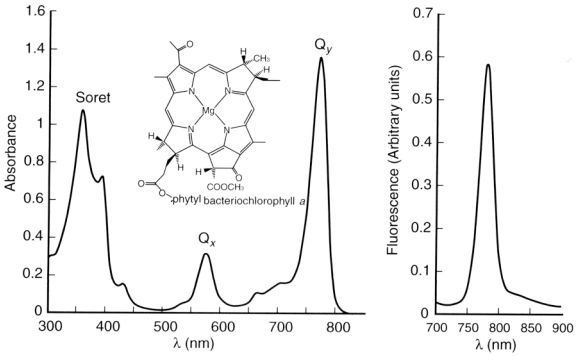
SC/BIOL 2010.040
Plant Biology
Final Exam
5 April 2012

The Anatomy of Plants
by Nehemiah Grew
(1682)

NAME:_____

INSTRUCTIONS: Please begin when told to do so. Transfer your answers to the scantron sheet accurately. When finished, please hand in **both** your scantron sheet **and** your final exam.

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)?



[01] Least energetic transition:

[02] 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)

[03] What is an action spectrum of photosynthesis?

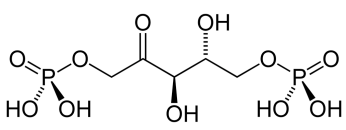
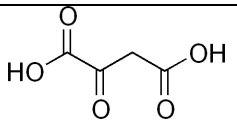
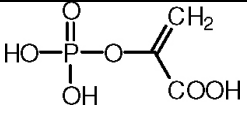
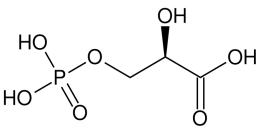
A. None of the below
B. It is the absorbance spectrum of the light-harvesting chlorophylls (and other pigments), responsible for transferring the exciton to the reaction center (resonance energy transfer)
C. It is the wavelengths of light causing oxygen production and/or carbon dioxide fixation
D. It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

[04] The cytochrome b_6/f complex performs which of the following function(s) in photosynthesis?

A. It accepts electrons from *only* P_{680}
B. It accepts electrons from *only* P_{700}
C. It transfers *only* protons across the thylakoid membrane, into the chloroplast stroma
D. It transfers *only* protons across the thylakoid membrane, into the chloroplast lumen
E. It transfers *both* electrons and protons across the thylakoid membrane, into the chloroplast stroma
F. It transfers *both* electrons and protons across the thylakoid membrane, into the chloroplast lumen
G. A and C
H. B and E

[05] What are the substrates of the enzyme responsible for the initial carbon dioxide fixation in C3 photosynthesis?

A. oxaloacetate and carbon dioxide
B. oxaloacetate and bicarbonate
C. phosphoenolpyruvate and carbon dioxide
D. phosphoenolpyruvate and bicarbonate
E. ribulose 1,5 bisphosphate and bicarbonate
F. phosphoglycerate and bicarbonate
G. ribulose 1,5 bisphosphate and carbonate
H. none of the above

ribulose 1,5 bisphosphate	oxaloacetate	phosphoenolpyruvate	phosphoglycerate
			

[06] Which of the following characteristics **could not** be used to classify procaryotes (choose the best answer)?

A. cocci/bacilli/spirilli morphology
B. aerobic/anaerobic requirement
C. presence/absence of nucleoid
D. sensitivity to specific antibiotics
E. carbon source requirement
F. ribosomal RNA sequences
G. E and F
H. all of the above can be used

[07] Which one of the following compounds is produced from Ribulose 1-5-bisphosphate in the Calvin cycle?

A. glyceraldehyde-3 phosphate
B. phosphoglycerate
C. phosphoglycolate
D. phosphoenolpyruvate
E. sedoheptulose 1,7-bisphosphate
F. fructose 6-phosphate
G. xyulose 5-phosphate
H. ribulose 5-phosphate

[08] Which of the following could be used to identify coliform bacteria?

A. Gram-staining
B. Succinate
C. Lactose
D. CO_2 production in liquid cultures
E. A, B and C
F. A, C and D
G. B, C and D
H. A, B and D

[09] What does the term cryptic bacteria mean?

A. A bacteria with cryptic DNA sequences
B. A bacteria which uses cryptic chemicals to communicate with neighboring bacterial cells
C. A bacteria which grows only on cryptic medium
D. A bacteria which cannot be successfully cultured and is only known to exist based upon polymerase chain reaction amplification of DNA and/or RNA sequences
E. A bacteria which is known to grow only in duedonal or endothelial crypts
F. A bacteria which produces crypton as a byproduct of an extremely bizarre form of photosynthesis
G. A chemotrophic bacteria which reduces crypton
H. None of the above

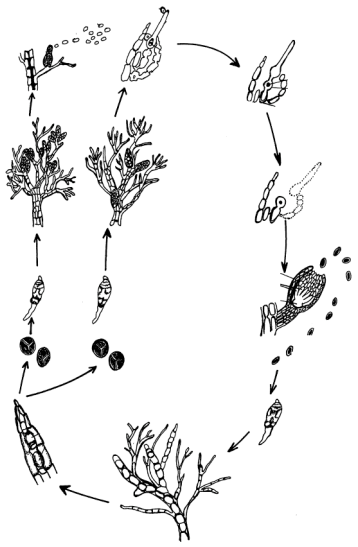
Match the three following three unicellular or multi-cellular divisions of the Protists with the one most distinguishing characteristic for each division. Choose the best answer.

[10] Cryptophyta
[11] Haptophyta
[12] Rhodophyta

A. Chlorophyll a, phycobilins and carotenoids
B. Cell wall composed of cellulose plates
C. Cell wall composed of non-cellulose polysaccharides
D. Starch food reserve
E. Chlorophylls a and b
F. Chrysolaminarin food reserve
G. Laminarin food reserve
H. Paramylon food reserve

[13] Which of the following are correct for the life cycle (from your lab manual)?

A. It is a Zygomycete life cycle
B. It is a Dictyosteliomycota life cycle
C. It is an Oomycete life cycle
D. It is a wheat rust (*Puccinia*) life cycle
E. It is a *Fucus* life cycle
F. It is an *Ectocarpus* life cycle
G. It is a *Polysiphonia* life cycle
H. It is a Bacillariophyta (diatom) life cycle



[14] Among the following heterotrophic clades, which group lacks flagella during all parts of its life cycle?

A. Oomycota B. Myxomycota C. Dictyosteliomycota D. Chytridiomycota
E. Allomyces F. B and C G. A, D and E H. None of the above

[15] Phytophthera, the cause of famine and human migration in the 1800's is a member of which heterotrophic clade?

A. Oomycota B. Myxomycota C. Dictyosteliomycota D. Chytridiomycota
E. Ascomycota F. Zygomycota G. Basidiomycota H. None of the above

[16] Amongst Zygomycota, Ascomycota and Basidiomycota, which of the following characteristics are unique to <u>only one</u> of the phyla (choose the best answer)?

A. crozier B. persistent dikaryotic stage C. mycelia D. clamp connections
E. haustoria F. A, B and C G. A, B and D H. A, D and E

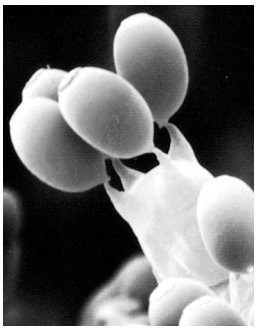
Match the following terms with the most appropriate definition (Choose the best answer)?

[17] conidium *pl*. conidia **[18]** chitin **[19]** appressorium

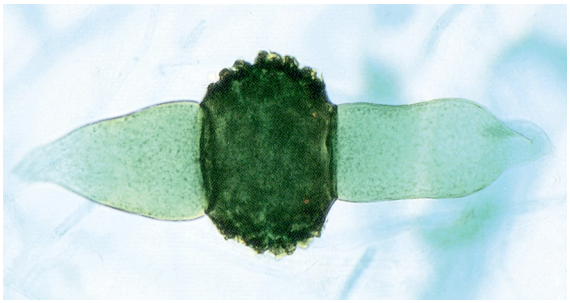
A. None of the below
B. A small mass of vegetative tissue; an outgrowth of the thallus, for example in liverworts or certain fungi.
C. A flattened, hyphal organ, from which a minute infection peg grows and enters the host.
D. The strips of tissue on the underside of the cap of many hymenomycetes.
E. A single tubular filament of a fungus, oomycete, or chytrid.
F. A projection of a fungal hypha that functions as a penetrating and absorbing organ.
G. A tough, resistant, resistant, nitrogen-containing polysaccharide forming the cell walls of certain fungi.
H. An asexual fungal spore not contained within a sporangium; it may be produced singly or in chains; it is often multinucleate.

Match the following images with the most appropriate fungal group (Choose the best answer)

[20]



[21]



A. Ascomycete B. Ustilago C. Hymenomycete D. Gasteromycete
E. Basidiomycete F. Zygomycete G. Lichens H. Teliomycete

[22] Which of the following is/are propagules of lichens —containing both the mycobiont and algal or cyanobacterial photobiont— that serve to disseminate this unusual example of a symbiotic organism (Choose the best answer)?

A. isidia B. peristome C. sclerotia D. soredia
E. ascospore F. gemma G. operculum H. none of the above

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

[24] Place the following groups in order of increasing complexity of their adaptations to survival on land, or appearance in the fossil record?
1. Bryidae 2. Hornworts 3. Cycadales 4. Liverworts 5. Pteridophyta

A. 1,2,3,4,5	B. 2,1,4,3,5	C. 3,1,5,4,2	D. 4,2,1,3,5
E. 4,3,2,1,5	F. 4,5,3,2,1	G. 3,4,5,1,2	H. none of the above

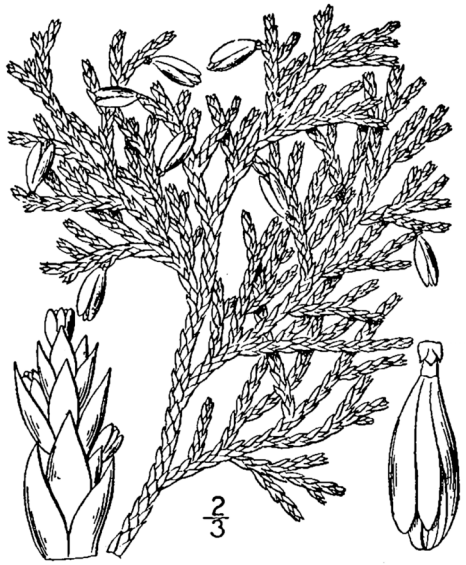
[25] What specialized cell, functioning as a component of adaptation to terrestrial environments, is usually lacking in Anthocerophyta (hornworts) but present in the Bryidae (mosses)?

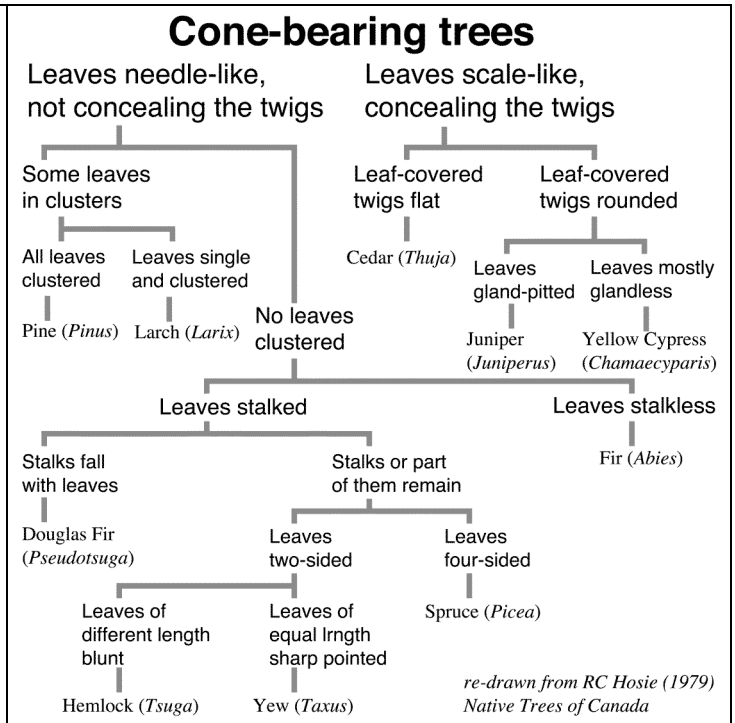
A. stomates	B. phloem	C. leptoids	D. rhizoids
E. motile sperm	F. root hairs	G. epidermis	H. none of the above

[26] What unique characteristic(s) distinguish Pteridophyta (ferns) from Gymnosperms (conifers)

A. xylem and phloem	B. microgametophytes	C. eustelar anatomy	D. prostelar anatomy
E. homospory	F. silicaceous walls	G. A and B	H. none of the above

[27] Identify the Gymnosperm shown below to genus using the key.
A. Abies B. Tsuga C. Taxus
D. Picea E. Pinus F. Larix
G. Thuja H. Pseudotsuga





[28] Which of the following is true of microgametogenesis in angiosperms (choose the best answer)?
1. meiosis results in the formation of four spores in a tetrad
2. tapetal tissue is haploid
3. pollen exine is produced soon after spores are released from the tetrad
4. the initial haploid nuclei of the microspore undergoes 2 cycles of mitosis to form three nuclei: two generative (sperm cells) and one vegetative.
5. pollen enter domancy during maturation, prior to release from the anther.
6. the mother pollen cell is haploid
7. the tapetal initial cell is diploid

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

[29] Which of the following is true of megagametogenesis in angiosperms (choose the best answer)?
1. the megaspore undergoes 3 cycles of mitosis to form eight haploid nuclei in the embryo sac
2. the antipodal cells do not fuse with one of the sperm cell nuclei.
3. the synergid cells are located near the micropyle with the egg cell
4. meiosis results in the formation of one (monosporus), two (bisporus) or four (tetrasporus) haploid megaspore(s)
5. nucellus tissue is diploid
6. 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
7. the nucellus is enclosed by one or two integuments.

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

[30] For the early spring flower shown in the photo. Which of the following pollination vector(s) would you expect to be a pollinator of this floral structure.
A. wind pollination
B. pollination by butterflies or moths
C. pollination by small hovering birds
D. pollination by primitive insect groups, such as beetles
E. pollination by bees
F. A, B and D
G. B, C and E
H. none of the above

Match the following terms with the correct definition.

[31] dioecious
[32] hermaphrodite
[33] monoecious

A. male and female flowers on different individuals
B. male and female flowers on the same plant
C. male and female in the same flower
D. separate male and female flowers on the same plant
E. staminate flowers reverting to pistillate
F. pistillate flowers reverting to staminate
G. assexual reproduction (clonal)
H. None of the above

[34] Approximately what percentage of plants species are hermaphrodite?

A. 0% B. 2.5% C. 5% D. 25%
E. 50% F. 75% G. 95% H. 100%

[35] In sporophytic incompatibility, which of the following are known to be components of the mechanism that results in an incompatible response (Choose the best answer)?

1. glycoprotein
2. phosphatase
3. receptor kinase
4. callase
5. phytochrome
6. distylic pollination

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

[36] During development of the embryo, there is <u>one</u> very distinct difference between the two major groups of angiosperms.

A. only one of the groups contains triploid endosperm
B. food storage is principally starch in one group, protein or oil in the other group.
C. in one group, food storage is in the diploid cotyledon; in the other group, food storage is in the triplod endosperm
D. in one group, a single cotyledon develops, in the other group two cotyledons develop during embryogenesis.
E. the polarity of the embryo is reversed between the two groups
F. angiosperms are normally divided into three groups, not two, based on whether female gametophyte development is monosporic, bisporic, or tetrasporic.
G. all of the above.
H. none of the above

[37] When does the embryo exhibit polarity during embryogenesis?

A. eight-cell stage B. two-cell stage C. heart-shape stage D. globular stage
E. four-cell stage F. blastocyte stage G. protoderm stage H. none of the above

[38] Seed dormancy plays a role in survival of a species, although dormancy can be taken to an extreme, such as the case of Lotus (*Nelumbo*): dormancy for at least 1300 years! Which one of the following is the major mechanism ensuring dormancy (choose the best answer).

A. the absence of light B. the absence of water C. the absence of metabolism
D. the absence of oxygen E. the absence of phytochrome F. the absence of hormones
G. the absence of photosynthesis H. the absence of required temperature

[39] To examine the light requirement for germination, scientists have performed sequential treatments of red (R: 660 nm) and far-red (FR: 730 nm) light and determined their effect upon the percentage of seed germination. Which one of the following would you predict to cause maximal germination?

1. R
2. R : FR
3. R : FR : R
4. R : FR : R : FR
5. R : FR : R : FR : R
6. R : FR : R : FR : R : FR

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

[40] 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 7
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, 5, 6 and 7

The following data set is for ash (*Fraxinus*) 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
Non-treated samara	----	2.8 mmol/kg
Stratified samara	----	1.8 mmol/kg

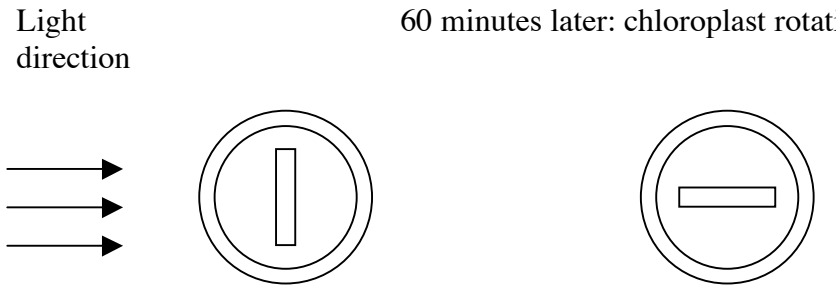
[41] Choose the best interpretation of the data

A. the seeds must be stratified by removing the samara before they are able to germinate.
B. the seeds require a cold treatment before they are able to germinate.
C. ABA leaks out of the seed after it is stratified by removing the samara. No longer inhibited by ABA, the seed germinates
D. During the cold period, ABA is depleted. No longer inhibited by ABA, the seed germinates
E. A and B F. A and C G. B and D H. C and D

[42] What effect would exogenous GA treatment have on germination (choose the best answer)?

A. stimulate germination of both non-treated and stratified seeds
B. stimulate germination of stratified seeds.
C. inhibit germination of both non-treated and stratified seeds
D. It would stimulate germination only if ABA were depleted
E. It would stimulate germination only if ABA was elevated
F. no effect G. B and D H. None of the above.

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

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

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

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

C. 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

D. 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

E. 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

F. the 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. C and E

H. None of the above

To determine the nature of *downstream* transduction after red light absorption by phytochrome, scientists examined the properties of a tomato mutant (*aurea*) that *lacks* phytochrome (PhyA). They injected various compounds into the cells, and assayed for light activation of gene expression and anthocyanin synthesis.

[44] Which of the following injections caused GUS expression, (indicating light activation of genes) but not pigment (anthocyanin) synthesis?

A. PhyA injection B. PhyA with inhibitor of G-proteins C. low (<0.5 μM) Ca^{2+} injection
D. higher (0.5 to 5.0 μM) Ca^{2+} injection E. A and B F. B and C G. None of the above.

[45] In these types of experiments, it is imperative to compare effects with controls. To explore the role(s) of G-proteins in downstream transduction, the scientists injected GTPγS, a non-hydrolysable GTP analogue that will not hydrolyse after binding to the G-protein, causing the G-protein to be constitutively activated G-protein. Which of the following are required controls for GTPγS injection?

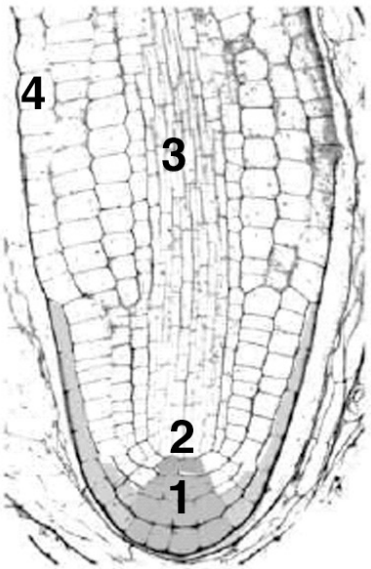
A. Injection of GTP
B. Injection of PhyA and GTPγS
C. Injection of PhyA plus GDPβS (an inhibitor of G-proteins).
D. Injection of PhyA plus ADPβS (a non-active GDPβS analogue).
E. A and C F. B, C and D G. C and D H. All of the above

[46] 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

Identify the marked regions on the root diagram. You may use each answer more than once.

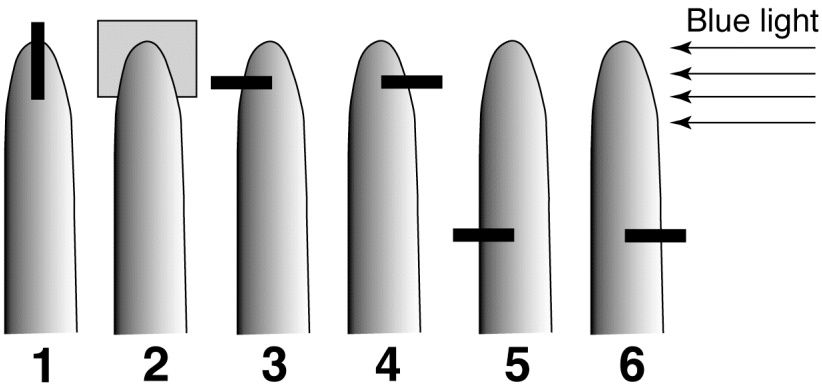


[47] region 1	A. root cap	B. tunica
[48] region 2	C. cortical cells	D. quiescent center
[49] region 3	E. corpus	F. epidermis
[50] region 4	G. basal meristem	H. none of the above

[51] What gene motif can be responsible for cellular and even multicellular differentiation in both plants (e.g., lateral root genesis) and animals (e.g., muscle cell differentiation)?

A. a pox gene B. chemical X C. an INSANE box domain D. a MADS box domain
E. a USB7 domain F. the R2D2 gene G. all of the above H. none of the above

[52] 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

[53] Which of the following are true of the photoreceptor that controls coleoptile phototropism?

A. The photoreceptor is activated by blue light, and inactivated by irradiation with red light.
B. The photoreceptor is part of the light-harvesting complexes of photosynthesis.
C. The photoreceptor is a flavin, of which one example is FAD/$FADH_2$ (an electron transport chain component of both mitochondria and chloroplasts).
D. Very similar photoreceptors are found in animals, where they play a role in entrainment of circadian rhythms and even animal magnets.
E. A and B
F. B and C
G. C and D
H. A, C and D

[54] How was the positional integrity of tunica and corpus zones in apical meristems demonstrated experimentally?

A. by carefully comparing the anatomical structure of apical meristems from simple land plants (for example, Lycophyta) with those from the more complex gymnosperms and angiosperms.
B. by careful dissection to remove either the tunica layer or the corpus region and observe how the apical meristem continued to grow.
C. by marking either the tunica layer or corpus layer with a persistent fluorescent marker or carbon black.
D. by carefully applying colchicine to cause polyploidy of either the tunica or the corpus.
E. by injecting either the tunica or corpus with big nuclei.
F. by hand sectioning apical meristems at various stages of development.
G. by irradiating the apical meristem with x-rays to cause mutations that cause the nuclei to enlarge.
H. none of the above

[55] During the development of a dicotyleden leaf, which of the following statement(s) are true?

A. Immediately after leaf initiation, cellular divisions will be maximal, occurring at the base of the leaf, while cell expansion occurs later and is maximal at the tip of the developing leaf.
B. During the early development of the leaf, photosynthesis rates are high enough to provide photosynthate to other organs in the plant.
C. Ink marking the young, expanding leaf should reveal a higher rate of cell expansion near the base of the leaf.
D. Cellular division and expansion occur throughout the leaf (both at the base and the tip) during development.
E. About the time the leaf reaches its final form, phosphorus is exported to other organs of the plant
F. B, C and E
G. B, D and E
H. B, C and E

[56] During the development of a monocotyleden leaf, which of the following statement(s) are true?
A. Immediately after leaf initiation, cellular divisions will be maximal, occurring at the base of the leaf, while cell expansion occurs later and is maximal at the tip of the developing leaf.
B. During the early development of the leaf, photosynthesis rates are high enough to provide photosynthate to other organs in the plant.
C. Ink marking the young, expanding leaf should reveal a higher rate of cell expansion near the base of the leaf.
D. Cellular division and expansion occur throughout the leaf (both at the base and the tip) during development.
E. About the time the leaf reaches its final form, phosphorus is exported to other organs of the plant
F. B, C and E
G. B, D and E
H. B, C and E

[57] What is partitioning?
A. The well-defined zones of meristematically active tissue that maintain positional determinants of development patterns in root and shoot tips, and leaves.
B. The separation of tissues by vascular bundles. For example, venation in a leaf.
C. The term partitioning is used to describe carbohydrate movement into the quiescent centers of either the apical meristem of the shoot, or the root tip.
D. The term partitioning is used to describe the absence of cellular division in quiscent regions.
E. The term partitioning is used to describe allocation of photosynthate between sinks and sources.
F. A region of low pressure which 'pulls' water through the xylem; the 'pulling' force for water movement in the plant.
G. The genetically (and developmentally) controlled senescence (death) of impaired plant organs (either shoot, root or leaves).
H. None of the above

[58] With respect to the transition to flowering, what to plants measure that triggers flowering?

A. The length of day.	B. The length of night.	C. High light intensity.	D. Low light intensity.
E. Photosynthate.	F. Photo-activated flavin.	G. All of the above.	H. None of the above

[59] Identify the crop plant to genus

A. Thuja	B. Zea	C. Triticum
D. Solanum	E. Aphanes	F. Arachis
G. Abies	H. none of the above	

[60] This plant is a member of the Fabaceae. It belongs to which one of the two major groups of flowering plants?
A. Monocotyledonae
B. Dicotyledonae
C. none of the above

[61] Where did this crop plant originate?

A. North America	B. Northern Africa
C. Central Mexico	D. Central South America
E. Eastern Asia	F. Europe
G. Australia	H. none of the above

In a wild species of a grain crop plant (for example, wheat and barley) what are the functions of the following components of the floret/inflorescence anatomy?

[62] awn **[63]** spike **[64]** rachilla

A. A structure holding a cluster of anthers to maximize pollen release in wind pollination
B. A modified feathery stigma that functions to maximize pollen capture in wind pollination
C. A structure subtending the lemma that protects the ovary of the floret
D. A stiff barbed structure that 'plants' the seed in the ground and may assist in soil penetration
E. Long slender bristles that may aid in dispersal by attaching to passing herbivores
F. The 'pedicel' of the floret that abscises to release the seed upon maturity
G. A structure subtending the glume which in turn protects the anthers and feathery stigma
H. None of the above

[65] What still remains a serious problem affecting crop productivity, and was a problem even 4000 years ago for a Sumerian farmer?

A. Finding labor to till the fields.
B. Drought.
C. Salinization of the soil as a consequence of water shortage.
D. Salinization of the soil as a consequence of water irrigation.
E. Loss of soil fertility due to leaching of potassium, phosphorus and nitrogen by irrigation.
F. B, C and E
G. B, D and E
H. B, C and E