Directions: Please WRITE your name and ID on this Exam AND on the ANSWER SHEET by bubbling in Your Name and Panther ID. Please note that numerical answers without their units are wrong and that Genus species names must be italicized or underlined. Please answer all questions by bubbling in on the Answer Sheet, the BEST possible lettered answer.

1. All receptor enzymes:
   a. act by phosphorylating cAMP.  
   b. alter gene expression 
   c. have their active sites on the cytosolic side of the plasma membrane. 
   d. consist of more than one subunit.  
   e. all of the above.

2. G-protein receptors:
   a. have a single transmembrane domain. 
   b. are ion channels. 
   c. act in the nucleus. 
   d. have enzymatic activity. 
   e. generate second messengers.

3. Which of the following occurs in a cell as a result of insulin binding to its receptor? 
   a. Glycogen synthase becomes activated. 
   b. Glucose is released from the cell. 
   c. The glucose transporter GLUT4 moves from the plasma membrane to internal membrane vesicles. 
   d. Cyclic GMP is produced. 
   e. Cyclic AMP is produced.

4. Activation of a G protein-coupled receptor causes stimulatory G protein (Gs) to:
   a. replace its bound GDP with GTP. 
   b. dissociate from adenylyl cyclase. 
   c. hydrolyze GTP into GDP and Pi. 
   d. generate cGMP. 
   e. all of the above.

5. A chemical reaction is more likely to occur spontaneously if:
   a. the products of the reaction are more complex than the reactants. 
   b. the system takes up heat from its surroundings. 
   c. the system gains free energy. 
   d. the products of the reaction are more disordered than the reactants.

6. If a chemical reaction starts with 1M concentrations each of reactants A and B and products C and D, under what conditions of Keq and ΔG° will the reaction proceed in the forward direction (ΔG° = -RT ln Keq)?
   a. If Keq is greater than 1 and ΔG° is negative. 
   b. If Keq is 0 and ΔG° is negative. 
   c. If Keq is negative and ΔG° is negative. 
   d. If Keq is less than 1 and ΔG° is positive.

7. Which of the following has a thioester bond?
   a. Phosphoenolpyruvate. 
   b. ATP. 
   c. phosphocreatine. 
   d. acetyl-CoA. 
   e. NADH.

8. Which of the following carbon-containing molecules is most fully oxidized?
   a. carbon monoxide. 
   b. carbon dioxide. 
   c. methane. 
   d. ethanol. 
   e. pyruvate.

9. Electrons can be transferred from one molecule (electron donor) to another molecule (electron acceptor) by all of the following ways except:
   a. as a hydride ion. 
   b. directly as an electron. 
   c. as a proton. 
   d. as a hydrogen atom. 
   e. none of the above.

10. Below are the standard reduction potentials (E°) for two conjugate redox pairs:
    Pyruvate-/lactate-  E° = –0.185v 
    NAD+/NADH   E° = –0.320v
    Which of the following is true?
    a. The pyruvate/lactate conjugate redox pair has a greater tendency to lose electrons than the NAD+/NADH redox pair.
    b. Pyruvate has a greater affinity for electrons than NAD+. 
    c. NAD+ is a reducing agent. 
    d. Under standard conditions, NAD+ is more likely to be converted to NADH, than pyruvate is to be converted to lactate. 
    e. none of the above.
11. When the Keq of a reaction is equal to one, then the ΔG, in kJ/mole is (this is a thought problem; it does not require R, T, or any other constants):
   a. 10.        b. 1.0.        c. 0.        d. -1.        e. -10.

Some standard E° values in volts for half cells are:
   NAD⁺/NADH -0.32 v  Fumarate/Succinate 0.03 v
   FAD/FADH₄ -0.22 v  Ferredoxin³/Ferredoxin⁺² -0.43 v
   Cytochrome-a 0.29 v Oxaloacetate/Malate -0.17 v
   Cytochrome-c 0.25 v ½ O₂/water 0.82 v

12. From the information above, which molecule can reduce NAD⁺?
   a. oxygen.      b. fumarate.      c. succinate.      d. ferredoxin.      e. cytochrome-c.

13. From the information above, could succinate reduce cytochrome-c?
   a. yes.          b. no.          c. maybe.

14. From the information above calculate the ΔG° for the malate dehydrogenase reaction at pH 7.0 when 96.5 kJ/v.mole at 25°C: malate + NAD⁺ =====> oxaloacetate + NADH + H⁺

15. This means that the malate dehydrogenase reaction:
   a. goes as written above.      b. goes in the reverse direction.      c. is at equilibrium.
   d. is thermodynamically impossible.      e. none of the above.

16. The hydrolysis of phosphoenolpyruvate has a ΔG° = -62 kJ/mole. The great contributing factor to this number is stabilization of the product pyruvate by:
   a. electrostatic attraction.       b. ionization.       c. polarization.       d. resonance.       e. tautomerization.

17. If glucose was labeled with ¹⁴C in C-1 and fed to yeast carrying out the ethanol fermentation, where would the ¹⁴C label be in the products:
   a. C-1 of ethanol and CO₂.       b. C-1 of ethanol only.       c. C-2 (methyl) of ethanol only.
   d. C-2 of ethanol and CO₂.       e. CO₂ only.

18. In an anaerobic muscle preparation, glucose ¹⁴C-labeled in C-3 and C-4 would end up in lactate in:
   a. all carbons.       b. only the carbon bonded to -OH.       c. only in carboxyl carbon.
   d. only in the methyl carbon.       e. methyl and carboxyl carbons.

19. The ultimate electron acceptor in the fermentation of glucose to ethanol is:
   a. acetaldehyde.       b. acetate.       c. ethanol.       d. NAD⁺.       e. pyruvate.

20. The first few steps in the Pentose Phosphate Pathway:
   a. are oxidative.       b. produce ATP.       c. produce GTP.       d. are transketolases.       e. are transaldolases.

21. Transketolases transfer _____ carbon units:
   a. 1.       b. 2.       c. 3.       d. 4.       e. 5.

22. When the pentose pathway metabolizes glucose, the C-1 of glucose ends up mostly in:
   a. CO₂.       b. glycogen.       c. 3-phosphoglycerate.       d. pyruvate.       e. ribulose-5-phosphate.

23. The pentose phosphate pathway is used to provide metabolic intermediates for the biosynthesis of:
   a. glucose.       b. fructose.       c. aromatic amino acids.       d. triacylglycerol.       e. alanine.

24. Which of the following statements is not true concerning glycolysis in anaerobic muscle?
   a. Fructose 1,6-bisphosphatase is one of the enzymes of the pathway.    b. It is an exothermic process.
   c. It results in net synthesis of ATP.    d. It results in synthesis of NADH.    e. all of the above.

25. During strenuous exercise, the NADH formed in the glyceraldehyde 3-phosphate dehydrogenase reaction
in skeletal muscle must be reoxidized to $\text{NAD}^+$ if glycolysis is to continue. The most important reaction involved in the reoxidation of NADH is:

a. dihydroxyacetone phosphate $\rightarrow$ glycerol 3-phosphate.  
b. glucose 6-phosphate $\rightarrow$ fructose 6-phosphate.  
c. isocitrate $\rightarrow$ $\alpha$-ketoglutarate.  
d. oxaloacetate $\rightarrow$ malate.  
e. pyruvate $\rightarrow$ lactate.

26. An enzyme used by both glycolysis and gluconeogenesis is:

a. phosphoglucomutase-1.  
b. hexokinase.  
c. pyruvate kinase.  
d. glucose-6-phosphatase.  
e. 3-phosphoglycerate kinase.

27. After glucose-6-phosphate is converted to 6-phosphogluconate in the PPP, it is converted to:

a. glycerate and 3-phosphoglycerate by an aldolase split.  
b. glycolic acid and 4-phospho-erythrose by an aldolase split.  
c. 1,6-bisphosphogluconate.  
d. keto and aldopentoses.  
e. oxidized to a six carbon dicarboxylic acid.

28. The entry of galactose into glycolysis involves:

a. dephosphorylation.  
b. decarboxylation.  
c. epimerization.  
d. conversion to fructose.  
e. none of the above.

29. The entry of glycerol into glycolysis produces:

a. ATP.  
b. NAD$.^+$  
c. GTP.  
d. NADH.  
e. CO$_2$.

30. A major driving force in PEP carboxykinase is:

a. NADPH.  
b. dATP.  
c. GTP.  
d. ATP.  
e. cAMP

Written Answer Questions:

1. Diagram epinephrin activation of Ca$^{++}$ release from the endoplasmic reticulum. Be sure to label all the parts of your diagram. (7 points)
2. The complete oxidation of glucose to 6 waters and 6 CO$_2$ has a $\Delta G^\circ = -2,840$ kJ/mole. Suppose a cell converted 1 mmole of glucose to CO$_2$ and water, how many ATP's could be generated? (7 points)

3. Central metabolism contains several pathways (glycolysis, pentose-phosphate-pathway, citric acid cycle). All of these pathways have two general outputs: (6 points)

One is ____________________________, and the other is ____________________________.