1. What enzyme controls the rate limiting step for glycogenesis in the liver after a meal?
2. Glucokinase
3. Hexokinase
4. Glycogen Synthase
5. Glycogen Phosphorylase
6. Which statement is true about the cortisol-dependent regulation of Glucose-6-Phosphatase (G6Pase)?
7. The regulation of G6Pase is by protein phosphorylation, and therefore is a long lasting response
8. The regulation of G6Pase is by protein phosphorylation, and therefore is a rapid response
9. The regulation of G6Pase is transcriptional, and therefore is a long lasting response
10. The regulation of G6Pase is transcriptional, and therefore is a rapid response
11. 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
12. Which macromolecule has the highest Atwater factor
    1. Carbohydrate
    2. Protein
    3. Fat
    4. They are all the same
13. Which of these hormones inhibits gluconeogenesis?
    1. Insulin
    2. Glucagon
    3. Epinephrine
    4. Cortisol
14. 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
15. Which statement is **false** regarding enzymes
    1. Enzymes stabilize the transition state intermediates
    2. Enzymes alter the G’0 of a reaction
    3. Enzymes may be regulated by transcription, phosphorylation and allosteric modulation
    4. Enzymes can catalyze both directions of some reactions
16. Which of the following affect resting energy expenditure (REE)
    1. Thermic effect of food
    2. Activity levels
    3. Basal metabolic rate
    4. All of the above
17. Which enzyme is regulated differently in muscle compared with liver?
    1. Hexokinase
    2. Phosphofructokinase-2
    3. Pyruvate Kinase
    4. Glycogen Synthase
18. 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
19. Which is the most potent negative regulator of phosphofructokinase-1 (PFK1)
    1. Citrate
    2. ATP
    3. AMP
    4. Fructose-2,6-bisphosphate
20. Elevated ATP levels will affect which of these enzymes in the liver?
    1. Glucokinase
    2. PFK1
    3. PFK2
    4. -Ketoglutarate Dehydrogenase
21. 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)
22. Which process is anaplerotic?
    1. Gluconeogenesis
    2. Glycolysis
    3. Amino acid biosynthesis
    4. The electron transport chain
23. What governs the decision to convert pyruvate to lactate or to acetyl-CoA
    1. ATP levels as sensed by pyruvate dehydrogenase
    2. ATP levels as sensed by lactate dehydrogenase
    3. ATP levels as sensed by pyruvate dehydrogenase kinase
    4. All of the above
24. Which enzyme **does not govern** a regulated step within the TCA cycle
    1. Citrate synthase
    2. Isocitrate dehydrogenase
    3. -Ketoglutarate dehydrogenase
    4. Pyruvate dehydrogenase
25. 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
26. What is the primary regulator of the electron transport chain activity?
    1. NADH levels
    2. ATP levels
    3. ADP levels
    4. Citrate levels
27. How does UCP-1 generate heat?
    1. It generates a proton gradient, consuming NADH
    2. It hydrolyses ATP, releasing the energy in the phosphodiester bond
    3. It dissipates the proton gradient generated by the Electron Transport Chain
    4. It inhibits the TCA cycle
28. 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
29. What polysaccharide does glycogen most closely resemble?
    1. Amylose
    2. Amylopectin
    3. Cellulose
    4. Glucose
30. Muscle glycogen phosphorylase is activated by which of the following?
    1. Protein desphosphorylation
    2. Glucose-6-phosphate
    3. AMP
    4. All of the above
31. What would glycogen debranching enzyme deficiency result in?
    1. Long unbranched chains of glycogen
    2. Hyperglycemia
    3. Muscle weakness/exercise intolerance
    4. Hypolipidemia
32. How does epinephrine directly affect the muscle?
    1. Promotes gluconeogenesis
    2. Activates glycogenolysis
    3. Impairs glucolysis
    4. Epinephrine does not affect the muscle
33. 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
34. 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
35. 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
36. 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

# Long Answer Questions

These are for 3 points each

1. Describe how basal metabolic rates are affected by weight loss, and explain how this helps or hinders permanent weight loss.
2. Briefly describe how insulin affects muscle glycogen metabolism, glycolysis and gluconeogenesis in muscle including the key proteins that are affected.
3. Explain how an energetically unfavorable reaction such as Aldolase (G’o = + 22 kJ) can proceed under physiological conditions.
4. Describe the physiological relevance of the different glucose affinities between glucokinase and hexokinase.
5. Explain why a deficiency in muscle phosphofructokinase-1 (PFK1) can cause a glycogen storage disease. Make sure to describe the normal role of PFK1.
6. Describe how a deficiency in liver phosphofructokinase-1 (PFK1) would be expected to affect galactose and fructose catabolism
7. Describe how cataplerosis can affect the fate of fatty acids as they are broken down for energy.
8. How would a deficiency in Pyruvate Dehydrogenase affect exercise capacity? Would it affect lipid, protein and carbohydrate catabolism equally?
9. Explain how glycogen catabolism differs between muscle and liver, including both how it is regulated and what the ideal end products are.
10. Describe how muscle glycogen phosphorylase deficiency could affect a patient and what a reasonable nutritional therapy might be.
11. How does fructose-2,6-bisphosphate co-ordinately regulate both glycolysis and gluconeogenesis?
12. Describe why elevated PEPCK levels in the muscle might affect exercise tolerance.
13. In terms of ATP utilization/generation, explain why it would be counterproductive to have both gluconeogenesis and glycolysis occurring simultaneously.
14. Hyperglycemia is a common side effect of glucocorticoid treatment. Describe how cortisol (a glucocorticoid) may cause these effects, including the specific targets of this pathway.