or diverticulum ( divert = turned aside )
  - Inflammation of these pouches results in diverticular disease, or **diverticulitis**
- ❖ Symptoms include pain, fever, nausea, cramps in lower abdomen and constipation or diarrhea
- ❖ Diagnosis involves blood tests(to check for infection), stool sample(checked for abnormal parasites causing infection), sigmoidoscopy(endoscopy in sigmoid colon), and colonoscopy
- ❖ Treatments involve antibiotics, pain medications, and a temporary liquid diet
  - Surgery in severe cases

# Gastroesophageal Reflux Disease (GERD)

- ❖ Does anyone know what causes heartburn?
- ❖ Irritation of esophagus produced by malfunction of gastroesophageal sphincter
  - Stomach contents leak back into esophagus
- ❖ Symptoms include burning sensation in chest(heartburn), chest pain, difficulty swallowing, regurgitation of food, sensation of a lump in throat
- ❖ Diagnosis involves physical exam, upper endoscopy, ambulatory acid probe test(identifies when and for how long acid regurgitates) and x-rays of upper digestive system
- ❖ Treatments include antacids, medications reducing acid production, and surgery

# Celiac Disease

- ❖ An immune reaction to eating gluten(protein found in wheat, barley and rye)
- ❖ Eating gluten triggers immune reaction which damages small intestine(damages villi)
  - Prevents small intestine from absorbing nutrients
- ❖ Cause is unknown but is generally inherited in families
- ❖ Symptoms include diarrhea, fatigue, weight loss, bloating, abdominal pain, nausea, and constipation
- ❖ Diagnosis involves blood test(looks to elevated levels of antibodies characteristic of immune response) and endoscopy
- ❖ Treatment largely includes following a gluten-free diet excluding wheat, barley, bulgur, malt, rye and some other foods
  - Anti Inflammatory drugs may be used to control inflammation

# Any questions?

# 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