**Nutritional Sciences 630: Principles of Nutrition**

**Exam 1**

**Multiple Choice: please choose one correct answer (2 points each; 46 points total)**

**Short Answer: please answer the following questions. The length of the answer should be as many sentences as the question is worth – give or take one sentence. (34 points total)**

MC -> 46 points

Liv -> 18 points

Dave -> 16 points

**Lecture 1 (some overlap of 2)**

1. Exposure to small concentrations of bacteria like Salmonella does not result in food-borne illness in healthy adults because:
2. The low pH (acidic environment) in the esophagus kills Salmonella before causing gastrointestinal distress
3. **The mucosal layer contains special immune-functioning tissue that can target Salmonella before causing gastrointestinal distress**
4. Salmonella is absorbed at the villi thus gastrointestinal distress, originating in the large intestine, is bypassed
5. Exposure to Salmonella stimulates the parasympathetic nervous system to *escalate* (increase)peristalsis, thus moving it through the tract too quickly before causing gastrointestinal distress
6. Peristalsis is important for movement of the bolus forward through the digestive tract. Which of the following is true in regard to the muscle movement:
7. **Peristalsis is highly regulated by the enteric nervous system**
8. Peristalsis results in a churning like motion to help mechanically break apart nutrients
9. Gastrin, a regulatory hormone, decreases peristalsis in the stomach
10. The submucosal layer is made of longitudinal and circular muscles that work together to create peristalsis
11. Secretin is produced:
12. Within the stomach and will stimulate the opening of the pyloric sphincter, allowing for chyme to move into the small intestine
13. Within the stomach and will stimulate the release of hydrochloric acid which allows for the cleavage of pepsinogen into pepsin
14. **Within the small intestine and will decrease gastric juice secretions and gastric motility of chymel**
15. Within the small intestine and will stimulate the contraction of the gallbladder to release bile into the duodenum

**Lecture 2 (and some overlap of 4)**

1. Which is the correct order of bile recirculation?
   1. Large intestine 🡪 liver 🡪 gallbladder
   2. **Small intestine 🡪 liver 🡪 gallbladder**
   3. Small intestine 🡪 gallbladder 🡪 liver
   4. Liver 🡪 small intestine 🡪 gallbladder
2. A person suffers from pancreatitis (inflammation of the pancreas) and is unable to produce and release sufficient pancreatic juice to the small intestine. What will result from lack of pancreatic juices?
   1. Damaged parietal cells from the inflammation results in insufficient hydrochloric acid release
   2. **Lipid absorption at the small intestine is compromised**
   3. Macronutrient digestion is unaffected because most digestion occurs in the stomach
   4. Chyme remains in the stomach due to insufficient bicarbonate release

**Lecture 4**

1. A 6-year old female just started Kindergarten. She is complaining of stomach discomfort after the morning snack, which consists of milk products including a glass of milk, cheddar cheese, and yogurt. Which is correct concerning her symptom of stomach discomfort?
   1. She is likely lactase persistent resulting in improper digestion of lactose
   2. She is too young to be complaining of lactose intolerance so she should continue to eat milk-containing food products
   3. Lactose is accumulating in her stomach where it absorbs water causing bloating and the feeling of stomach pain
   4. **She is missing a mutation at the lactase gene so she has insufficient production of lactase to properly digest lactose**
2. Please choose the correct statement regarding carbohydrate transportation.
   1. Fructose is efficiently transported through the apical membrane of the enterocyte because it is transported by passive diffusion
   2. Glucose is the only monosaccharide that can be absorbed through the entire enterocyte
   3. Fructose is not absorbed efficiently through the intestinal enterocyte because it is a disaccharide
   4. **Lower levels of galactose in the lumen depend on an active carrier mediated transporter protein at the apical membrane**
3. What enzyme controls the rate limiting step for glycogenesis in the liver after a meal?
4. Glucokinase
5. Hexokinase
6. **Glycogen Synthase**
7. Glycogen Phosphorylase
8. Insulin-stimulated glucose uptake in fat and muscle is mediated by:
   1. Active transport, via GLUT4
   2. **Passive transport, via GLUT4**
   3. Active transport, via GLUT1
   4. Passive transport, via GLUT1
9. Which of these hormones inhibits gluconeogenesis?
   1. **Insulin**
   2. Glucagon
   3. Epinephrine
   4. Cortisol
10. Which mechanism(s) inhibit glycolysis in muscle?
    1. Phosphorylation of Phosphofructokinase-2 (PFK2) by PKA
    2. Phosphorylation of Pyruvate Kinase (PK) by PKA
    3. **Glucose-6-phosphate mediated inhibition of Hexokinase**
    4. All of the above
11. Why is fructose more lipogenic than glucose
    1. It is a disaccharide and therefore has more energy content
    2. It promotes insulin secretion more potently than glucose
    3. **Its catabolism skips several metabolic control points**
    4. Fructose is primarily metabolized in the adipose tissue
12. Which is the most potent negative regulator of phosphofructokinase-1 (PFK1)
    1. Citrate
    2. ATP
    3. AMP
    4. **Fructose-2,6-bisphosphate**
13. Which enzyme **does not govern** a regulated step within the TCA cycle
    1. Citrate synthase
    2. Isocitrate dehydrogenase
    3. -Ketoglutarate dehydrogenase
    4. **Pyruvate dehydrogenase**
14. If an amino acid (such as glutamine) enters the TCA cycle as-Ketoglutarate, which statement is true about its first trip through the cycle? (NB -Ketoglutarate is sometimes referred to as 2-oxoglutarate)
    1. No energy is produced
    2. **Its catabolism is inhibited by high NADH levels**
    3. Its catabolism is inhibited by high ATP levels
    4. Its catabolism is inhibited by both high NADH and ATP levels
15. Why does aerobic glycolysis generate more ATP than anaerobic glycolysis
    1. It is faster
    2. It is present only in muscle tissues
    3. It generates only ATP
    4. **Glucose is more full fully oxidized**
16. Muscle glycogen phosphorylase is activated by which of the following?
    1. Protein desphosphorylation
    2. Glucose-6-phosphate
    3. **AMP**
    4. All of the above
17. What would glycogen debranching enzyme deficiency (Cori’s disease) result in?
    1. Long unbranched chains of glycogen
    2. Hyperglycemia
    3. **Muscle weakness/exercise intolerance**
    4. Hypolipidemia
18. Which of the following will dictate whether glucose enters the pentose phosphate pathway (PPP) or glycolysis
    1. Elevated AMP will direct glucose towards PPP
    2. **Elevated AMP will direct glucose towards glycolysis**
    3. Elevated NADH will direct glucose towards PPP
    4. Elevated NADH will direct glucose towards glycolysis
19. Why is gluconeogenesis most efficient in the liver?
    1. Muscle has less protein available to convert to glucose
    2. **The presence of glucose-6-phosphatase in the liver**
    3. The liver but not the muscle responds to epinephrine
    4. Hexokinase in the liver has a higher affinity for glucose
20. Which enzyme **is not** regulated by Fructose-2,6-bisphosphate levels?
    1. Fructose-2,6-bisphosphatase-1 (FBPase1)
    2. Phosphofructokinase-1 (PFK1)
    3. **Pyruvate kinase**
    4. They are all regulated by Fructose-2,6-bisphosphate
21. How does cortisol affect gluconeogenesis
    1. It promotes glucose uptake in the liver
    2. It causes the phosphorylation of Phosphofructokinase-2 (PFK2)
    3. **It causes the production of more G6Pase and PEPCK**
    4. It causes the production of more glucokinase and PFK1
22. What **is not** a difference between muscle and liver tissue
    1. The enzyme that phosphorylates glucose
    2. Whether Glucose-6-phosphate can inhibit glucose phosphorylation
    3. Whether PFK2 can be regulated by protein phosphorylation
    4. Whether Citrate can regulate pyruvate kinase (PK)

# Short Answer Questions

1. Describe how basal metabolic rates are affected by weight loss, and explain how this helps or hinders permanent weight loss (2 points).
   1. **0.5 point for metabolic rates decrease with weight loss**
   2. **0.5 point for the fact that this is fairly permanent**
   3. **1 point that this causes positive energy balance and weight regain if food intake stays the same.**
2. Describe the tissue expression differences between glucokinase and hexokinase and how their kinetics affect their physiological role (4 points).
   1. **1 point to mention hexokinase has higher affinity, or phosphorylates glucose at a lower concentration**
   2. **1 point to mention that glucokinase has a higher overall rate**
   3. **1 point to mention that hexokinase irreversibly traps glucose in the muscle**
   4. **1 point to mention that glucokinase will not phosphorylate glucose at a lower level**
3. Explain why a deficiency in muscle phosphofructokinase-1 (PFK1, or Tarui’s disease) can cause a glycogen storage disease (1 point). Describe the normal role of PFK1 in your answer (1 point) and describe at least one symptom (1 point) of this disease other than glycogen storage, and why this symptom would occur (1 points, 4 points total).
   1. **1 point to describe that PFK1 is the first committed step of glycolysis**
   2. **1 point to explain how impairing glycolysis leads to glycogen storage**
   3. **1 points to name to correct symptoms (among Muscle weakness, Myopathy)**
   4. **1 points to have a reasonable explanation**
4. Explain how glycogen catabolism differs between muscle and liver. Describe both how glycogenolysis is regulated differently (1 point) in each and what the expected end products are (1 point). Based on this, how and why would you treat a liver glycogen phosphorylase deficiency different from a muscle glycogen phosphorlylase deficiency (4 points, 6 points total for this question)
   1. **0.5 point that glucose inhibits phosphorylase in liver**
   2. **0.5 point that AMP inhibits phosphorylase in muscle**
   3. **0.5 point that the end product in liver is glucose**
   4. **0.5 point that the end product in muscle is ATP/energy**
   5. **1 point to treat PYGM with high protein diets**
   6. **1 point to explain why**
   7. **1 point to treat PYGL with regular glucose infusion**
   8. **1 point to explain why**

Lola has been complaining of a ‘burning sensation’ in her chest after eating some meals. She went to the doctor and was diagnosed with gastroesophageal reflux (GERD). (6 pts total)

1. What is happening that results in this ‘burning’ symptom? (2 pts)

**The LES is not closing properly, it is staying relaxed. Acid from the gastric juice is making its way into the esophageal lining and causing irritation to the mucosa.**

1. *Explain* (do not list) 3 risk factors for this condition? (3 pts)

**High fat food or large meals sit in stomach longer resulting in increased acid production; nicotine, mint, chocolate, etc. is a muscle relaxant relaxing the LES; pregnancy, obesity, large meals add pressure to the LES not allowing it to close properly; laying horizontally – LES closure prevented**

1. What is 1 way Lola can control GERD? (1 pt)

**Lose weight if overweight, sit up at least 1-2 hours after meals, avoid large meals, take an antacid, avoid muscle-relaxing foods**

An adult male is taking medicine to help control his allergies. He is experiencing a dry mouth (decreased saliva production), which after some research and discussion with his physician, he learns is a side effect of the medication. (4 pts total)

1. Will decreased saliva production affect macronutrient digestion and absorption? If so, how? (3 pts)

**Yes, saliva contains alpha 1,4 amylase, which is a digestive enzyme important in initiating the enzymatic digestion of carbohydrates. This enzyme travels with saliva as it is swallowed through the digestive tract where it continues to work in a limited capacity in the stomach and more so in the less acidic environment of the small intestine. If there is less saliva being produced, carbohydrates will not be adequately digested for absorption at the small intestine. Student may mention lubrication as well.**

1. Are there other health concerns besides digestive and absorptive processes that this male should worry about and why? (1 pt)

**Saliva helps in protecting tooth decay and oral health– it contains an enzyme called lysozyme that works on bacteria in the mouth**

Although, starch, glycogen, and cellulose are all polyglucoses (a polysaccharide made of glucose units linked together) they still vary in structure. (8 points total)

1. Please elaborate on how they differ in structure (please describe both amylopectin and amylose when discussing starch). (4 pts)

**Amylose – linear chain of alpha 1,4 glucose linked by alpha 1,4 bond**

**Amylopection – moderately branched chain of alpha 1,4 glucose linked by alpha 1, 4 bond with alpha 1,6 branching points**

**Cellulose - beta 1,4 glucose linked by beta 1,4 bonds**

**Glycogen - storage form in humans. Same as amylopectin but highly branched**

1. How do these structural differences affect digestion and absorption? Please describe chemical breakdown of amylose, amylopectin and cellulose and the end products that are absorbed. (4 pts)

**Discussion of alpha amylase only working on alpha 1,4 bonds.  Branching points require isomaltase. Glucose is formed from starch breakdown and absorbed. Cellulose not absorbed and goes to large intestine because resistant to digestive enzymes.**