[01] Which of the following atmospheric gas(es) do not absorb significant amounts of solar radiation at the visible wavelengths (*ca* 400–700 nm)?

A. N_2 (nitrogen) B. O_3 (ozone) C. Ar (argon) D. CO_2 (carbon dioxide)
E. O_2 (oxygen) F. B and D G. B and E
H. Visible wavelengths are not absorbed by any of these atmospheric gas(es).

Ozone absorbs in the UV, carbon dioxide and water absorb in the infra-red, none of the major atmospheric gases absorb in the visible, the answer is ***H****.*

[02] An incandescent human emits light with a maximum intensity at a 'color' in the infrared (*ca* 12000 nm, beyond our vision capability). What is the incandescent human's temperature (in Kelvin, K: ºC = K + 273)? You may need to know that Wein's Displacement Law defines the wavelength of maximal photon flux as a constant divided by temperature in Kelvin (K) ($\lambda_{max} = 3.6 \times 10^6$ (nm K) / T (K)).

A. *ca* 0.03 K B. *ca* 0.3 K C. *ca* 3 K
D. *ca* 30 K E. *ca* 300 K F. *ca* 3,000 K
G. *ca* 30,000 K H. Humans don't emit electromagnetic radiation.

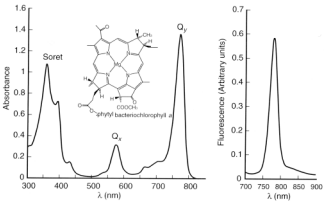
$(3.6 \bullet 10^6)/12000 = 300K$, the answer is ***E****.*

[03] An incandescent human emits light with a maximum color in the far-red (*ca* 12000 nm, beyond our vision capability). What is the energy of the emitted photons (in kcal)? You may need to know that the energy of a photon is equal to $h \bullet (c/\lambda)$ where h is Planck's constant (1.584×10^{-37} kcal•sec), c is the speed of light (3×10^{17} nm •sec^{-1}) and λ is the wavelength (in nm)

A. *ca* 3.96×10^{-12} kcal B. *ca* 3.96×10^{-14} kcal C. *ca* 3.96×10^{-16} kcal
D. *ca* 3.96×10^{-18} kcal E. *ca* 3.96×10^{-20} kcal F. *ca* 3.96×10^{-22} kcal
G. *ca* 3.96×10^{-24} kcal H. Humans don't emit electromagnetic radiation.

$(1.584 \times 10^{-37}) * (3 \times 10^{17}$ nm •$sec^{-1})/(12000$ nm$) = 3.96 \times 10^{-24}$, the answer is ***G****.*

There are two *major* electron orbital transitions allowed in bacteriochlorophyll (the structure and spectrum of the pigment, found in photosynthetic purple bacteria, are shown at right). What wavelength range do these transition energies correspond to (choose the best —that is, closest— answer)?



[04] Least energetic transition: **[05]** Most energetic transition:

A: UV (250-300 nm) B: violet (375-425 nm) C: blue (450-500 nm) D: green (485-535 nm)
E: yellow (545-595 nm) F: orange (565-615 nm) G: red (625-675 nm) H: infrared (>740 nm)

The least energetic transition of bacteriochlorophyll is between 725–800 nm, the closest answer is ***H****. The most energetic is between 350–400 nm, the closest answer is* ***B****.*

[06] What is an action spectrum of photosynthesis?

A. It is the absorbance spectrum of the light-harvesting chlorophylls, responsible for transferring the exciton to the reaction center
B. It is the wavelengths at which light is absorbed to cause the electron to 'jump' to the excited state.
C. It is the wavelengths of light emitted when an excited electron returns to the ground state.
D. It is the absorbance spectrum of the reaction center chlorophyll that undergoes photochemistry ($Chl^* \longrightarrow Chl^+ + e^-$)
E. It is the wavelengths of light causing oxygen production (or CO_2 fixation).
F. It is the combined spectra for exciton transfer and photochemistry (B and D)
G. It is the combined spectra for absorbance and fluorescence (B and C)
H. None of the above

The answer is ***E****.*

[07] In the 'Z-scheme' of photosynthesis, Raven describes three major complexes: Photosystems I and II, and the cytochrome b_6/f complex. Which of these three complex(es) will contribute to the acidification of the lumen (creating the electrochemical proton gradient that 'powers' the synthesis of ATP by the ATP synthase complex)?

A. ATP synthesis *only* occurs during cyclic electron flow by Photosystem I and the cytochrome b_6/f complex.
B. Photosystem I.
C. Photosystem II.
D. cytochrome b_6/f complex.
E. B and C.
F. B and D
G. C and D
H. All of the complexes (B, C and D)

*All of the complexes contribute to the electrochemical proton gradient, the answer is **H**.*

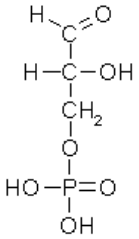
[08] Both NADH (in mitochondrial respiration) and NADPH (in chloroplast photosynthesis) provide reducing equivalents (that is, they donate electrons: NADH —> $NAD^+ + H^+ + 2e^-$ and NADPH —> $NADP^+ + H^+ + 2e^-$), and are chemically quite similar. Which of the following best describes the different role(s) of NADH and NADPH in a photosynthetic cell?

A. NADPH provides reducing equivalents to the electron transport chain to cause the synthesis of ATP on the thylakoidal membrane.
B. NAD^+ is reduced by the electron transport chain of mitochondria to cause the synthesis of ATP.
C. Both NADH and NADPH are used to provide reducing equivalents in many biosynthetic pathways; they are interchangeable.
D. NADPH provides reducing equivalents in biosynthetic pathways, especially the Calvin cycle; NADH provides reducing equivalents to the electron transport chain of mitochondria.
E. A and B F. A and D G. B and C H. B and D

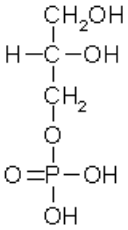
*As noted by Raven, NADH plays a role as electron donor in electron transport chains, NADPH plays a role in biosynthesis pathways, the answer is **D**.*

[09] Which of the following molecule(s) is synthesized from 3-phosphoglycerate and is used as the building block to regenerate ribulose 1,5 – bisphosphate for continued carbon dioxide fixation by RuBisCO (ribulose 1, 5 – bisphosphate carboxylase / oxygenase)?

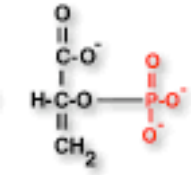
A. 3-phosphoglyceraldehyde



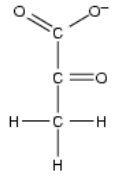
B. glycerol-3-phosphate



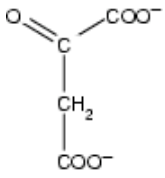
C. phosphoenolpyruvate



D. pyruvate



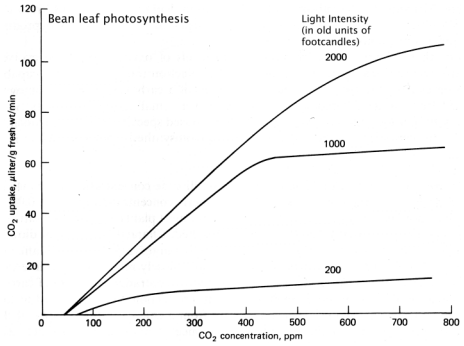
E. oxaloacetate



F. A and B G. C and D H. D and E

*The aldehyde group on 3-phosphoglyceraldehyde is important in carbon skeleton re-arrangement to produce RuBP, the answer is **A**.*

[10] The graph shows an example of the complex relationship between light intensity and CO_2 concentration and their effect(s) on photosynthetic rate. Which of the following interpretation(s) are valid for the data?



A. It's clear from the graph that elevated CO_2 will not increase the photosynthetic rate and therefore accumulation of carbohydrate.
B. It's clear from the graph the elevated CO_2 causes a dramatic increase in the photosynthetic rate under all conditions.
C. There is a complex interplay between light intensity and CO_2 concentration. At low light intensities, elevated CO_2 is not limiting at concentrations above about 300 ppm; at high light intensities, elevated CO_2 is limiting.
D. Light intensity limits the photosynthetic rate under all conditions.
E. Light intensity only limits the photosynthetic rate at elevated CO_2.
F. A and D G. B and D H. None of the above
*Different factors limit under different conditions. With insufficient light intensity, carbon dioxide has no effect, but is limiting at high light intensities, the answer is **C**.*

[11] What is/are major feature(s) that distinguish(es) prokaryotes from eukaryotes?
A. Prokaryotes have a single circular DNA chromosome that aggregates in the nucleoid.
B. Prokaryotes have no internal membrane structures; eukaryotes have an endomembrane system.
C. Prokaryotic flagella utilize a molecular dyenin motor that uses an electrochemical proton gradient to turn the flagellar filament.
D. Prokaryotes lack double membrane organelles.
E. A and B F. A, B and C G. A and D H. All of the above
*Prokaryotes have a circular chromosome that aggregates in the nucleiod and lack the double membrane organelles of eukaryotes, the answer is **G**.*

[12] Which of the following characteristics **could** be used to classify (eu)bacteria?
A. oxygen requirement B. cocci/bacilli/spirilli morphology C. metabolic requirements
D. type of fermentation product E. ribosomal RNA sequence F. all of the above
G. all of the above except A and C
H. all of the above except A and D
*All could be used, the answer is **F**.*

[13] Which of the following distinguishes Gram-negative from Gram-positive bacteria?
A. Crystal violet stains only Gram-positive bacteria
B. Safranin stains only Gram-negative bacteria
C. Only Gram-negative bacterial walls are dissolved by solvents (e.g., acetone or ethanol)
D. Only Gram-positive bacterial walls are dissolved by solvents (e.g., acetone or ethanol)
E. Mordants (which fix the dye) penetrate only Gram-positive bacterial walls
F. Mordants (which fix the dye) penetrate only Gram-negative bacterial walls
G. A and E
H. C and D
*It is the ability of solvents to break down the wall of Gram-negative bacteria that is crucial, the answer is **C**.*

[14] Which one of the following groups has chlorophyll b?
A. Chrysophyta B. Euglenophyta C. Dinophyta D. Cryptophyta
E. Bacillariophyta F. Rhodophyta G. Phaeophyta H. none of the above
*Euglenophyta is unique amongst the listed algal groups in having chlorophyll b, the answer is **B**.*

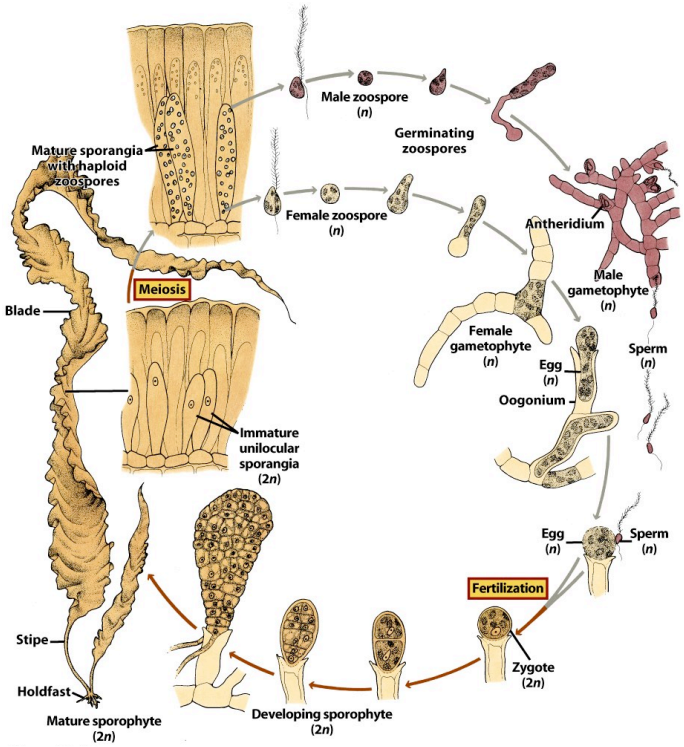
[15] Which one of the following groups contains starch?
A. Rhodophyta B. Euglenophyta C. Bacillariophyta D. Phaeophyta
E. Dinophyta F. Chrysophyta G. Haptophyta H. none of the above
*Dinophyta is the only starch-utilizing group in the list (Rhodophyta uses Floridean starch), the answer is **E**.*

[16] Which one of the following groups is a heterokont (one tinsellated undulipodium, one whiplash)?

A. Rhodophyta B. Chlorophyta C. Phaeophyta D. Haptophyta
E. Cryptophyta F. Dinophyta G. Euglenophyta H. none of the above

*Amongst the groups listed above, Phaeophyta is the only heterokont (**C**).*

[17] Which of the following are correct for the life cycle (from your textbook)?



A. It is a Phaeophyta life cycle
B. It is a Rhodophyta life cycle
C. It is a Chlorophyta life cycle
D. It is a zygotic meiosis life cycle
E. It is a sporic meiosis life cycle
F. A and D
G. B and D
H. A and E

*It's Laminaria, a Phaeophyte, the life cycle is sporic (**H**)*

Match the three unicellular, autotrophic divisions of the Protists with the one most distinguishing characteristic for each division. Choose the best answer.

[18] Cryptophyta
[19] Haptophyta
[20] Euglenophyta

A. Chlorophyll a; phycobilins
B. No cell wall, or silicaceous (rarely cellulosic) scales
C. Layer of vesicles beneath the plasma membrane, with or without cellulose
D. Fucoxanthin
E. Chlorophylls a and c; phycobilins
F. Chrysolaminarin
G. Laminarin
H. Paramylon

*Cryptophyta has chlorophylls a and c and phycobilins (**E**), Haptophyta uses chrysolaminarin for food storage (**F**), Euglenophyta uses paramylon for food storage (**H**).*

Match the three major multicellular, autotrophic divisions of the Protists with the one most distinguishing characteristic for each division. Choose the best answer.

[21] Rhodophyta
A. chlorophylls a and b
E. A and C

[22] Phaeophyta
B. phycobilins
F. glycogen

[23] Chlorophyta
C. paramylon D. peridinin
G. fucoxanthin H. C and G

*Rhodophyta has phycobilins (**B**), Phaeophyta has fucoxanthin as an accessory pigment (**G**), Chlorophyta has chlorophylls a and b (**A**).*

[24] The Chlorophytes are typically divided into three major groups, the Ulvophyceae, and Chlorophyceae and the Charophyceae. Which of the following trait(s) distinguishes the Ulvophyceae from the other two major groups (Choose the best answer)?

A. zygotic meiosis B. marine habitat C. photorespiratory enzymes D. centrioles
E. A and B F. B and C G. C and D H. phycobilins

*Amongst the characteristics distinguishing the three groups, Ulvophyceae is a marine group (**B**), Chlorophyceae and Charophyceae are terrestrial or freshwater. Other traits (such as photorespiratory enzymes, etc.) are shared with either Chlorophyceae or Charophyceae **(per Table 15-2 of your textbook).***

[25] Three genera of the Oomycetes (Oomycota) —Saprolegnia, Achlya and Phytophthera— are often used in basic biological research. They share many similarities (for example glycogen for food storage and cellulosic walls). In what way(s) are the three genera different?

A. Saprolegnia and Achlya are both avirulent, rarely causing disease (some are parasitic), while Phytophthera is well known for its plant pathogens.
B. Phytophthera is typically terrestrial, while Saprolegnia and Achlya are aquatic.
C. Saprolegnia and Achlya lack an asexual means of reproduction, unlike Phytophthera.
D. Unlike most other genera in the Oomycota, Phytophthera is isogamic, rather than oogamic, and lacks a motile zoospore stage.

E. A and B F. A and C G. A, B and C H. B and C

*Not only are Phytopthera spp. often pathogens, but the group is terrestrial, the answer is **E**.*

[26] Which of the following trait(s) distinguishes the Dictyosteliomycota (cellular slime molds) from the Myxomycota (acellular slime molds)?

A. chitin-rich walls B. glycogen C. heterokont D. solely amoeboidal
E. A and B F. B and C G. C and D H. all of the above

*Cellular slime molds lack a motile stage, the answer is **D**.*

[27] The potato blight was caused by which of the following genera?

A. Saprolegnia B. Achlya C. Dictyostelium D. Pythium
E. Hemitrichia F. Arcyria G. Physarum H. none of the above

*Potato blight is caused by Phytopthera, the answer is **H**.*

[28] If you decide to pursue a career in plant biology, which one of the following groups would you choose to study, to ensure you worked in a warm, tropical setting (Choose the best answer).

A. Phaeophyta B. Rhodophyta C. Haptophyta D. Dinophyta
E. Chrysophyta F. Bacillariophyta G. Chlorophyta H. Euglenophyta

*The answer is **B** (Rhodophyta)!*

Finis!