[01] Which of the following atmospheric gas(es) absorb significant amounts of solar radiation at wavelengths shorter than the visible wavelengths (*ca* 400–700 nm)?

A. O_3 (ozone) B. O_2 (oxygen) C. Ar (argon) D. N_2 (nitrogen)
E. CO_2 (carbon dioxide) F. A and B G. B and C H. A and C

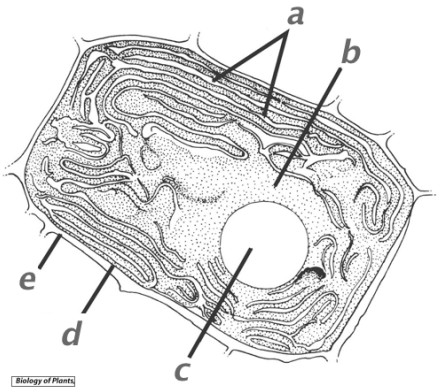
Of the gases listed, the only one that absorbs significant amounts of ultraviolet radiation (<400nm) is O_3 (CO_2 absorbs in the infrared): ***A***.

[02] Wein's Displacement Law defines the wavelength of maximal photon flux as a constant divided by temperature in Kelvin (K) ($\lambda_{max} = 3.6 \bullet 10^6$ (nm K) / T (K)). On a hot day, leaf temperatures can exceed 325 K (about 55 ºC, much hotter than the air temperature), what would be the approximate (*ca*) wavelength of maximal photon flux the leaf emits?

A. *ca* 11 nm B. *ca* 110 nm C. *ca* 1,100 nm
D. *ca* 11,000 nm E. *ca* 110,000 nm F. *ca* 1,100,000 nm
G. *ca* 11,000,000 nm H. no electromagnetic radiation is emitted because on a hot day, it is absorbed.

A calculator will give you 11,077 nm (ca 11,000), or you can subtract the powers of 10 (6-2=4) for 11,000 nm: ***D***.

[03] Which of the following is/are correct for the electron micrograph from your textbook (choose the best answer)?



A. The structures labeled '*a*' are endoplasmic reticulum.
B. The structures labeled '*a*' are thylakoids.
C. The region labeled '*b*' is the cytoplasm.
D. The region labeled '*c*' is the vacuole.
E. The structure labeled '*d*' is the periplasm.
F. The structure labeled '*e*' is the peptidoglycan coat
G. A, C and E
H. A, C and F

Cyanobacteria (which are prokaryotes), like the Anabaena shown, have remarkable internal membrane structures. As indicated in the textbook, the one correct answer is: ***B (a marks the thylakoids)*** *(the region labeled b is the nucleoid; the region labeled c is a food reserve, and e and d are the cell wall and plasma membrane, respectively).*

There are two major electron orbital transitions allowed in chlorophyll (a cyclic tetrapyrolle containing a divalent magnesium ion complexed with the N-atoms of the cyclic tetrapyrolle). What wavelength range do these transition energies correspond to (choose the best answer)?

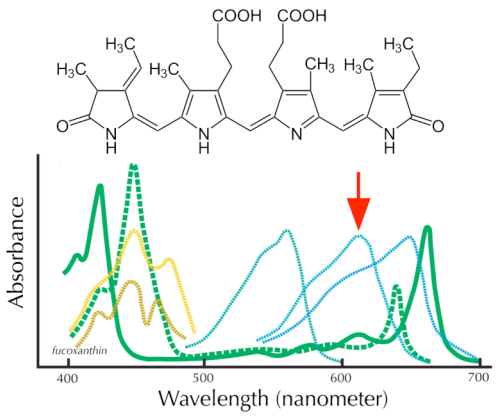
[04] Most energetic transition: **[05]** Least energetic transition:

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 spectrum below provides guidance. The blue absorbing peak is the most energetic transition of chlorophyll (****C****), the red absorbing peak the least energetic (****G****).*

[06] For the molecular structure and spectrum (shown with an arrow), what would be its principle role in photosynthetic organisms (choose the best answer)?

A. Electron transfer in the electron transport chain (especially the cytochrome b_6f complex)
B. Protection from infra-red radiation
C. As a light-sensing pigment (rhodopsin) that the alga would use in vision, to identify regions of light suitable for photosynthesis.
D. It is a chlorophyll and would function in light-harvesting to provide excitons to the reaction centers.
E. 'Splitting' of H_2O to produce H^+, e^- and O_2
F. It is a bilin and would function in light-harvesting to provide excitons to the reaction centers.



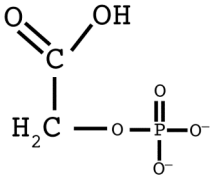
G. It is a carotenoid and would function in light-harvesting to provide excitons to the reaction centers.
H. None of the above
It's phycocyanobilin (a linear tetrapyrolle) (quite different from a carotenoid because of the 4 cyclic N-containing pyrolles), most commonly found in cyanobacteria. It's used to 'harvest light' in the light reactions of photosynthesis: ***F****.*

[07] During the light reactions, which chloroplast compartment becomes alkaline (Choose the best answer)?

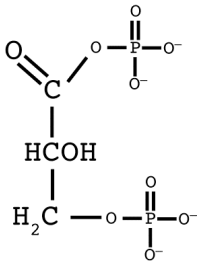
A. stroma B. granal C. thylakoid D. lumen
E. intermembrane space F. plastoquinone G. matrix H. cristae
The lumen of the thylakoids becomes acid (with a high concentration of $[H^+]$*). The chloroplast stroma becomes alkaline. The pH gradient across the thylakoid membrane 'drives' the ATP synthetase.*

Match the following structures with the most appropriate biochemical pathway (choose the best answer; you may choose each answer more than once).

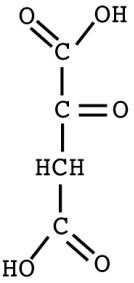
[08] 2-phosphoglycolate



[09] 1,3-bisphosphoglycerate



[10] oxaloacetate



A. C2 pathway (photorespiration) B. C3 pathway (Calvin Cycle) C. C4 pathway (Hatch-Slack)
D. cyclic photophosphorylation E. Glycolysis F. non-cyclic photophosphorylation
G. A and E H. B and E
'Counting the carbons' –as explained in lecture– provides a useful hint: ***A, B and C. H*** *was also accepted for 1,3-bisphosphoglycerate [09] because it is also very important in glycolysis*

[11] Which one of the following 3 carbon compounds is produced from 3-phosphoglycerate using ATP and NADPH?

A. glyceraldehyde-3 phosphate B. phosphoenolpyruvate C. glycolate 1-phosphate
D. sedoheptulose 1,7-bisphosphate E. ribose 5-phosphate F. erythrose 4-phosphate
G. xylose 5-phosphate H. none of the above
The glyceraldehydes 3-phophate provides the 'building block' for the C3 (Calvin) cycle to regenerate ribulose 1,5-phophate, and is synthesized from 3-phosphoglyervate using ATP and NADPH: ***A.***

[12] Which of the following characteristics **could not** be used to classify (eu)bacteria?

A. pigment composition B. ribosomal RNA sequence C. cocci/bacilli/spirilli morphology
D. metabolic requirements E. lactose production F. anaerobic *versus* aerobic respiration
G. genome DNA sequence H. all of the above can be used
Lactose consumption, yes. But not lactose production: ***E.***

[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 (peptidoglycan) are dissolved by solvents (e.g., acetone or ethanol)
D. Only Gram-positive bacterial walls (mucopolysaccharide) are dissolved by solvents (e.g., acetone or ethanol)
E. A and C F. B and C G. B and D H. None of the above
Gram-negative bacteria have mucopolysaccharide walls dissolvable with solvents, Gram-positive bacteria have peptidoglycan walls, so you have to choose: ***H.***

[14] Which one of the following groups contains phycobilins?

A. Chrysophyta B. Euglenophyta C. Dinophyta (dinoflagellates) D. Haptophyta
E. Bacillariophyta (diatoms) F. Xanthophyceae G. Cryptophyta H. none of the above

It may not be a good way to start a conversation, but it's Cryptophyta: ***G.***

[15] Which one of the following groups is notorious for the production of neurotoxins (and other toxins) that target animal cells?

A. Chrysophyta B. Euglenophyta C. Dinophyta (dinoflagellates) D. Haptophyta
E. Bacillariophyta (diatoms) F. Rhodophyta G. Cryptophyta H. none of the above

No comment: ***C.***

[16] Some protist groups exhibit triple-membrane-bound chloroplasts (reported in Euglenoids, for example), while others have chloroplasts that are bounded by four membranes (reported in Dinophyta). Based on mechanisms of ingestion, which of the following endosymbiotic (or other) event(s) would result in four membranes?

A. A four membrane bound chloroplast could only result from the autogenous mechanism in a prokaryote
B. A four membrane bound chloroplast could only result from the autogenous mechanism in a eukaryote
C. A procaryote ingesting a phototrophic eukaryote D. A eucaryote ingesting a phototrophic eukaryote
E. A procaryote ingesting a phototrophic prokaryote F. A eucaryote ingesting a phototrophic prokaryote
G. C and D H. B or D

The only way to get to four membranes is by ingesting a 'three-membrane' cell. That is, a eukaryote with a plasma membrane (1) and a chloroplast (2): ***G.***

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

[17] Euglenophyta
[18] Haptophyta
[19] Xanthophyceae (yellow-green algae)

A. Chlorophyll a and phycobilins
B. No cell wall, or silicaceous (rarely cellulosic) scales
C. Cell wall composed of cellulose or calcified scales
D. Oil food reserves
E. Paramylon
F. Fucoxanthin
G. Laminarin
H. Chlorophylls a and c

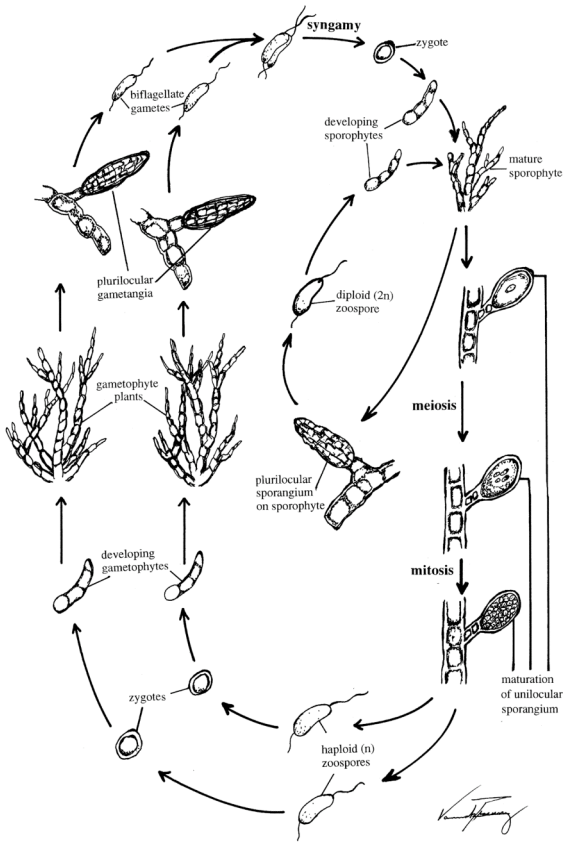
*Euglenoids have paramylon (**E**), Haptophyta have cellulose or calcified scale walls (**C**), Xanthophyceae use oil food reserves (**D**).*

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

[20] Rhodophyta **[21]** Phaeophyta **[22]** Chlorophyta

A. only chlorophyll a B. carotenoids C. only chlorophyll b D. laminarin and mannitol
E. phycobilins F. glycogen G. cellulose walls H. None of the above

*Rhodophyta have phycobilins (**E**), Phaeophyta use laminarin and mannitol (**D**), nothing distinguishing for Chlorophyta (**H**).*



[23] For the life cycle shown (from your lab manual), identify the group (Choose the best answer).

A. Ulvophyceae (green algae) B. Fucus

C. Charophyceae (green algae) D. Chlorophyceae (green algae)

E. Phaeophyta (brown algae) F. Rhodophyta (red algae)

G. Polysiphonia H. Volvox

*It is Ectocarpus, a Phaeophyta (**E**).*

[24] Two genera of the Oomycetes (water molds) —Saprolegnia and Achlya— are often used in basic biological research. They share many similarities (for example glycogen for food storage and cellulosic walls) and both can be isolated from similar ecological habitats. In what way(s) are the two species uniquely different?

A. Saprolegnia is unique, being the only heterokont in the Oomycota.
B. Saprolegnia forms oospores, Achlya does not.
C. Saprolegnia is sexually dimorphic and homothallic (bearing male and female structures on the same individual), Achlya is not sexually dimorphic (the two mating types are morphologically the same).
D. Saprolegnia is homothallic, but Achlya species are often heterothallic (male and female structures are borne on separate individuals).
E. Saprolegnia can reproduce sexually and asexually, Achlya reproduces only asexually.

F. B and E G. B, C and E H. none of the above

*We are like Achlya, with male and female individuals. Saprolegnia is homothallic (**D**).*

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

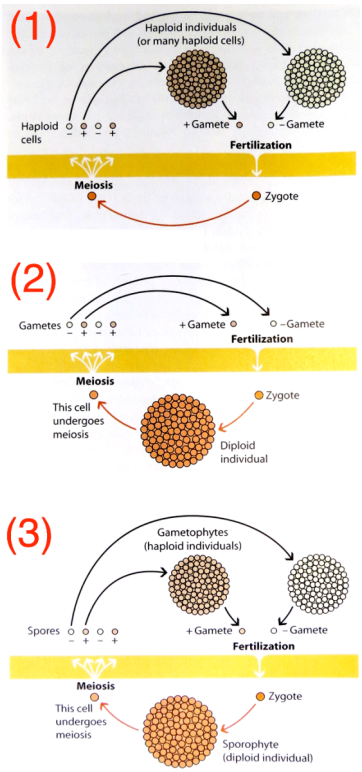
A. glycogen food storage B. heterokont C. proteinaceous walls D. cellulose-rich walls
E. chitinous walls F. B and C G. B and D H. all of the above

*It's cellulose-rich walls for Dicty (**D**).*

[26] Which of the following multicellular groups(s) are heterokonts (Stramenopiles)?

A. Myxomycota B. Phaeophyta C. Oomycota D. Rhodophyta
E. Dictyosteliomycota F. Chlorophyta (green algae) G. A and C H. B and C

*Phaeophyta and Oomycota share that honor (**H**).*



[27] Which one of the meiotic life cycles shown to the left would you expect to be most common in Chlorophyceae (green algae) (Choose the best answer)?

A. 1 (zygotic) B. 2 (gametic) C. 3 (sporic) D. None of the above

*Chlorophyceae has a zygotic meiotic life cycle (**A**).*

[28] Which one of the meiotic life cycles shown to the left would you expect to be most common in the Phaeophyta (brown algae) (Choose the best answer)?

A. 1 (zygotic) B. 2 (gametic) C. 3 (sporic) D. None of the above

*Phaeophyta have sporic life cycles (**C**).*