1. The reactions shown in the diagram at the right occur in the cells of ash tree roots. From the inputs and outputs you can tell which metabolic pathway this is. If you know which pathway it is, you know where in the cell it occurs.

Where?

a. extracellular space  
b. cytosol (endoplasm)  
c. stroma of chloroplasts  
d. matrix of mitochondria  
e. thylakoids

2. When the roots of the ash tree are flooded, their supply of O₂ is greatly reduced. Under this condition they produce a toxic compound. What is that compound?

a. CO₂  b. ethanol  c. glucose  d. NAD⁺  e. pyruvic acid

3. The compound DNP was used as a weight reducer in the early part of the twentieth century. DNP causes H⁺ to leak from one side of a membrane to the other down its concentration gradient. In mitochondria DNP would tend to inhibit...

a. the synthesis of ATP.  
b. the uptake of O₂.  
c. the oxidation of glucose.  
d. the production of NADH.  
e. all of the processes listed above.

4. If you draw a diagram that couples photosynthesis and respiration together, you will show that free energy goes into the system as light, and it all comes out as ...(choose the most complete answer)...

a. ATP  b. ATP + heat  c. glucose + O₂  d. light  e. NADH
5. Consider an accessory pigment in an oak leaf that absorbs a green photon. The excitation energy is transferred to the chlorophyll in the reaction center of Photosystem I (PSI). If there is no NADP+ to accept an excited electron from PSI, the energy will be lost by fluorescence, the emission of a light photon. What color will the photon be?

   a. red     b. blue     c. green     d. ultraviolet     e. any of the foregoing

6. In a standard operating photosynthetic system, such as was described in lecture, how many light photons does it take to make one molecule of O$_2$?

   a. 1     b. 2     c. 4     d. 8     e. It depends on the color of the light.

7. Chi-Minh is studying a mutant alga that has lost the ability to make glucose through photosynthesis. He finds that the isolated chloroplasts of the alga can make ATP, but not NADPH. Which of the components of photosynthesis listed below might be lost?

   a. PSI     b. PSII     c. ATP synthase     d. H$^+$ gradient     e. rubisco

8. Chi-Minh’s colleague has another mutant that is blocked in photosynthesis. She has isolated the chloroplasts, broken them open, and separated the enzymes of the stroma from the proteins of the thylakoids. The block is in the enzymes, not the thylakoid proteins. Which of the components of photosynthesis listed below might be lost?

   a. PSI     b. PSII     c. ATP synthase     d. H$^+$ gradient     e. rubisco

9. Normally, strains of the bacterium Bacillus subtilis die when placed in medium containing ampicillin. These normal strains are called amp$^S$ (for "ampicillin sensitive"). There are also mutant strains known which can live in ampicillin. These are called amp$^R$ ("ampicillin resistant"). Which of the following experiments would allow you to test for transformation in this bacterium?

   a. Extract enzymes from amp$^R$; mix with amp$^S$ cells; grow the cells on medium containing ampicillin.
   b. Extract DNA from amp$^S$; mix with amp$^R$ cells; grow the cells on medium containing ampicillin.
   c. Extract DNA from amp$^S$; mix with amp$^R$ cells; grow the cells on medium without ampicillin.
   d. Extract DNA from amp$^R$; mix with amp$^S$ cells; grow the cells on medium containing ampicillin.
   e. Treat amp$^S$ cells with ampicillin; look for cells that cannot grow on medium without ampicillin.
10. In the "virus infection experiment" that helped determine the molecular location of genetic information, radioactive phosphorus was incorporated into the viruses that infected a bacterium. After the virus "ghosts" were separated from the bacterium, the radioactive material ($^{32}$P) was...

   a. found primarily in the bacterium.
   b. found primarily in the virus ghosts.
   c. found totally in the solution (as phosphate), but not in the ghosts.
   d. not found at all

11. Carlos has purified two pieces of DNA, each 1000 base-pairs long. The first piece (DNA 1) has 600 G bases; the second piece (DNA 2) has only 400 G bases. When heated, which of these pieces of DNA will melt (divide into separate polynucleotide chains) at the lower temperature.

   a. DNA 1
   b. DNA 2
   c. They will both melt at the same temperature.
   d. They may melt at different temperatures, but one cannot predict which will melt at the lower temperature from the information given.

12. In the diagram of DNA at the right, what would be an appropriate label for the box at the bottom?

   a. 5' end
   b. 3' end
   c. $^{32}$P
   d. $^{35}$S
   e. any of the above
13. In bacteria, the first step in the decoding of the genetic information in DNA to specify the amino acid sequence of a polypeptide chain is ______________; the second step is __________.

   a. transformation; transcription.
   b. translation; transmigration.
   c. transliteration; transpiration.
   d. transcription; translation.
   e. transpiration; transgression.

14. The sequence of a particular mRNA is 5′-GAUGAAAUAAGGUAGAACA-3′, where the “5′” and “3′” tell you which is the 5′ end and 3′ end of the RNA molecule. The DNA template for the synthesis of this mRNA was...

   a. 5′-GATGAAAATAGGCTAGAACA-3′
   b. 3′-CTACTTTTATCCCATCTGT-5′
   c. 3′-ACAAGATGGGATAAAGTAG-5′
   d. 5′-CUACUUUUAUCCCAUCUUGU-5′
   e. 3′-GAUGAAAUAAGGUAGAACA-3′

15. The diagram at the right describes polysomes extracted from bacterial cells. The lower polysome is from cells that have just been treated with an inhibitor of protein synthesis; the upper polysome is from control (untreated) cells. From this diagram, you can tell that the inhibitor specifically blocks one stage in protein synthesis. Which stage?

   a. Initiation
   b. Elongation
   c. Termination
   d. Transcription
   e. Synthesis of deoxyribonucleotide triphosphates
16. The diagram below shows four ribosomes in various stages of protein synthesis. For one of the ribosomes, the next step is to add an amino acyl-tRNA with the appropriate anticodon. Which ribosome?

![Diagram of ribosomes](image)

e. none of the above

17. The energy for the synthesis of DNA comes directly from...

a. DNA polymerase  
b. DNA ligase  
c. the release of pyrophosphate as a deoxyribonucleoside triphosphate is added to a growing polynucleotide chain.  
d. ATP  
e. glucose plus O₂

18. Which of the phrases below best describes the function of DNA ligase?

a. Begins the formation of DNA by synthesizing a short RNA chain  
b. Unwinds a double helix  
c. Allows two DNA polynucleotide chains to form a double helix  
d. Adds a nucleoside triphosphate to a growing polynucleotide chain.  
e. Links two DNA polynucleotide chains together (end to end)
19. (2 points) Fill in the boxes with the correct compounds and stoichiometry.

\[ 2 \text{C}_3\text{H}_4\text{O}_3 \quad 2\text{C}_6\text{H}_{12}\text{O}_6 \quad 6\text{H}_2\text{O} \quad 2(GDP + \text{Pi}) \quad 2\text{(GTP + Pi)} \quad 2\text{NAD}^+ \quad 8\text{NAD}^+ \quad 8\text{NADH} \quad 2\text{FAD} \quad 2\text{FADH}_2 \quad 32(\text{ADP + Pi}) \quad 32(\text{ATP + H}_2\text{O}) \]

20. (2 points) Using the genetic code chart below, give the amino acid sequence coded by this RNA. Remember, proper starts and stops are essential.

GUGAGUGUAUGCCCGUAGUUUGAGGUGACGGAAAA

28. (2 points) You are designing an experiment to detect transformation in bacteria. You have two strains of the bacteria: strain A can grow on "minimal" medium that contains only salts and glucose. Strain B cannot grow on minimal medium but can grow on medium containing tryptophan. You can assume that strain B lacks a gene for an enzyme that is necessary for making tryptophan. (a) Which strain should you use as a source of genes in your transformation experiment? (b) Which strain should you use as a
test organism to receive the genes? (c) How will you recognize bacteria that have been transformed?