The theme of this exam is a hated but useful insect, the yellow jacket.
8. Growing yellow jacket larvae need a good supply of molecules like the one below:

\[ \text{CH}_3\text{-CH-COO}^- \]
\[ \text{NH}_4^+ \]

This molecule is a(n)  
a) monosaccharide.  
b) nucleotide.  
c) fatty acid.  
d) amino acid.

9. At cellular pHs the molecule above has two opposite charges (as shown), so it has no net charge. If the molecule above were put at a low pH and were allowed to come to equilibrium, its charge would be  
a) more negative.  
b) more positive.  
c) unaffected.

10. The uncharged version of the molecule above is

\[ \text{CH}_3\text{-CH-COOH} \]
\[ \text{NH}_3 \]

If we are transitioning from the uncharged form (this question) to the charged form (question 8), the ... group on the uncharged molecule is acting as a(n)  
a) NH\textsubscript{2} ... base.  
b) COOH ... base.  
c) CH\textsubscript{3} ... acid.  
d) NH\textsubscript{2} ... acid.

11. At cellular pHs, the charged form in question 8 is the dominant one found in cells. Is there any pH at which the uncharged form question 10 would be seen?  
a) Yes, it would be seen at exactly neutral pHs.  
b) Yes, it would be seen at acid pHs.  
c) Yes, it would be seen at basic pHs.  
d) No, it could not exist at any pH.

12. If two molecules like the one in question 8 are joined by dehydration synthesis, the core of the bond between them would be a bond between  
a) two carbonyl groups.  
b) an amino group and a carbonyl group.  
c) two amino groups.  
d) a methyl group and a carboxyl group.

13. A cell would probably create the bond in question 12  
a) on the surface of a crista.  
b) inside a thylakoid membrane.  
c) on a ribosome.  
d) in a lysosome.

14. In DNA synthesis, a particular nucleotide is added at a particular position because ...; in protein synthesis, a particular amino acid is added at a particular position because  
a) DNA has two purines and two pyrimidines ... RNA only has pyrimidines.  
b) DNA can only be synthesized 3' to 5' ... RNA can be synthesized in either direction.  
c) of the complementary nucleotide in mRNA ... of the complementary nucleotide in rRNA.  
d) of the nucleotide on the complementary DNA strand ... of a triplet of nucleotides in mRNA.

15. Yellow jackets have an exoskeleton with muscles on the inside. If their voluntary muscles have a structure like human voluntary muscles, a sarcomere contains regions with  
1. myosin but no actin  
2. actin but no myosin  
3. both myosin and actin

If travel from Z line to Z line within a relaxed sarcomere, the order in which you will encounter these regions is  
a) 2 3 1 3 2.  
b) 1 2 3 2 1.  
c) 3 2 1 2 3.  
d) 2 1 3 1 2.
#16. If yellow jacket muscles operate like human muscles, then they contract because of the following events:

1. An action potential arrives on a motor neuron.
2. Myosin binds to actin.
3. Myosin heads bend.
4. Tropomyosin changes shape.
5. Calcium ions spill from the sarcoplasmic reticulum.

The correct order of these events in a relaxed sarcomere beginning a contraction is:

a) 5 1 4 6 3 2  b) 1 5 4 2 3 6  c) 1 5 6 2 3 4  d) 2 3 4 1 5 6

#17. Muscle contraction uses energy from ATP. In human muscle contraction, ATP is directly used to:

a) send the myosin heads back to their high-energy position.
b) separate the two strands of actin.
c) break the bonds between the Z lines and the actin.
d) break the bonds between the Z lines and the myosin.

#18. You are interested in the efficiency of ATP production in the yellow jacket’s wing muscles. You compile the following data on yellow jacket flight speed in a wind tunnel. The origin is zero for both axes and both axes increase as the distance from the origin increases. At the highest flight speeds, the insect rapidly becomes exhausted.

![Graph showing ATP per glucose vs. flight speed]

Flight Speed

The best explanation for this pattern is that at low flight speed ... but at high flight speed:

a) glucose is being used as an energy source ... more energetic molecules are being used.
b) no electron transport is being used ... electron transport is slowing metabolism.
c) oxygen is the final electron acceptor ... fermentation is the main energy source.
d) glucose is being reduced ... glucose is being oxidized.

#19. See the point where the curve intersects the y axis? This should be at about ... ATPs/glucose.

a) 12  b) 64  c) 6  d) 36

*20. Your research advisor congratulates you on the graph above, and says that you also should graph ATPs used per second as a function of flight speed. Uh-oh, you never measured that directly, but can you derive it from the curve in question 18? The curve showing the rate of ATP use on the y axis and flight speed on the x axis would have a shape like:

a)  

b)  

c)  

d) The shape of the ATP curve cannot be derived from the curve in question 18.
Yellow jackets live in large colonies, founded by a queen. In some species, the queen emerges in early spring and finds a rodent burrow. Then she begins to construct a paper nest inside the cavity with hanging cells where eggs are laid and larvae develop. This gets more and more elaborate as the summer progresses, until it might achieve the size of a basketball and contain 5,000 workers by late summer!

21. Many homeowners find they have a subterranean yellow jacket nest when they pass over the nest with a lawn mower and hundreds of yellow jackets swarm out of a tiny, unseen hole in the ground and sting them. When they realize what is happening, they will try to run. The hormone that will most directly help them cope with this sudden emergency is
a) epinephrine.  
 b) thyroxine.  
 c) aldosterone.  
 d) melatonin.  

*22. Yellow jackets can sting repeatedly, and if someone is allergic to their stings, he may go into anaphylactic shock when
a) red blood cells lyse and the person suffocates from lack of oxygen.  
 b) red blood cells lyse and the kidneys are clogged by hemoglobin fragments.  
 c) massive release of antibodies makes the blood so viscous that cardiac output drops seriously.  
 d) massive release of histamine causes blood pressure to drop seriously.  

23. A face view of a southern yellow jacket shows one of their prominent features:

The jawlike structures being indicated by the arrow are
a) mandibles.  
 b) chelicerae.  
 c) tarsi.  
 d) pedipalps.  

#24. The workers use the prominent feature above to chew up wood and make the paper that constructs the nest. This means that the paper is principally made out of ... contained in
a) starch and xylose ... amyloplasts.  
 b) cellulose and lignin ... xylem.  
 c) pectin and cellulose ... microtubules.  
 d) cellulose and glycogen ... mesophyll.
#25. Not all nests are constructed in underground cavities. Sometimes nests are built in trees and shrubs. If a yellow jacket starts to chew through a branch of a woody shrub from the outside in, it will encounter the following layers:

1. vascular cambium
2. cork cambium
3. secondary phloem
4. secondary xylem
5. cork

The order in which the chewing yellow jacket would reach these layers is:
a) 4 1 5 3 2  
    b) 2 5 3 4 1  
    c) 5 2 3 1 4  
    d) 5 2 1 3 4

*26. It’s a hot summer day. As a yellow jacket gouges out wood from the shrub branch, the leaves on the end of the branch start to wilt. The wilting is probably caused by ..., and the guard cells on the leaves are probably reacting by

a) destruction of phloem ... opening.
b) stripping of cork from the branch ... opening.
c) puncturing of mesophyll cells ... closing.
d) interruption of xylem vessels ... closing.

27. Several yellow jackets have been attracted to a dead frog. The frog has been dead a while and is heavily contaminated with prokaryotes, mostly

a) bacteria.  
    b) protozoans.  
    c) viruses.  
    d) fungi.

28. The prokaryotic cells and the cells of the frog have some basic structural differences. The frog cells, but not the bacterial cells, would have

a) ribosomes.  
    b) cell walls.  
    c) mitochondria.  
    d) chloroplasts.

*29. Say you suspect that even yellow jackets must have some degree of decay beyond which they will not touch an animal corpse. But without some smell of decay, you think the yellow jackets probably will not find the food source. You buy some strips of bacon, leave them out at summer temperatures for several lengths of time, and then either place them close to a yellow jacket nest (where they’ll be easy to find) or at several distances away. You drape each bacon strip over a tent peg driven into the ground so they’ll be fairly obvious. Then you count the yellow jackets that feed on the bacon strips. The independent variable(s) here is (are) ...; the dependent variable is

a) decay time ... distance to nest.
b) decay time and distance to nest ... number of yellow jackets finding the food.
c) number of yellow jackets finding the food and distance to nest ... decay time.
d) number of yellow jackets finding the food ... decay time.

*30. The best way to present these data would be

a) a line graph with decay time on the x axis and distance to nest on the y axis.
b) a bar graph with number of yellow jackets on the y axis and distance to nest on the x axis.
c) a table with cells representing distance and decay time combinations and the number of yellow jackets within each cell.
d) a table with rows for the number of yellow jackets, columns for the distance to the nest, and decay times within each cell.

#31. You find that the yellow jackets show up in great numbers at close bacon strips, no matter what their degree of decay is. However, only the most decayed strips are found at large distances. A possible interpretation is that

a) yellow jackets forage visually as well as by smell.
b) strips that are close to the nest are close to each other. Yellow jackets foraging at one strip may find another strip by accident.
c) close to the nest, there is lots of yellow jacket traffic. More traffic means a greater probability of finding the strips by accident.
d) All of these are possible interpretations.
In late summer, adult yellow jackets are less interested in meaty foods because there are fewer larvae to feed. They then prefer sugary foods, especially soda in cans, and it is common to have picnics disrupted by hungry yellow jackets hovering around soda cans. Sometimes a person at a picnic may take a swig of soda, get a yellow jacket inside the can in his mouth, and receive a severe sting.

#32. A human drinking a soda will get a big does of sucrose. Sucrose is a ... and ingested sucrose will
a) disaccharide ... be split into monosaccharides by pancreatic enzymes.
b) monosaccharide ... be polymerized into glycogen in the pancreas.
c) polysaccharide ... directly enter the Krebs Cycle and be digested to CO₂ and water.
d) polysaccharide ... directly enter glycolysis and be broken into pyruvate fragments.

*33. In yellow jackets, as in bees, fertilized eggs develop into diploid females but unfertilized eggs develop into haploid males. This means that eggs produced by any one queen will be genetically ... and sperm produced by any one male will be genetically
a) identical ... identical.
b) different ... different.
c) identical ... different.
d) different ... identical.

#34. The situation above will tend to make individual yellow jackets in a nest ... related to each other than if both males and females were diploid. Thus, compared with the situation in which both males and females were diploid, natural selection will tend to ... the development of behavior in which the individual yellow jacket sacrifices itself for the benefit of the nest.
a) less ... favor
b) more ... favor
c) more ... inhibit
d) less ... inhibit

*35. All organisms occasionally get harmful mutations. If the mutations are recessive, they may persist in the gene pool for long periods. The sex determination in yellow jackets seems to be ... effective than that of humans at eliminating harmful, recessive mutations from the gene pool because haploid males
a) more ... have fewer alleles and a smaller chance of having a harmful one.
b) less ... cannot hide a recessive, harmful allele with a dominant, normal one.
c) more ... with a harmful, recessive mutation will probably never mate and the allele will be lost.
d) less ... with a harmful, recessive mutation will pass it along to all their offspring.

*36. All workers in a nest have the same mother, but they might have different fathers because a queen might have stored sperm from a dozen males. We are trying to determine the parentage of a worker and are considering three possible fathers. We perform a Southern blot that shows only a single allele cut by a restriction enzyme and we see the following results:

```
<table>
<thead>
<tr>
<th></th>
<th>Queen</th>
<th>Worker</th>
<th>Father 1</th>
<th>Father 2</th>
<th>Father 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
```

What can we conclude?
a) Father 1 is not the father.
b) Father 2 is the father.
c) Father 3 is the father.
d) No conclusions about the worker’s father are possible from these results.
37. Now imagine that we are trying to determine the parentage of a human baby and we get the same gel. So mentally substitute “Mother” for “Queen” and “Baby” for “Worker” in the picture on the previous page. Your conclusion is
   a) Father 1 is not the father.
   b) Father 2 is the father.
   c) Father 3 is the father.
   d) No conclusions about the baby’s father are possible from these results.

38. Say that yellow jackets that are DD, Dd or D (for the males) have dark pigment on their antennae, and yellow jackets that are dd or d have light gray antennae. If a Dd queen mates only with d males, then ... of the female offspring and ... of the male offspring will have dark antennae.
   a) 50% ... 0%       b) 50% ... 50%       c) 0% ... 50%       d) 0% ... 0%

*39. Say that this one Dd queen that has mated in the past only with d males produces a whole nest of over 1000 yellow jackets. 81% of the offspring have dark antennae. This ... support the hypothesis that the population is at Hardy-Weinberg Equilibrium (HWE) at the D/d locus.
   a) does not       b) does       c) These data are irrelevant to that question.

As the end of the summer approaches, the yellow jacket nest prepares for the next year. Most of the time, the queen and all the workers will perish as the cold weather takes hold. However, before that happens, special reproductive cells are built that will produce new males and queens. The males will quickly die after mating with the new queens, but the new queens will store a large amount of fat and will overwinter and found nests late in the following spring.

40. Say that each yellow jacket nest in an area gives rise to four surviving queens and each one founds a new nest. The next year, with more yellow jackets in the area, each old nest only founds 2.5 new nests. The next year, competition is more severe, and the each old nest gives rise to 1.5 new nests. If the number of yellow jackets in each nest is about the same each year, the population of yellow jackets seems to be growing
   a) exponentially.       b) logistically.