

Introductory Plant Biology Model Exam I¹

Name Key to Model Exam _____ PIN _____

Bonus _____ Exam Proper _____ Total _____

Check here if you wish to **withdraw permission** to have your grade posted by PIN.

Check here if you have written a **detailed explanation** by a question. This is your **only** opportunity to challenge a question if you believe it to have two correct responses with neither substantially better than the other or if you believe that no answer is correct. Start your explanation with “I chose answer ‘D’ instead of answer ‘B’ because” Only challenges started thus will be considered and, in some cases, credit will be given even if you mark an answer that does not correspond to the key. Identify the question that you challenge: _____.

I understand that it is a violation of the Honor Code to refer to information not specifically condoned by the instructor or to receive information from an unauthorized source during an exam. I also understand that I should report to the instructor any violation of the Honor Code unless the person who violates the code reports himself or herself.

Signature

Bonus Section (Optional Reading)

1. (2 pts) List three (ONLY three) of the top five food plants that together contribute most (70 %!) of the calories to the human diet. If you use common names, be certain that the name that you use will not be ambiguous or misleading to any other English speaker.

wheat rice maize potato barley

Test taking hint: Always read the question and follow directions. E.g. “corn” would receive no credit because some English speakers would consider it the same as wheat and others, the same as maize.

Test taking hint: Give only the information requested. E.g. if you listed four plants and one is not correct, points should be taken off.

¹On this model exam, I have also included a number of test-taking hints that I have learned from students over the years. These hints quickly become redundant, so they will not be included on subsequent model exams. Of course, the same hints can be carried forward.

Test taking hint: (Similar to above) Be brief, to the point. You get no credit for restating the question (a very common mistake,) and you may reveal a flaw in understanding if you provide extraneous, but incorrect, information. This hint, however, is not an excuse to avoid a complete answer.

2. (2 pts) From a culinary point of view, why is the protein in wheat endosperm so important?
provides elasticity and traps air bubbles

Test taking hint: If you do not know the meaning of a word (perhaps in this instance, “culinary”), by all means, ask. If the question merits an answer, the answer will be given to all students on the overhead. This is another reason not to rush through the exam and leave. It is possible that another student will ask a question, the answer to which may prompt your memory.

3. (2 pts) Name one change in a characteristic of a particular plant that is associated with the domestication of that plant for food production.

Characteristic: *any of several (e.g. loss of specific environmental factors required for seed germination)*

Plant: *again, any of several, BUT the trait and plant must match! _____*

4. (3 pts) Although it is not the usual case, in some plant species, embryos are formed asexually. Explain the development of such an asexual embryo.

Asexual embryos develop from cells of the nucellus (maternal sporophytic tissue surrounding the female gametophyte).

Exam Proper

1. An example of a taxon is a particular
 - a. genus.
 - b. species.
 - c. kingdom.
 - XXXd. all of the above.

A taxon is simply any category used in taxonomy, and therefore all the answers given are valid.

2. Select the best statement.
 - XXXa. Morphological characters are exclusively those of form and structure.
 - b. Morphological features include all the characteristics used to classify organisms.
 - c. All species within a single genus have identical morphological characteristics.
 - d. Morphological characteristics are useful for field identification by novices, but are not considered seriously by professionals in the classification of organisms.

Morphological means “pertaining to form, body,” so answer b is incorrect because many traits (e.g. presence of a particular chemical, like chlorophyll b) are used. Answer c is incorrect because often morphological characteristics are valuable and sufficient to distinguish members of a genus. In class, we noted that the leaves of various oak species are very different. (Oaks are all within the same genus.) Answer d is incorrect; plant identification guides are often based mostly or solely on morphological characteristics.

Test taking hint: First go through an exam carefully and eliminate any answers that are positively incorrect. You might wish to do this by considering each response separately and viewing the response as a true-false question. On subsequent reviews of the exam, you will have the more difficult task of choosing the correct response from two or more candidates.

Test taking hint: *If a question seems easy, it probably is easy. Instructors do not wish to “trick” students. The most positive feedback that an instructor can receive is high performance by his or her students on an exam.*

Test taking hint: *Expect some questions to be easy and some questions to be more difficult. Easy questions are placed on an exam as a diagnostic tool. An instructor may wish to be certain that all students have mastery of certain elementary concepts that will be built on in class later. If he or she finds that students do not perform well on the basic concepts, it may indicate that those concepts need more “drill” time in class. More difficult questions also are diagnostic, but the purpose of these questions shifts toward distinguishing the better-prepared from the less-well prepared students. With regard to the difficult questions, I evaluate how well students who otherwise scored in the upper-50% fared compared with those in the lower-50%. A difficult question performs well in my judgement if 75% of the better prepared students answer it correctly while only 50% of the less-well prepared students answer it correctly. A difficult question performs poorly in my judgement if 60% of BOTH the better-prepared students and the less-well prepared students answer it correctly (because it did not distinguish the two groups of students).*

3. Used alone, which element of the Latin binomial conveys the most information about the organism to another person who is familiar with classification system?
- a. species.
 - b. ecotype.
 - XXXc. genus.
 - d. family.

The Latin binomial comprises two elements, the genus and species names; therefore, answers b and d are incorrect. The genus name is unique to a collection of related organisms; e.g. all oaks are in the genus Quercus. The species name is often descriptive and may be used redundantly. For example, Quercus alba is white oak (alba = white) and Pinus alba is white pine. Therefore, the species name provides limited information because alba alone would not allow one to even discern whether the organism is an angiosperm or a gymnosperm!

4. Select the best statement.
- a. Linnaeus discovered sex in plants.
 - b. Unlike most of his contemporaries, Linnaeus believed that plants did NOT reproduce by sexual means.
 - c. Linnaeus invented the concept of genus.
 - XXXd. Linnaeus’ use of floral morphology immediately brought evolutionary order into the classification of plants.

Sexual reproduction in plants, discovered long before Linnaeus, was accepted by him so answers a and b are incorrect. Linnaeus did not invent the genus concept (although he popularized the binomial), making answer c incorrect. Linnaeus used the “sex organs” of plants, flowers, as a prime taxonomic tool. The evolutionarily conservative nature of the flower immediately caused related plants to be categorized together, regardless of other adaptive differences such as being woody or herbaceous.

5. Theophrastus
- a. was a student of Linnaeus.
 - b. was a contemporary supporter of Linnaeus.
 - c. donated his plant collection to Linnaeus.
 - XXXd. did not know Linnaeus or his work.

Theophrastus lived a couple of millennia before Linnaeus, so answers a–c are incorrect.

6. Select the best statement.
- Virtually all present species, about 100 million, have been described by Western science.
 - There are virtually identical numbers of plant and animal species, about 10 million each.
 - XXXc. A good “ball-park” estimate (i.e., $\pm 10x$) of the number of species on Earth is 30 million.
 - The trend in modern biology is to refute the concept of species, implying that the preceding estimates are nonsense.

Many, maybe most, species of fungi and protists await discovery, making answer a incorrect. Answer d is incorrect—there is no trend to toss aside the species concept, although it is sometimes hard to define.

Test taking hint: *Answer b is incorrect because there are fewer than a half-million species of plants. Answer b is also incorrect because most species, say maybe up to 100,000,000, are animals (think insects!). Break down complex questions; if any part is incorrect, it is altogether an incorrect response. As an example, break down answer b into three parts: Are there 10 million species of plants? Are there 10 million species of animals? Are both of these answers “yes?”*

Test taking hint: *Instructors value perspective more than memorization. Therefore, in a question like the preceding, I look only for your understanding and would not ask a student to distinguish between close numbers as that difference is unimportant (even when it is known).*

7. Select the best statement as it pertains to the appearance of organisms on Earth.
- Photosynthetic organisms have been on Earth about 10x longer than Man.
 - Compared with its current age, Earth was already very old before photosynthetic organisms appeared.
 - XXXc. Photosynthetic organisms have been on Earth for about 75% of Earth’s existence.
 - none of the above.

Photosynthetic organisms have been on Earth for about 3.5 billion years, compared with Earth’s age of 5 billion years, which means that answer c is correct and answer d cannot be correct. This same knowledge also indicates that answer b is incorrect. Man has been around for a vanishingly short period of time (maybe 2–4 million years) meaning that answer a is incorrect.

8. The difference between the six–kingdom system and the three–domain (or super kingdom) system is
- All eukaryotes are included in a single large taxon.
 - The prokaryotes are split into separate Domains, in recognition of their fundamental differences.
 - Fungi, animals, plants and protists are all combined into one Domain.
 - XXXd. all the above.

In the six–kingdom system, fungi, animals, plants and protists are placed in separate kingdoms, but they are combined in the three–domain system, so answers a and c (essentially redundant) are correct. Answer b is also correct— Archaeabacteria and Eubacteria are placed in separate domains in the three-domain system.

Test taking hint: *Questions that are coupled to an “all of the above” response can be the most difficult. These questions require a correct solution to three separate true/false statements. It is sometimes easier to decide whether answer a is a better answer than answer b than whether answers a, b and c are all correct. You may want to scan the exam and mark such questions as deserving of special attention. Time should not be a problem.*

9. Select the list of characteristics or structures typical of ALL plants, but NOT found in ANY prokaryotes.
- photosynthetic, multicellularity, sexual reproduction.
 - chloroplasts, sterile cells in reproductive structures, DNA NOT housed in a membrane-bound nucleus.
 - internal fertilization, sexual reproduction, cellular vacuoles.
 - sexual reproduction by production of flowers, multicellularity, membranes formed of lipid bilayers.

Test taking hint: As mentioned before, break down complex questions into components. Remember, the first time through the test your goal is simply to identify incorrect responses. Thus, you would first go through the responses simply: is answer a **typical of all plants**? is answer b **typical of all plants**? is answer c **typical of all plants**? is answer d **typical of all plants**? Then, go through a second time: is answer a **not found in any prokaryote**? and so forth. To organize your responses, construct a table on the margin and put a “+” or “-” in the appropriate cell as you go through the test the first time. Of course, if you are not sure of the answer to that cell, leave it blank and come back later.

Answer a is incorrect because MANY prokaryotes conduct photosynthesis. Answer b is incorrect because DNA IS in a membrane-bound nucleus in plants. Answer d is incorrect because MANY plants reproduce sexually without flowers and because membranes formed of lipid bilayers are characteristic of bacteria.

10. The two major taxa within the Kingdom Plantae are
- flowering and nonflowering plants.
 - sexual and asexual plants.
 - vascular and nonvascular plants.
 - leaf-bearing and needle-bearing plants.

On first reading, you can easily note that answer b is incorrect (“all” plants are sexual). All the other answers are plausible at this point because there are flowering and nonflowering plants, vascular and nonvascular plants, and leaf-bearing and needle-bearing plants. . . . but the question asked for refinement.

Test taking hint: The key element in the sentence is major. I recommend that you underline such absolute qualifiers because they will be important. This is, by no means, “tricky,” but this question does underscore the value of reading each question carefully. Like many of you, I too have to restrain myself as I easily “read over” important words. Slow down. Unfortunately, that deep sigh—“Ahhhhh”—after the exam review does not count. ☺

There are several approaches to selection of the best answer now. The simplest is to recall the chart that showed that all plants can be placed in one of two categories, vascular and nonvascular, so these are THE TWO MAJOR taxa.

11. ANY organism that reproduces sexually by alternation of generations forms gametes
- by meiosis.
 - that are diploid and forms spores that are haploid.
 - by mitosis from a single-celled haploid organism.
 - by mitosis of a haploid nucleus within/on/of a haploid organism.

Answer a is incorrect because gametes are formed mitotically in organisms that exhibit alternation of generations. Answer b is incorrect because gametes are haploid. Answer c is incorrect because all plants reproduce sexually by alternation of **multicellular** generations. Answer d is correct by default.

Test taking hint: As usual, divide the answers or questions to simplify. In this case, for example, the question and answer *b* can be simplified to: are gametes diploid? Almost everyone will know that the answer is no, without qualification, and you have eliminated that response without the need to know anything about alternation of generations or spores. You have, therefore, improved your odds from one out of four to one out of three. Not bad for only knowing the most basic element of sexual reproduction!

Test taking hint: Always, always consider the context; default to the simplest level and you will probably be right (on tests, but also in life). An exam maker has no intent to confuse. For example, in this context, answer *b* is incorrect because we have simplified the “truth” and equated sporophyte with diploid and gametophyte with haploid. There are countless exceptions; if this were a graduate course on potato genetics, then gametes of some are indeed diploid, but answer *b* would still be wrong because spores would be diploid also. The key point is to always select the most straightforward interpretation. Sometimes, this is your first impression, so always think twice before changing an answer.

12. Select the best statement that pertains to sexual reproduction by zygotic meiosis.
- XXXa. The zygote is the only diploid phase in the life cycle.
 - b. At least for a brief period, the zygote grows into an embryo by mitotic divisions.
 - c. The premise of the question is incorrect: zygotic meiosis is a description of an asexual life cycle.
 - d. Gametes are formed by meiosis.

Answer b is incorrect because the zygote is the only diploid cell of organisms that sexually reproduce by zygotic meiosis. Answer c is incorrect—anytime you see meiosis or zygote, you know sex is involved. Answer d is incorrect because only the zygote is diploid, and only diploid cells undergo meiosis (aka “reduction division”).

13. Select the best statement.
- a. A homosporous species produces a single type of spore, and the spore will develop into EITHER a female OR a male gametophyte.
 - b. A homosporous species produces a single type of gamete, and fusion of any two of these identical gametes to form a zygote is essentially a random process.
 - XXXc. A homosporous species produces two types of gametes on a single type of gametophyte.
 - d. Homosporous plants, by definition, cannot reproduce sexually.

Test taking hint: Questions that require that you select the best response are inherently difficult. Mark them. They require that you have all the facts on hand for starters, then you must discriminate among answers that may seem to be “a little correct.” Such questions are important for evaluation, however, as they distinguish performances based on perspective from those based on rote memory, which fades ever so quickly.

*Answer a is incorrect because homosporous species have bisexual gametophytes (with some apparent exceptions discussed later in the course). Answer b is incorrect because identical gametes do not fuse (although morphologically similar gametes, like those of *Chlamydomonas* sp. do.) Answer d would be eliminated on first reading since spores are always part of the sexual life cycle of plants (although spores in some organisms are involved in asexual reproduction).*

14. The evolutionary trend in plants is
- to eliminate the gametophyte generation altogether.
 - XXXb. to have a relatively larger sporophyte, compared with the gametophyte.
 - to eliminate the production of spores in the sexual life cycle.
 - to develop an equal balance (“Doctrine of Equality”) in the sizes of the haploid and diploid organisms.

Answers a and c are eliminated on first reading since all plants exhibit alternation of generations, which implies gametophytes and spores. Answer d is plausible to a person who is uninformed on the unit contents, but who otherwise may be an expert biologist. Answer d is incorrect, however, and provides a measure of the understanding of the specific question.

Test taking hint: *Well constructed exams do not have “foolish” answers. By no-foolish-answers, I mean you did not find among the choices such examples as “development of metal leaves.” It is common knowledge that plants do not have metal leaves, such a response provides no measure of your learning; you will not find them on my tests. As a sweeping general rule, I intend all the responses to be equally appealing to someone who has a C average in the prerequisites but has not studied BOT 3015 (because the exams are intended to gauge performance in BOT 3015). There are often reasons to deviate from this sweeping rule, however. For example, I may include a question on glycolysis (always be guided by the objectives!). In this instance, I would be using the stick (of carrot-and-stick fame) as an inducement to bone up on prerequisite topics that are essential to understanding certain aspects of BOT 3015.*

15. Select the best statement.
- A seed coat is found on all seeds; it is diploid and genetically identical to the embryo.
 - XXXb. The nutritive tissue of seeds of gymnosperms, dicots, and monocots, are typically remnants of the female gametophyte, the cotyledons, and the endosperm, respectively.
 - Gymnosperms are homosporous and angiosperms are heterosporous.
 - As a monocot seed germinates, nutrients from the endosperm are leached into the soil.

As usual, break down the questions: thus, a seed coat is found on all seeds, the seed coat is diploid, but the final component fails—the seed coat is part of the “maternal” sporophyte generation and therefore answer a is incorrect. Answer c is incorrect because all seed plants are heterosporous (required to form the different gametophytes—one (the pollen grain) released and motile and the other (the embryo sac) remaining on the sporophyte). Answer d is incorrect—the nutrients from the endosperm are taken up by the scutellum, a modified cotyledon. By default, answer b is correct.

16. The order of insertion and the function, if listed, of floral organs, starting at the base are
- sepals, petals (attract pollinators), carpels (produce megaspores), stamen (produce microspores).
 - sepals, petals (attract pollinators), carpels (produce microspores), stamen (produce megaspores).
 - XXXc. sepals, petals (attract pollinators), stamen (produce microspores), carpels (produce megaspores).
 - sepals, petals (attract pollinators), pistil (produce megaspores), stamen (produce microspores).

Answer a is incorrect because carpels are the inner-most of the four types of floral organs. Answer b is incorrect because carpels are the inner-most of the four types of floral organs and because the functions of stamen and carpels are reversed. Answer d is incorrect because carpels (which make up the pistil) are the inner-most of the four types of floral organs.

17. Select the best general statement.

- a. Flowers of monocots (e.g. grasses) are NOT showy, but usually dicot flowers (e.g. orchids) are showy.
- b. Monocot flowers (e.g. lily) have many carpels, but dicot flowers (e.g. pea) have only one carpel.
- XXXc. Petals of monocot flowers are in multiple integers of 3 whereas dicot petals are in multiple integers of 4 or 5.
- d. Monocot flowers (e.g. maize) are imperfect but dicot flowers (e.g. rose) are perfect.

Answer a is incorrect because monocot flowers can be showy (e.g. orchids) and because orchids are monocots. Dicots often have more than one carpel (think of an apple cross-section) so answer b is incorrect. Monocot flowers are often perfect (e.g. the first flowers in a banana cluster) and dicot flowers are often imperfect (remember marijuana?); in short, no rule “connects” perfect and imperfect flowers with monocots or dicots, meaning answer d is incorrect. Answer c is correct.

18. Select the list of floral characteristics that are advanced evolutionarily.

- a. reduction in the number of parts, fusion of parts, marginal placentation.
- b. superior ovary, proliferation in the number of stamen, floral organs arranged in whorls.
- c. floral organs arranged in spirals, reduction in the number of parts, basal placentation.
- XXXd. fusion of parts, reduction in the number of parts, irregularity of flowers.

Answer a is incorrect because marginal placentation is primitive. Answer b is incorrect because a superior ovary (unfused) is primitive and because a large number of parts is also primitive. Answer c is incorrect because the spiral arrangement of floral organs is primitive.

19. According to the model presented in this class, free-central placentation evolved

- a. from the inversion of a single carpel.
- b. from the fusion of the midribs of three or more carpels and the subsequent loss of the carpel margins.
- c. through the erosion of the floral base.
- XXXd. from the fusion of the margins of carpels and the subsequent loss of appressed carpel walls.

Answer a is incorrect because free–central placentation evolved from the fusion of several carpels. Answer b is incorrect because the center results from the fusion of margins, not midribs. Answer c is incorrect because this placentation arises from the floral base.

20. The differentiation of each whorl or spiral of floral organs is controlled by

- a. the sequential NONoverlapping expression of four classes of genes, one for each type of floral organ.
- b. positional effects alone—i.e., small Mr substances formed during the differentiation of sepals “direct” the next organs to be petals.
- XXXc. the sequential overlapping expression of three classes of genes.
- d. the simultaneous expression of four classes of genes in which the most abundantly expressed over–rides the other three.

Answers a and d are incorrect because the overlapping expression of three genes (ABC) control differentiation into floral organs. Answer b is incorrect because differentiation into floral organs is not a result of positional effects.

21. Select the best statement as it pertains to sexual reproduction in angiosperms.
- XXXa. The megagametophyte is always retained within the “maternal” sporophyte tissue.
 - b. The gametophyte is bisexual, i.e., it forms either egg(s), sperm, or both.
 - c. Within each ovule, four individual megagametophytes develop from the meiotic division of the megaspore mother cell.
 - d. Double fertilization means that two sperm nuclei fuse with the polar nucleus of the megagametophyte, which occurs in addition to the normal fertilization event to form the zygote.

Answer b is incorrect because all seed plants are heterosporous. Answer c is incorrect because three of the meiotic products (megaspores) abort. Answer d is incorrect because only a single sperm is involved in each of the two fertilization events in angiosperms.

22. Select the best statement as it pertains to sexual reproduction in angiosperms.
- a. In contrast to the situation in more primitive plants, the zygote is retained within the female gametophyte and develops into an embryo there.
 - b. The number of species in which the female gametophyte is transported to the sporophyte bearing the male gametophyte is about equal to the number in which the male gametophyte is transported to the sporophyte bearing the male gametophyte.
 - XXXc. The tube (\equiv vegetative) nucleus does not undergo mitosis, but the generative nucleus does.
 - d. The megaspore nucleus divides mitotically and ONE of the daughter cells divides ONLY one additional time, whereas the other daughter cell gives rise to the remaining nuclei of the female gametophyte.

Answer a is incorrect because the zygote develops into an embryo in all plants. Plants are embryophytes. Answer b is incorrect because the female gametophyte is not motile in any plant. (In seed plants, however, the male gametophyte (the pollen grain) achieves motility via the wind, water, or various biological vectors, such as bees.) Answer d is incorrect because the megaspore nucleus divides mitotically and each of the daughter nuclei divides mitotically, as do their daughter nuclei.

23. Select the best statement as it pertains to sexual reproduction in angiosperms.
- XXXa. The fusion of one sperm nucleus with the two polar nuclei of the female gametophyte forms the endosperm.
 - b. Once it has been delivered into the female gametophyte, the “male” nucleus divides meiotically to form the sperm nuclei that are involved in double fertilization.
 - c. Two egg nuclei “compete” for the sperm nucleus and, in a high percentage of cases, all three will fuse by a process called triple fertilization, which is diagnostic for angiosperms.
 - d. The megaspore is stimulated to develop into the megagametophyte by a certain ratio of regulatory chemicals released by the arriving pollen tube.

Answer b is incorrect because the male gametophyte is haploid. Answer c is incorrect because “triple fertilization” is a contrived event. Answer d is incorrect because in most (or all?) angiosperms, the female gametophyte has completed development before arrival of the pollen grain.

24. Select the best statement as it pertains to sexual reproduction in angiosperms.
- a. Endosperm is formed by only one group of angiosperms, the monocots.
 - XXXb. The formation of the endosperm is a distinguishing characteristic of angiosperms.
 - c. Endosperm refers to all the tissues—whatever they may be—that are located internal to the seed coat.
 - d. The endosperm in one kernel of maize is genetically identical to the endosperm of all other kernels ON the same cob.

Answer a is incorrect because formation of endosperm (a result of double fertilization) occurs in all angiosperms. Answer c is incorrect because endosperm is only that portion of the seed that develops from the non-zygote-forming fertilization event. Answer d is incorrect because the endosperm of each kernel resulted uniquely from a single fertilization.

25. Seed germination

- a. is simply a physical process—uptake of water (“growth”) is an osmotic phenomenon resulting from preexisting high concentrations of solutes.
- XXXb. is, in part, under the control of the plant growth regulators (“hormones”) abscisic acid and gibberellin (or, gibberellic acid).
- c. usually requires that seeds be exposed for a certain time to warm conditions (e.g. 20 days at 30° C).
- d. without exception, requires a certain period of “rest.”

Answer a is incorrect because germination is a complex developmental process. Answer c is incorrect because seeds either require no temperature treatment or require a cold treatment to break dormancy. Answer d is incorrect because many seeds (e.g. from tropical plants) do not require a dormant period.