SC/BIOL 2010.04 Plant Biology *Final Exam* (winter term, 2012/13)

NAME:_____

Instructions:

• Please have your photo card and sessional card ready to show the invigilator when you sign the sign-in sheet.

• Please make sure that your name and student ID number are entered correctly on the scantron sheet!

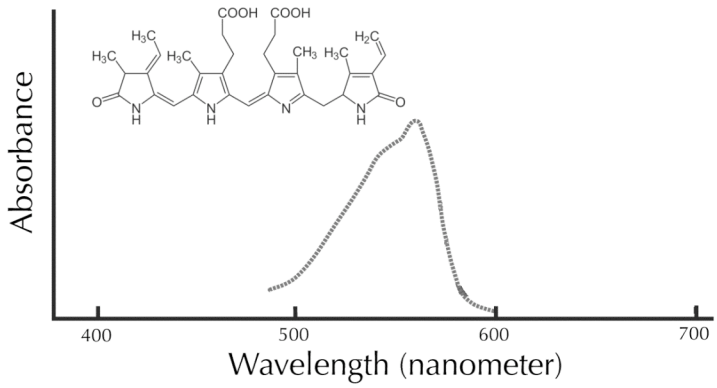
• Answer all questions and ensure that they are transferred to the scantron sheet accurately!

• When you have finished, please hand in *both* the exam and your scantron sheet (and please be quiet for the sake of others still taking the exam).

[01] Which of the following atmospheric gases absorb significant amounts of solar radiation at wavelengths shorter than the visible range (choose the best answer)?

A. N_2 (nitrogen) B. CO_2 (carbon dioxide) C. CO (carbon monoxide) D. Ne (neon)
E. Ar (argon) F. A and B G. B and C H. None of the above

[02] For a molecular structure and spectrum similar to the one shown, what would be its principle role in photosynthetic organisms (choose the best answer)?



A. Protection from ultra-violet radiation
B. Protection from infra-red radiation
C. Electron transfer in aldehyde formation
D. Excitation of orbital photons
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

[03] What is an action spectrum of photosynthesis (Choose the best answer)?

A. It is the wavelengths of fluorescence: the light emitted when an excited electron returns to the ground state
B. It is the absorbance spectrum of the light-harvesting chlorophylls, responsible for transferring the excited state e^- to the reaction center (resonance energy transfer)
C. It is the absorbance spectrum of the reaction center chlorophyll that undergoes photochemistry ($Chl^* \longrightarrow Chl^+ + e^-$)
D. It is the wavelengths of absorbance: when light is absorbed to cause the electron to 'jump' to the excited state
E. It is the wavelengths of light causing ATP and NADPH production
F. It is the combined spectra for absorbance and fluorescence (A and B)
G. It is the combined spectra for excited state e^- transfer and photochemistry (C and D)
H. It is the wavelengths of photons that are active in breaking molecular bonds.

[04] In the reaction center photochemistry ($Chl^* \longleftrightarrow Chl^+ + e^-$) of PS II, which must occur first to allow the light reactions to continue (choose the best answer)?

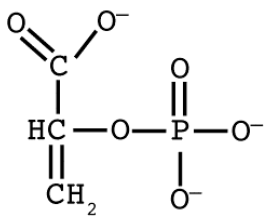
A. The electron (e^-) must be donated to a plastoquinone, so that it is no longer available to reduce the Chl^+ to Chl.
B. The electron (e^-) must be accepted by the cytochrome b_6f complex, so that the Chl* can be oxidized to Chl^+.
C. The electron (e^-) must be donated to plastocyanin, so that the Chl^+ can be reduced to Chl* ($Chl^+ + e^- \longrightarrow Chl^*$)
D. Water is partially split to provide an electron to Chl^+ so that the electron (e^-) can be donated to cytochrome b_6f.
E. The excited orbital state of the Chl* must revert to the non-excited (ground) state, releasing a photon which will reduce the Chl^+ to Chl ($Chl^+ + e^- \longrightarrow Chl^*$).
F. A and D G. A and C H. None of the above

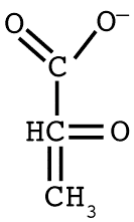
[05] Following Raven's outline of cyclic and noncyclic electron flow in Photosystem I alone (cyclic) or both Photosystems I and II (noncyclic), which of the following components are associated with ***only*** noncyclic ***and not*** cyclic electron transfer?

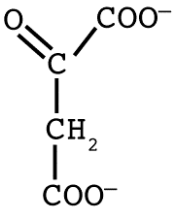
A. P680 B. Plastocyanin C. Ferredoxin D. Cytochrome b_6/f complex
E. P700 F. A, B and C G. C, D and E H. None of the above

[06] Which of the following molecule(s) is/are the immediate substrates(s) of carboxylation in the C4 pathway of photosynthesis?

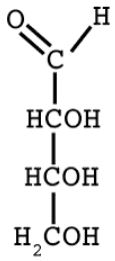
A. phosphoenolpyruvate B. pyruvate C. oxaloacetate

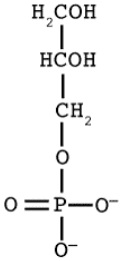






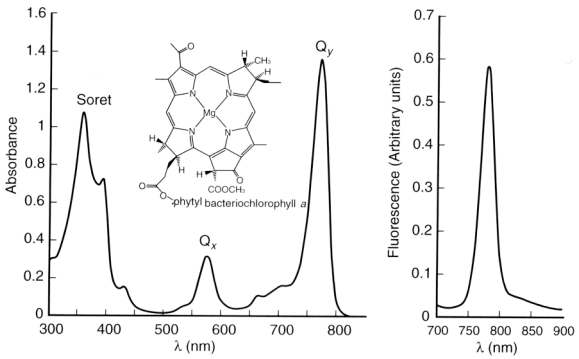
D. erythrose E. glycerol-3-phosphate





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

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; the two major transitions are the Soret and Q_y bands). What wavelength range do these transition energies correspond to (choose the best —that is, closest— answer)?



[07] 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)

[08] Least energetic transition:

[09] Which of the following is/are the major feature(s) that distinguishes 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 rotor/stator motor that uses an electrochemical proton gradient to turn the flagellar filament.
D. Prokaryotes lack double membrane organelles.
E. A and B F. A and C G. A and D H. A, C and D

[10] Which of the following distinguishes Gram-negative from Gram-positive bacteria in the Gram differential staining technique?

A. Crystal violet stains the thicker peptidoglycan wall of only Gram-negative bacteria
B. The counterstain safranin reacts with crystal violet to selectively stain Gram-negative bacteria
C. The crystal violet selectively stains Gram-positive bacteria, creating a purple color.
D. The solvents (alcohol or acetone) selectively dissolve mordant-fixed crytal violet in Gram-negative bacteria.
E. Treatment with solvents such as alcohol or acetone selectively breakdown the thinner wall of Gram-positive bacteria, allowing the mordant-fixed dye to leave the bacterial cell.
F. Treatment with solvents such as alcohol or acetone selectively breakdown the thinner wall of Gram-negative bacteria, allowing the mordant-fixed dye to leave the bacterial cell.
G. The mordants (NaI or I_2) can only enter Gram-negative bacteria, fixing the crystal violet dye so that it is trapped inside the cell
H. None of the above

[11] Which of the following characteristic(s) can be used to classify eubacteria (choose the best answer)?

A. Carbon dioxide (gas) production when supplied with a preferred carbohydrate
B. Gram-staining
C. Ribosomal RNA sequences unique to a particular bacterial group or species
D. morphology; cocci (rod), baccili (round), and spirili (spiral or helical) are typical morphologies
E. A, B and C F. B, C and D G. A, C and D H. All of the above

[12] Which of the following ***cannot*** be used to classify and identify the major groups of autotrophic protists?

A. Use of laminarin for food storage	B. Silicaceous (glass) walls	C. Proteinaceous walls
D. Mucopolysaccharide walls	E. Phycobilins	F. Use of oil for food storage
G. Chlorophylls a, b and c	H. All of the above can be used	

Match the following unicellular, autotrophic divisions of the Protists with the one most distinguishing characteristic for each division. Choose the best answer. Do not use each answer more than once.

[13] Euglenophyta	A. proteinaceous pellicle (walls)	B. phycobilins
[14] Chrysophyta	C. fucoxanthin	D. laminarin food storage
[15] Dinoflagellates	E. Floridean starch	F. oil food storage
	G. carotenoids	H. peridinin

Match the three major multicellular, autotrophic divisions of the Protists with the one most distinguishing characteristic for each division. Choose the best answer. Do not use each answer more than once.

[16] Rhodophyta	A. Only chlorophyll b	B. peridinin
[17] Phaeophyta	C. Paramylon	D. Starch food reserves
[18] Chlorophyta	E. Glycogen	F. Chrysolaminarin
	G. Flagella absent	H. None of the above

[19] What is a pyrenoid?

A. An organelle that contains peridinin.
B. A protein-rich structure that contains a limited quantity of DNA (a nucleomorph)
C. The pigment that is located in the eyespot of many eukaryotic protists.
D. A threadlike structure that extends from the body of the protist cell.
E. A small membrane-bound cavity under the cell surface.
F. A protein-rich structure that contains the enzymes required for synthesizing silicaceous cell walls.
G. A region of the chloroplast that contains RuBisCO, in which starch is formed.
H. None of the above

[20] Which of the following groups are stramenopiles (heterokonts)?

A. Xanthophyceae B. Chrysophyceae C. Bacillariophyceae D. Phaeophyceae
E. A, B and C F. A, C and D G. B, C and D H. all of the above

[21] What is a stramenopile?

A. An organism that has two tinsellated undulipodia (flagella).
B. An organism that has two whiplash undulipodia (flagella).
C. An organism that has both a tinsellated and a whiplash undulipodium (flagellum).
D. An organism in which reproduction (sex) involves two types of motile gametes.
E. An organism that evolved from a secondary endosymbiotic event (of two different eukaryotic cells).
F. As opposed to a homokont, a heterokont organism has dimorphic alternation of generations.
G. An organism that evolved from two successive endosymbiotic events (involving two different prokaryotic cells).
H. None of the above

Match the following major heterotrophic divisions of the Protists with the one most distinguishing characteristic for each division. Choose the best answer.

[22] Oomycota
A. only terrestrial
D. cellulosic cell walls
G. chitinous walls

[23] Dictyosteliomycota
B. zoospores
E. no undulipodia
H. none of the above

[24] Myxomycota
C. glycogen food storage
F. heterokont

Match the following characteristics with the most appropriate fungal division (Choose the best answer, you may use an answer more than once).

[25] Budding Cells **[26]** Rhizomorph **[27]** Truffles

A. Basidiomycota B. Teliomycetes C. Ascomycota D. Ustomycetes
E. Zygomycota F. Hymenomycetes G. Gasteromycetes H. None of the above

[28] At what stage in their life cycle are Ascomycetes dikaryotic?

A. after nuclear division B. before nuclear division C. after karyogamy
D. after meiosis E. after plasmogamy F. during mycelial growth
G. before plasmogamy H. they are never dikaryotic

[29] Which one of the following genera belong to the fungal division Zygomycota?

A. Psilocybe B. Coprinus C. Glomus D. Aspergillus
E. Entomopthora F. Amanita G. Ustilago H. None of the above

[30] What advantages does a mycorrhizal fungi obtain from the plant symbiont?

A. The Hartig net (hyphal network growing between the root cells of the plant symbiont) provides physical protection from soil predators of fungi
B. The arbuscules (tree-like network of hyphae growing between the root cells of the plant symbiont) provides physical protection from soil grazers of fungi.
C. The fungal symbiont obtains phosphorus and other essential nutrients from programmed death of selected cells in the plant symbiont.
D. The plant symbiont provides photosynthate to the fungal symbiont.
E. B and C F. B and D G. C and D H. all of the above

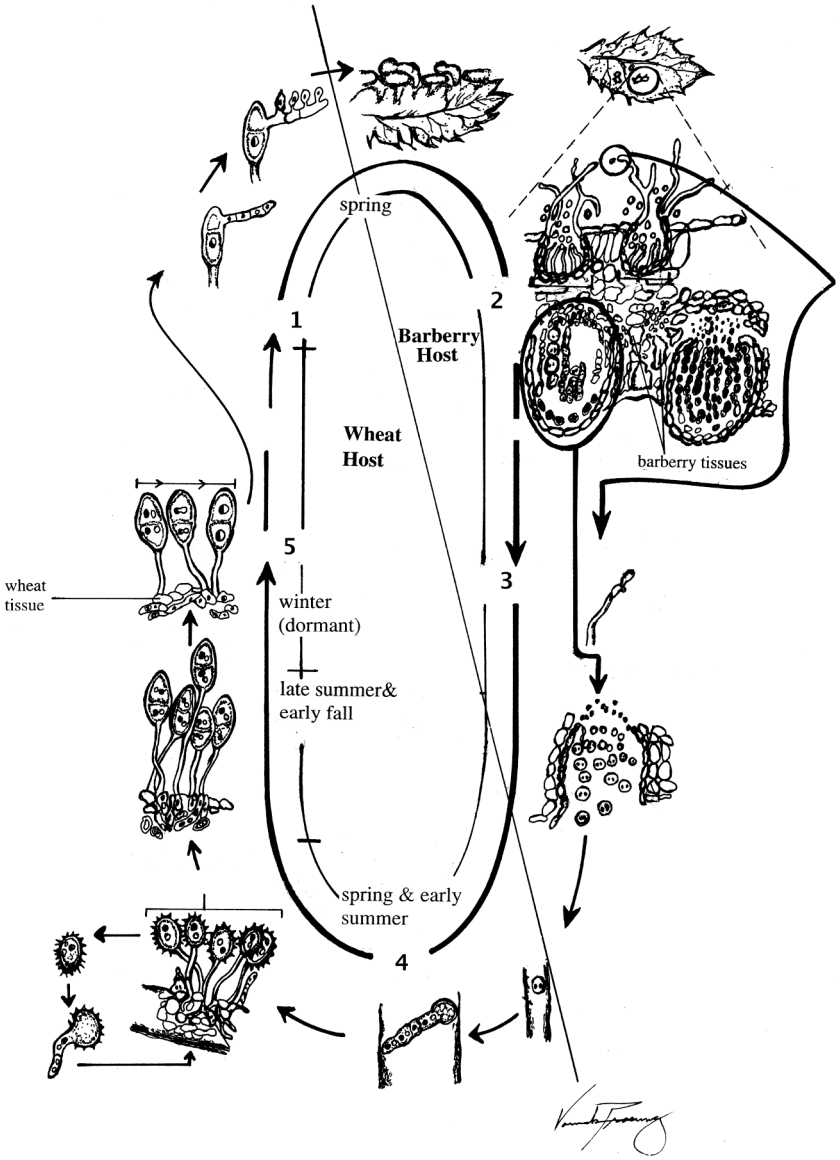
[31] Which one of the following terms does <u>not</u> describe a common trait, structure or characteristic of one or more of the fungal divisions?

A. gametangia B. sterigma C. theca D. hymenium E. gleba
F. pileus G. basidiomata H. all describe a common trait, structure or characteristic

[32] Which one of the following genera is known to have a very primitive 'eye' capable of guiding the sporangiophore towards light?

A. Aspergillus B. Saccharomyces C. Rhizopus D. Ustilago
E. Pilobolus F. Allomyces G. Entomophthora H. none of the above

Identify the numbered stages in the wheat rust ((*Puccinia graminis* var *tritici*) with the following genetics states and/or events.



[33] haploid
A. 1 B. 2 C. 3 D. 4 E. 5
F. A and B G. B and C
H. None of the above

[34] heterokaryon
A. 1 B. 2 C. 3 D. 4 E. 5
F. A and B G. B and C
H. None of the above

[35] diploid
A. 1 B. 2 C. 3 D. 4 E. 5
F. A and B G. B and C
H. None of the above

Some scientists hypothesize that the successful 'invasion of land' by plants required a symbiotic relationship between fungi and the 'ancestral' plant (presumably a chlorophyte). Certainly, lichens are one example of a successful 'land invasion' involving such a symbiotic relationship.

[36] Which one of the following characteristics is <u>not</u> true for the lichens?
A. lichens may be foliose, crustose or fruticose.
B. Cladonia species are a common ground cover in the Arctic.
C. lichens can survive long periods of time in a desiccated state.
D. the fungi 'invades' the photosynthetic cell using a haustorium or appressorium
E. they are a symbiotic association between a fungi (commonly an Ascomycete) and a photosynthetic organism (either a cyanobacteria or green algae).
F. the two symbionts can often be grown separately from each other.
G. the fungal 'mycobiont' typically forms an epidermis which serves to protect the cyanobacterial/algal 'photobiont' within the lichen structure
H. all of the above are true

[37] Which of the following is a small mass of vegetative tissue, an outgrowth of the haploid thallus (multicellular body) that is capable of growing into a new haploid gametophyte and is common in the liverworts?
A. rhizomorph B. elater C. androecium D. gametangiophore
E. placenta F. gemma G. caulonema H. none of the above

[38] What is a moss calyptra?
A. The sporangium
B. The lid of the sporangium
C. The female gametangium
D. The hood or cap that partly or entirely covers the capsule of some species, formed from the expanded archegonium wall
E. The packet-like swelling that contains the antheridia
F. The stalk that supports the capsule that is part of the sporophyte
G. A branch bearing one or more sporangia
H. None of the above

[39] What unique characteristic(s) distinguish Selaginella from Lycopodium?
A. hydroids and leptoids B. homospory C. eustelar anatomy D. protostelar anatomy
E. heterospory F. ligule G. D and E H. none of the above

[40] Which of the following *cannot* be used to distinguish an individual or group within the Pteridophyta (ferns)?
A. homospory
B. superficial initials forming the sporangia (eusporangia)
C. arrangement and form of the sori
D. form and function (fertile and sterile) of the leaves (fronds)
E. motile sperm
F. apical initial forming the sporangia (leptosporangia)
G. heterospory
H. All of the above can be used

[41] Which of the following *can* be used to distinguish major groups within the Gymnosperms (Coniferophyta, Cycadophyta, Ginkgophyta and Gnetophyta)?
A. non-motile sperm B. dioecious C. eustelar anatomy D. leaf morphology
E. A and B F. A, B and D G. B, C and D H. All of the above can be used

[42] Which of the following characteristics are key components of the successful invasion of land by plants (choose the best answer)?

1. leptoids and hydroids
2. indeterminant growth of sporophyte
3. rhizoids and roots
4. secondary meristems
5. stomata (or primitive variants thereof)
6. xylem and phloem

A. 1, 2, 3, 4 and 5 B. 2, 3, 4, 5 and 6
C. 1, 3, 4, 5 and 6 D. 1, 2, 4, 5 and 6
E. 1, 3, 4 and 5 F. 2, 3, 4 and 6
G. 2, 4, 5 and 6 H. 1, 4, 5 and 6

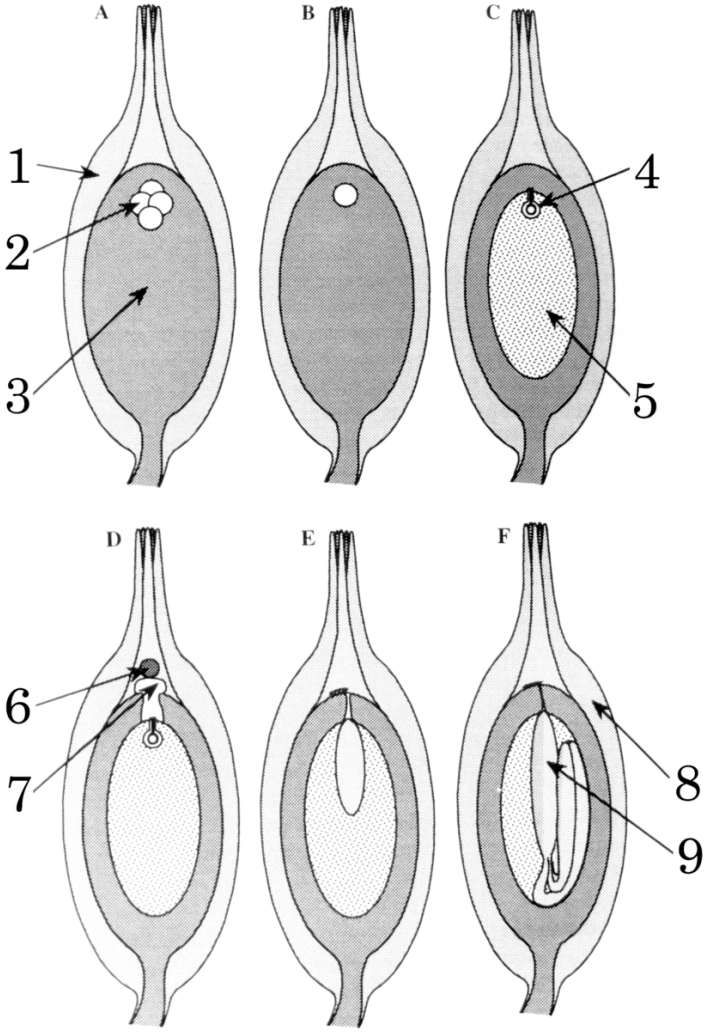
[43] How is water transported in vascular plants —most notably in trees (choose the best answer)?

A. Evaporation of water in the leaf 'pulls' water up the tree through the xylem.
B. Similar to a barometer, it is the atmospheric pressure that pushes water from the soil through the xylem to the top of the tree.
C. The high osmolarity of roots draws water into the plant from the soil at a pressure high enough to push it to the top of the tree.
D. The small diameter of the xylem allows water to be drawn to the top of the tree by capillary action.
E. Water movement up the xylem is caused by its movement down the phloem cells —a kind of rotatory pump.
F. Both A and B, working in concert.
G. Both C and D, working in concert.
H. None of the above.

In the diagrammatic representation of megagametogenesis in gymnosperms, identify the labeled structures.

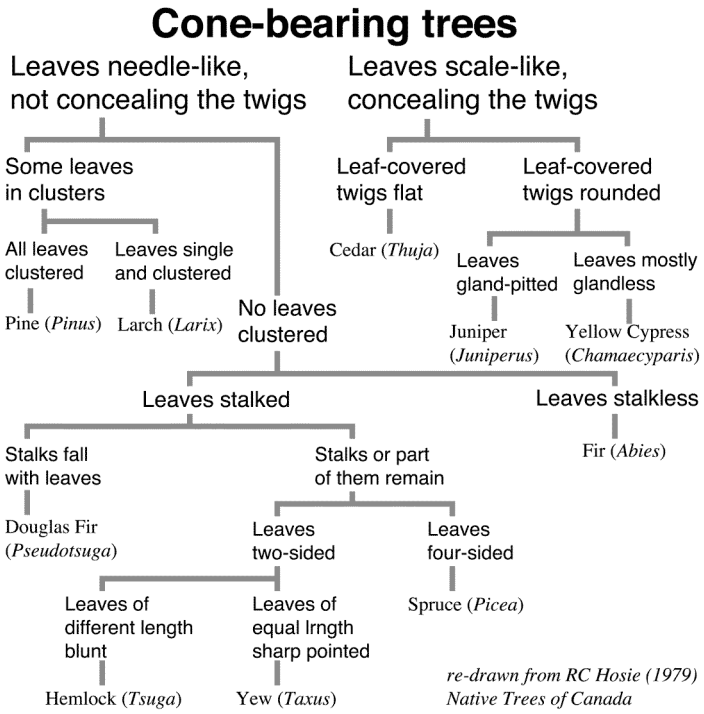
[44] '1' **[45]** '5'

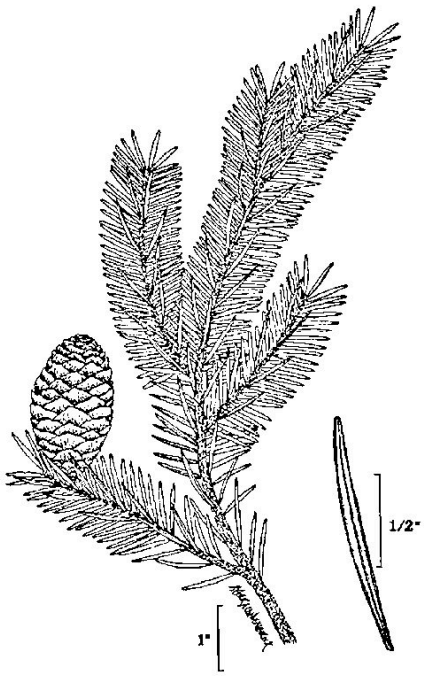
A. integument B. gametophyte
C. seed coat D. nucellus
E. microspore F. archegonium
G. megaspore H. none of the above



[46] Identify the Gymnosperm shown below to genus using the key.

A. Abies B. Juniperus C. Larix D. Picea
E. Pinus F. Taxus G. Thuja H. Tsuga





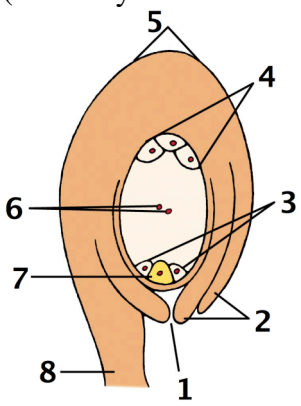
[47] Which of the following is <u>not</u> true of microgametogenesis in angiosperms (choose the best answer)?

A. All of the below are true
B. meiosis results in the formation of four spores in a tetrad
C. tapetal tissue is haploid
D. pollen exine is produced soon after spores are released from the tetrad
E. the initial haploid nuclei of the microspore undergoes 2 cycles of mitosis to form three nuclei: two generative (sperm cells) and one vegetative.
F. pollen enter domancy during maturation, prior to release from the anther.
G. the mother pollen cell is diploid
H. the tapetal initial cell is diploid

[48] Which of the following is not true of megagametogenesis in angiosperms (choose the best answer)?

A. All of the below are true
B. The integument is sporophytic in origin
C. meiosis results in the formation of one (monosporus), two (bisporus) or four (tetrasporus) haploid megaspore(s)
D. nucellus tissue is diploid
E. the two nuclei of the central cell of the embryo sac will fuse with one of the sperm cell nuclei to form the triploid endosperm
F. the megaspore undergoes 3 cycles of mitosis to form eight haploid nuclei in the embryo sac
G. the antipodal cells do not fuse with one of the sperm cell nuclei.
H. the synergid cells are located near the micropyle with the egg cell

For the angiosperm ovule shown in the diagram, identify the five regions/cells (1, 3, 4, 6 and 7) (You may use each answer only once)



[49] 1	A. polar nuclei	B. chalzea
[50] 3	C. funiculus	D. antipodals
[51] 4	E. integuments	F. egg cell
[52] 6	G. micropyle	H. synergids
[53] 7		

[54] If the S-locus genotype of one parental strain is S_1S_2 and the other parental strain is S_3S_4 and <u>neither</u> S_1 <u>or</u> S_2 pollen hydrates on the stigmatic surface of the S_3S_4 parent, what is the incompatibility mechanism (Choose the best answer)?

A. The experiment was done incorrectly since both S_1 and S_2 pollen should germinate on the S_3S_4 parent.
B. The experiment was done incorrectly since S_1 (but not S_2) pollen should germinate on the S_3S_4 parent
C. It is a classic example of a gametophytic incompatibility mechanism.
D. It is a classic example of a sporophytic incompatibility mechanism.
E. The S_3 and/or S_4 allele(s) must be dominant or co-dominant over both S_1 and S_2 to explain the results of this sporophytic incompatibility example.
F. The S_1 and/or S_2 allele(s) must be dominant or co-dominant over both S_3 and S_4 to explain the results of this gametophytic incompatibility example.
G. All of the above are possibilities
H. None of the above

[55] If the S-locus genotype of one parental strain is S_1S_2 and the other parental strain is S_3S_4 and <u>both</u> S_1 <u>and</u> S_2 pollen germinate on the stigmatic surface of the S_3S_4 parent and successfully fertilize the egg cell, what is the incompatibility mechanism (Choose the best answer)?

A. It is a classic example of a gametophytic incompatibility mechanism.
B. It is a classic example of a sporophytic incompatibility mechanism.
C. It could be either a gametophytic or a sporophytic incompatibility mechanism.
D. None of the above

[56] Which of the following are <u>not</u> mechanisms to ensure out-crossing (Choose the best answer)?

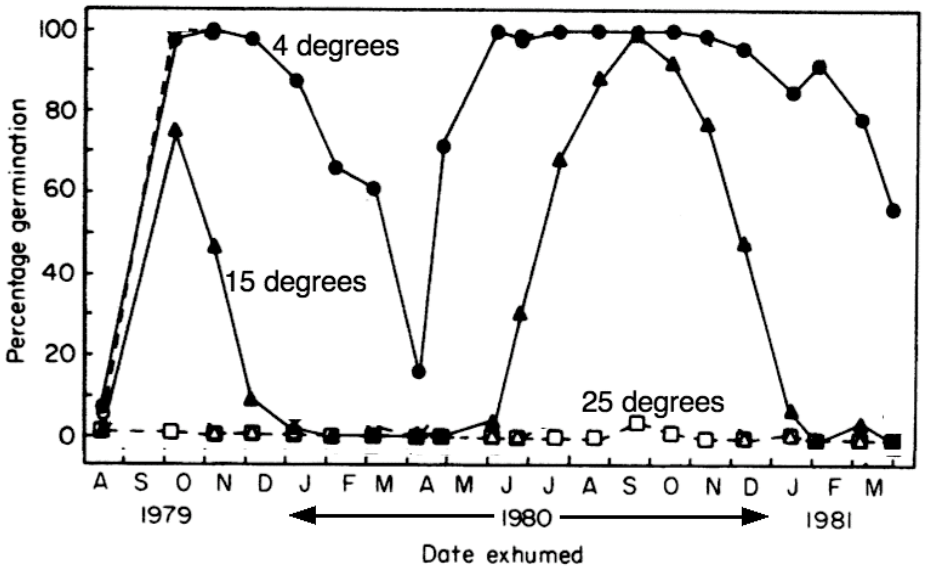
A. Dioecious
B. Pin and thrum floral morphologies
C. Sporophytic incompatibility
D. Gametophytic incompatibility
E. Moneocious
F. Differing timing of female and male flower maturation
G. Insect pollination
H. All of the above are mechanisms to ensure outcrossing

[57] Floral structures in many cases are targeted to pollinations by specific vectors, be they animal, wind, or even water. For a flower with a dish/bowl structure and profuse pollen production, what is the most likely pollination vector?

A. bees B. moths C. wind D. beetles
E. snakes F. bats G. birds H. none of the above

[58] What occurs during the first cellular division of higher plant embryogenesis?

A. polar axis formation
B. radicle formation
C. anticlinal (perpendicular to the surface) division
D. periclinal (parallel to the surface) division
E. segmentation
F. meristem formation
G. suspensor formation
H. none of the above



		Test Temperature (degrees Celsius)										
Date of Test		4	10	15	20	25	30	4/10*	4/20*	10/20*	10/30*	15/30*
July	Light	100	100	92	5	3	0	100	100	88	89	34
	Dark	16	10	0	0	2	1	37	31	3	9	1
September	Light	100	100	100	99	23	0	100	100	100	100	99
	Dark	93	73	17	6	0	4	97	70	49	58	14

*daily temperature fluctuation: 16 hours at the lower temperature, 8 hours at the higher temperature

Germination tests of Aphanes seeds buried in soil in 1979 and exhumed at the month and year shown. The germination tests were performed at the temperatures shown in the figure and table.

[59] Which of the following are <u>not</u> reasonable interpretations of the data, bearing in mind that Aphanes is a northern temperate species and an annual that completes its life cycle in one year.

A. Longer storage in the soil causes more germination.
B. Aphanes seeds can tell the difference between seasons of the year.
C. Unusually, low temperature induces germination.
D. Regardless of the month, fluctuating temperature induces germination
E. Sometimes, light induces germination.
F. We can speculate that warm temperature promotes dormancy.
G. A combination of light, temperature and fluctuating temperature control germination.
H. All of the above are reasonable interpretations.

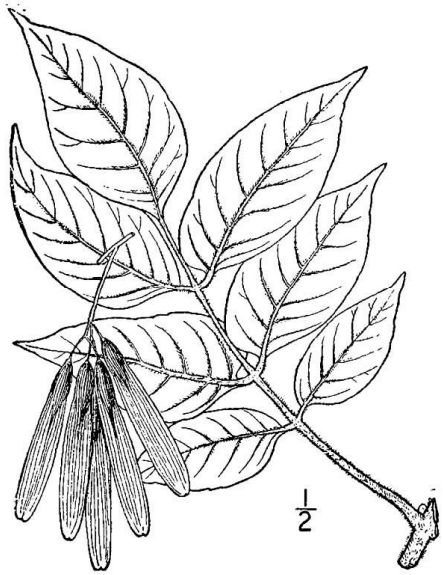
[60] For five days in the middle of the winter, the average temperature was constant at –12 degrees Celsius. For those five days, how many degree-days were accumulated?

A. about 0.15 degree-days B. about 1.5 degree-days C. about 15 degree-days
D. about 150 degree-days E. about 1500 degree-days F. about 15000 degree-days
G. about 150000 degree-days
H. no degree-days were accumulated, because the cut-off for degree-day calculations is –12 degrees Celsius

[**61**] The seed of a plant adapted to Elliott Lake (which accumulates 4500 degree days during the winter) is transported to Toronto (3500 degree days) in March. If accumulated cold was the only mechanism controlling germination, how many days later will the seed attempt to germinate in Toronto (under warm and moist conditions)?

A. 1 day later B. 5 days later C. 50 days later D. 500 days later
E. 5 days earlier F. 50 days earlier G. 500 days earlier
H. It would never attempt to germinate in Toronto

The following data set is for ash (*Fraxinus americanum*) a common temperate tree species. The samara is the wing-like structure that surrounds the seeds (unlike maple seeds, the ash samara is a single wing, rather than a double wing). Germination tests were performed at 20 degrees Celsius.



Biological Material	Germination (%)	ABA content
Non-treated seeds	0 to 3	1.7 mmol/kg
Stratified seeds	70-95	0.6 mmol/kg
Dormant samara	----	2.8 mmol/kg
Stratified samara	----	1.8 mmol/kg

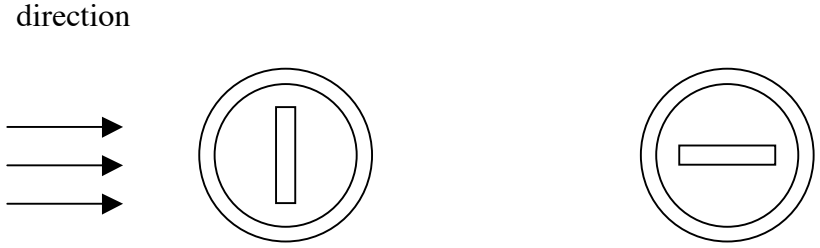
[62] Choose the best interpretation of the data

A. Samara removal causes lower ABA in the seed.
B. ABA in the samara has no effect on seed germination
C. We can speculate that the ABA degrading enzyme has an optimal temperature of about 4ºC (that is, cold).
D. It is likely that ABA causes dormancy, inhibiting germination.
E. A stratified samara should cause seed germination.
F. All except A and B
G. All except B and E
H. All except A and E

[63] Radicle emergence is associated with many functions required for seedling survival. Which of the following are not two urgent functions (Choose the best answer)?

A. water and nutrient uptake B. mechanical support for shoot photosynthesis
C. water uptake and photosynthesis D. negative gravitropism and positive phototropism
E. breakdown of food reserves and water uptake E. breakdown of food reserves and photosynthesis
G. positive gravitropism and negative phototropism H. All of the above are urgent functions.

Plants and lower eucaryotes (that is, algal protists) both contain the light sensor, phytochrome. Phytochrome has been implicated in numerous functions, such as germination, time of flowering etc. but is also known to be responsible for more rapid processes, such as movement of chloroplasts. In Mougeotia, a chlorophyte, red (660 nm) light irradiation causes the single slab-shaped chloroplast to rotate from a position perpendicular to the light direction to a position paralell to the light direction. This phenomena exhibits a property known as photoreversibility, as shown in the following data with a 'twist': there was a dark interval between the red and far-red light treatments:



Red light	dark interval	Far-red light	% rotation (60 minutes later)
30 sec	0 sec	0 sec	90
30 sec	0 sec	30 sec	0
30 sec	15 sec	30 sec	20
30 sec	30 sec	30 sec	25
30 sec	60 sec	30 sec	35
30 sec	90 sec	30 sec	55
30 sec	120 sec	30 sec	60
30 sec	180 sec	30 sec	90

[64] Which of the following is the best explanation for the effect of the dark interval on chloroplast rotation?

A. Phytochrome will be transformed into the $\mathbf{P_R}$ form by red light, but more $\mathbf{P_R}$ will revert to the $\mathbf{P_{FR}}$ form as the dark interval is increased, causing increased rotation

B. Phytochrome will be transformed into the $\mathbf{P_{FR}}$ form by far-red light, but more $\mathbf{P_{FR}}$ will revert to the $\mathbf{P_R}$ form as the dark interval is increased, causing increased rotation

C. Chloroplast rotation clearly requires a mix of the $\mathbf{P_R}$ and $\mathbf{P_{FR}}$ forms of phytochrome. The dark interval is changing the ratio of the two forms. A dark duration of 180 sec just happens to be optimal for chloroplast rotation.

D. As the dark interval increases, the chloroplast is unable to photosynthesize, and lacks the energy required to stay in one place.

E. The $\mathbf{P_R}$ form of phytochrome must activate some cellular process that holds the chloroplast in the perpendicular orientation. Whatever that cellular process is (perhaps elevated calcium?), it must take time for the cellular process to reach a commitment point and become irreversible, which is why increasing the duration of the dark interval stimulates chloroplast rotation

F. the $\mathbf{P_{FR}}$ form of phytochrome must activate some cellular process that causes the chloroplast to rotate. Whatever that cellular process is (perhaps elevated calcium?), it must take time for the cellular process to reach a commitment point and become irreversible, which is why increasing the duration of the dark interval stimulates chloroplast rotation

G. B and E

H. None of the above

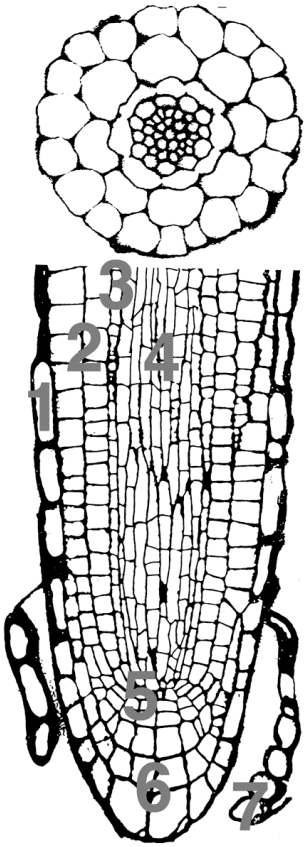
[65] Which of the following are propert(ies) or characteristic(s) of phytochrome?

1. It is a cyclic tetrapyrolle
2. It is a linear tetrapyrolle
3. The Pr form absorbs far-red light
4. The Pfr form absorbs far-red light
5. The Pr form dark reverts to the Pfr form
6. The Pfr form dark reverts to the Pr form
7. The Pfr form is the active form
8. The Pr form is the active form

A. 1, 3, 5 and 7
B. 2, 4, 6 and 8
C. 1, 4, 5 and 7
D. 2, 3, 5 and 7
E. 3, 5 and 7
F. 3, 5 and 8
G. 2, 3 and 6
H. 2, 4, 6 and 7

Identify the marked regions on the root below. You may use each answer more than once (Choose the best answer).

[66] region 2
[67] region 4
[68] region 6
[69] region 7



A. quiescent center
B. cortical cells
C. endodermis
D. root cap
E. stele (vasculature)
F. root cap cells
G. pericycle
H. epidermis

[70] Shoot emergence is associated with which of the following urgent function(s) required for the long-term survival of the seedling (Choose the best answer)?

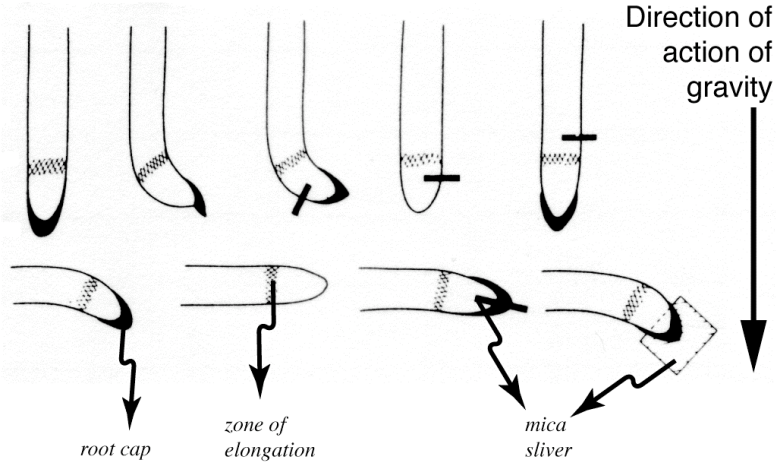
A. breakdown of carbohydrate food reserves
B. photosynthesis and net carbohydrate production
C. mechanical support and negative geotropism
D. mechanical support and positive phototropism
E. photosynthesis and water transport to the shoot apex
F. primary leaf development
G. secondary leaf development
H. All of the above are urgent functions

[71] Plants exhibit a number of 'tropisms'. Which of the following 'tropisms' would you *hypothesize* are important for survival of a germinating seedling (choose the best answer)?

1. positive phototropism
2. negative phototropism
3. positive gravitropism
4. negative gravitropism
5. positive hydrotropism
6. negative hydrotropism

A. 1, 2, 3 and 4
B. 2, 3, 4 and 5
C. 3, 4, 5 and 6
D. 1, 2, 5 and 6
E. 1, 3, 4 and 5
F. 2, 3, 4 and 6
G. 1, 3, 4 and 6
H. all of the above

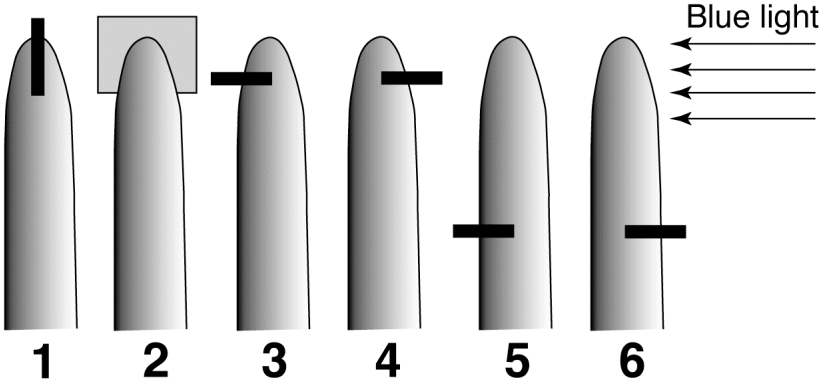
The figure shows the responses of a root to gravity after micromanipulations –either removal of part of the root cap or the insertion of a thin barrier at various locations.



[72] Which of the following are <u>not</u> reasonable interpretations of the data?

A. The presence of a root cap inhibits gravitropism.
B. Removal of half the root cap has no effect on the gravitropic response.
C. Insertion of a thin barrier below the zone of elongation has the same effect as removal of part of the root cap.
D. We can speculate that the root cap inhibits elongation.
E. The roots always respond the same if horizontal or vertical
F. A and B
G. A, B and E
H. All are reasonable interpretations

[73] In a coleoptile, a mica sliver is placed at the locations and orientations shown below (in 5 and 6, the mica sliver is placed *below* the zone of cell expansion). In which position(s) would positive phototropism be induced?



A. 1, 3 and 5
B. 1, 3 and 4
C. 2, 3 and 4
D. 1, 3, 4 and 6
E. 2, 4, 5 and 6
F. 1 and 4
G. 4 and 6
H. 4, 5 and 6

[74] What factors affect shoot emergence (Choose the best answer)?

A. flavin responses to blue light
B. water
C. gravity
D. flavin response to green light
E. carbon dioxide
F. A and B
G. A and C
H. A, B and C

[75] Which of the following describe the structure of an angiosperm apical meristem (Choose the best answer)?

A.No cell division
B. single apical initial
C. layered tunica
D. corpus
E. apical cell cluster
F. A, B and E
G. C. D and E
H. C and D

[76] A flowering plant is treated with a light/dark treatment of 8 hours of light followed by 36 hours of dark. Which of the following types of plants will flower (Choose the best answer)?

A.Short-day plants
B. Long-day plants
C. Day neutral plants
D.A and B
E. A and maybe C
F. B and maybe C
G. All will flower
H. None of the above

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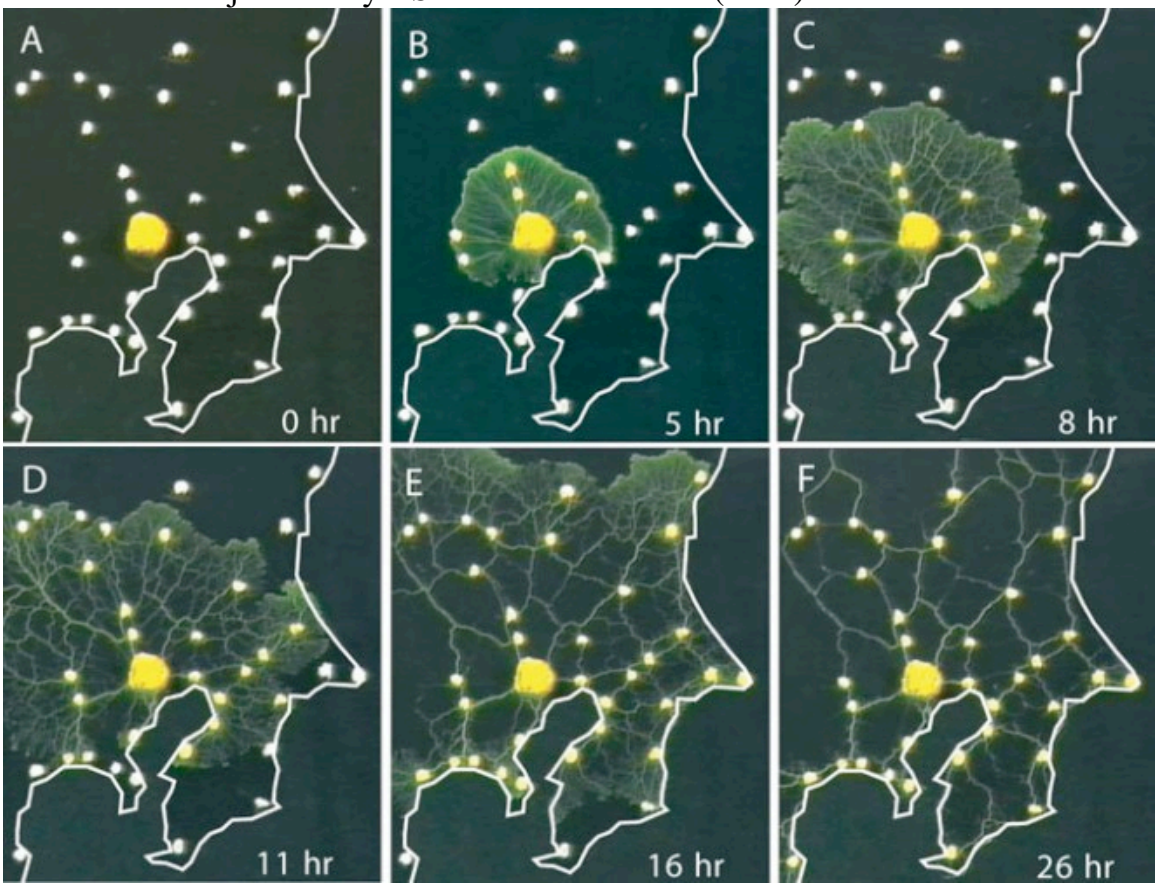
When provided with sources of nutrients that mimic major urban densities in the Tokyo region, slime plasmodium spans the nutrient sources by a protoplasmic transport network that matches major railways. Science 327:439-442 (2010).



Physarum Chip: Growing Computers from Slime Mould

Objective: We will design and fabricate a distributed biomorphic computing device built and operated by slime mould *Physarum polycephalum*. A Physarum chip is a network of processing elements made of the slime mould's protoplasmic tubes coated with conductive substances; the network is populated by living slime mould. A living network of protoplasmic tubes acts as an active non-linear transducer of information, while templates of tubes coated with conductor act as fast information channels.

Funded at a total cost of €2,716,324.00 by the EU's Seventh Framework Programme (Information and Communication Technologies).

Struggling with a question on the final exam? You could always ask, "How would an acellular slime mould answer it"!