BIO 3 GENERAL BOTANY LECTURE MANUAL

Sections 1102 & 1150, Spring 2018

Instructor- Dr. Jeffery R. Hughey

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General Botany- Biology 3

Lecture and Laboratory Schedule- Section 1102

Dr. Jeffery R. Hughey — Spring 2018, Hartnell College
T/F Lecture- 2:00-3:15 PM, S201 — T/F Lab- 3:30-6:20 PM, S113

Date	Lecture and Laboratory	Readings/Lab Topic
January 16	Introduction to the course, Why Study Plants? Introduction to Lab, Scientific Method	Chapter 1, 2, 21 Topic 2
January 19	Photosynthesis/Why Study Plants Dissection and Compound Microscopes	Chapters 1, 2, 7, 21 Topic 1
January 23	Why Study Plants? Plant Chemistry Primary and Secondary Metabolites	Chapters 1, 2, 7, 21 Handout
January 26	Systematics: The Science of Biological Diversity Herbarium and Dichotomous Keys	Chapter 12 Handout
January 30	Systematics: The Science of Biological Diversity Phylogeny exercise	Chapter 12 Handout
February 2	Prokaryotes: the Cyanobacteria Cyanobacteria	Chapter 13 Topic 11
February 6	Fungi Fungi	Chapter 14 Topic 12
February 9	Fungi Fungi	Chapter 14 Topic 12
February 13	Heterotrophic Protista Protista I	Chapter 15 Topics 13, 14
February 16	*Lincoln's Day Observed, College Closed*	---
February 20	Photosynthetic Protista Protista II	Chapter 15 Topics 13, 14
February 23	**FIRST EXAMINATION**	
February 27	*Field trip to Monterey to collect Marine Algae: Low tide 2:54 PM, -0.99*	
March 2	Plant Genomics Class Research Project	Website links
March 6	Plant Genomics Class Research Project	Website links

March 9	Bryophytes Bryophytes	Chapter 16 Topic 15
March 13	Seedless Vascular Plants Seedless Vascular Plants	Chapter 17 Topic 16
March 16	Seedless Vascular Plants Seedless Vascular Plants	Chapter 17 Topic 16
March 20	Gymnosperms Campus walk and Seed Plants: The Gymnosperms	Chapter 18 Topic 17
March 23	Gymnosperms Seed Plants: The Gymnosperms **Plant Genomics Report Due**	Chapter 18 Topic 17
March 26-March 31	*Spring Recess, College Closed*	---
April 3	Introduction to the Angiosperms Campus walk and Seed Plants: The Angiosperms	Chapter 19 Topic 18
April 6	Introduction and Evolution of the Angiosperms Seed Plants: The Angiosperms and Fruits	Chapters 19, 20 Topics 18, 19
April 10	Early Development of Angiosperms Early Development of Angiosperms	Chapter 22 Topic 20
April 13	Cells and Tissues of Angiosperms Cells and Tissues of the Plant Body	Chapter 23 Topic 21
April 17	**SECOND EXAMINATION**	
April 20	Roots The Root	Chapter 24 Topic 22
April 24	Shoots Primary Structure of the Stem and Leaf	Chapter 25 Topics 23, 24
April 27	Secondary Growth in Stems Woody Stems and Secondary Xylem	Chapter 26 Topics 25, 26
May 1	Ecology Transects and Quadrats	Chapters 31, 32 Handout
May 4	*Field trip to UCSC Fort Ord Natural Reserve, Marina*	

May 8	Plant Hormones, External Factors and Growth Plant Hormones, External Factors and Growth **HERBARIA DUE**	Chapters 27, 28 Topics 27, 28
May 11	Plant Nutrition and Soils Plant Nutrients and Soils Lab	Chapter 29 Topic 29
May 15	Plant Genetics Genetics	Chapter 8 Topic 10
May 18	**FINAL LABORATORY EXAMINATION (2:00-5:00 PM)**	
May 22	**FINAL LECTURE EXAMINATION (3:00-5:50 PM)**	

COURSE DESCRIPTION

Introduction to the principles of plant biology with an emphasis on cytology, energetics, structure, function, reproduction, genetics, systematics, and plant growth. Detailed morphological study of cyanobacteria, fungi, photosynthetic and heterotrophic protists, bryophytes, and vascular plants.

STUDENT LEARNING OUTCOME

Given any plant phylum, the student will be able to identify, describe, and list the functions of the structures that define the phylum, as well as discuss the ecology, evolution, physiology, life history, and biochemistry of a representative taxon from that phylum.

COURSE OBJECTIVES

1. Develop an appreciation for the botanical contributions of early explorers.
2. Investigate the commercial and ethnobotanical applications of plants.
3. Compare and contrast cellular plant diversity.
4. Identify the basic features of all plant cells.
5. Investigate the vital relationship between plants and the flow of energy.
6. Compare and contrast the photosynthetic pathways.
7. Examine the chromosomal basis for Mendelian genetics.
8. Investigate the structure of macromolecules and their role in plant function.
9. Isolate genetic material and analyze DNA sequences from lower and higher plants.
10. Investigate natural selection and its affects on populations.
11. Infer hypotheses by analyzing morphological and molecular phylogenetic data.
12. Investigate life histories of photosynthetic eukaryotes.
13. Identify diagnostic morphological characteristics of the major plant phyla.
14. Collect and curate botanical specimens from aquatic and terrestrial habitats.
15. Develop microscopy skills necessary for the examination of plant structures.
16. Investigate the affects of hormones on plant processes.
17. Examine the affects of macro and micronutrients on plant growth.
18. Investigate the interactions between plants and other organisms.
19. Investigate plant community and ecosystem development.
20. Investigate the adaptations plants have evolved to particular biomes.
21. Analyze the role of agriculture on human history and predict its role in the future.

INSTRUCTOR INFORMATION

Instructor- Dr. Jeffery R. Hughey
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Office Hours- Monday 1:00-2:00, Tuesday 1:00-2:00, Wednesday 1:00-2:00

REQUIRED TEXTBOOKS

Evert, R.F. and Eichhorn, S.E. *Raven Biology of Plants: 8th Ed*. W.H. Freeman, New York, 2013.
Evert, R.F. and Eichhorn, S.E. *Laboratory Topics in Botany: 8th Ed*. W.H. Freeman, New York, 2013.
Hughey, J. Bio 3- General Botany Lecture Manual: Sections 1102 and 1150, Spring 2018.

STRONGLY RECOMMENDED

Rushforth et al. A Photographic Atlas for the 7th Edition of Botany Laboratory. Morton Publishing, Englewood, 2012.

GRADING

Determination of grades in this course will be based on your performance on the following:

First Examination	100 pts. (50 pts. Lecture/50 pts. Laboratory)
Second Examination	100 pts. (50 pts. Lecture/50 pts. Laboratory)
Final Laboratory Examination	100 pts.
Final Lecture Examination	150 pts.
Herbarium	100 pts.
Plant Genomics Project	100 pts.
Total	650 pts.

Grade	Total Points Earned (Percentage)	Definition	Grade Points
A	568-650 pts. (87.5-100%)	Excellent	4
B	487-567 pts. (75.0-87.4%)	Good	3
C	406-486 pts. (62.5-74.9%)	Satisfactory	2
D	325-405 pts. (50.0-62.4%)	Barely Passing	1
F	324 or fewer (49.9% or less)	Failing	0

EXAMINATIONS

The Lecture portion of the examinations will consist of a combination of multiple choice, true or false, matching, short answer, and essay questions. Questions will come mainly from the lecture material, but will also be derived from assigned readings. Supply your own Scantron 882-E form and a number 2 pencil. The Laboratory portion of the examinations will focus on material in the lab manual and information from lab exercises and field trips. Laboratory questions generally require you to 1) identify plant structures and 2) name plant specimens.

MAKE UP EXAMINATION POLICY

If you are unable to attend an examination please notify me by telephone, email, or in person prior to the test. If you fail to contact me in advance and you miss the examination, submit a written letter signed by the authority involved (doctor, policeman) that includes their phone number and an explanation. If you have a valid excuse, I will schedule an intellectually comparable make up oral or essay examination. *No make ups will be granted for the final examination without prior approval from Dr. Hughey.*

HERBARIUM

A herbarium is a collection of pressed, boxed, or enveloped plant specimens. During scheduled field trips you will have the opportunity to collect plant specimens. All students are required to collect and assemble their own herbarium of representative specimens of the major phyla. Herbarium grades will be based on comprehensiveness, identification accuracy, label correctness (Including: Family, Genus and species, date of collection, locality, and collector), aesthetics, and effort in comparison to your peers.

PLANT GENOMICS CLASS RESEARCH PROJECT

All students will participate in the class research project. During two regular class meetings, students will work work with whole genome sequencing data with the objectives of: 1) assembling a mitogenome; 2) annotating the mitogenome; and 3) analyzing the mitogenome of a plant. Using data and files that students generate, the results will be used to write a paper. This project is worth 100 points.

Arriving to class on March 2 with fully functional genomics software	5 points
Arriving to class on March 2 with the downloaded genomic data	5 points
Assembling the mitogenome	10 points
Annotating the mitogenome	40 points
Submitting a completed draft of the mitogenome paper	40 points

The paper will follow the author instructions for the scientific journal *Mitochondrial DNA Part B: Resources*. It will contain an abstract, as well as a short introduction, methods, results paragraphs, 1 figure, and references. The report is due on March 23, 2017 at the beginning of class. I do not accept late work. We will submit a single, collaborative scientific paper to the above journal for publication.

ATTENDANCE POLICY

Regular attendance and consistent study are your responsibility and the two factors that contribute most to a successful college experience. I expect you to attend all class sessions. Absences in excess of two weeks (consecutive or non-consecutive) will result in dismissal. What does that mean? IF YOU MISS FIVE CLASSES, YOU WILL BE DROPPED FROM THE COURSE.

DROPPING THE COURSE

It is your responsibility to drop the course. Do not assume that I will submit the drop for you if you decide to stop coming to class. Students that do not officially drop the course by April 27, 2018 will receive a letter grade based on their total earned points.

CLASSROOM VISITORS

No one is permitted to attend this class unless he or she is a registered student.

CONDUCT

Please show respect for your peers and your instructor. If I observe any student performing or aiding in any of the types of misconduct listed under "Codes of Student Conduct" on page 31 of the Hartnell Catalog, that student will be dropped from the course. Disruptive behavior will not be tolerated (this includes text messaging during class).

SUGGESTIONS FOR PERFORMING WELL ON EXAMINATIONS IN BIOLOGY 3

1) Review your lecture and laboratory notes before coming to class
2) Study for examinations with a partner or in a group
3) Attend class and take complete notes
4) Outside of class study at least 15 hours per week
5) Attend Supplemental Instruction study sessions
6) Study the practice questions

IN CASE OF EMERGENCY

- In the event of a life threatening emergency call 911.
- To report a non-life threatening incident, safety hazard, or a suspicious activity please contact campus security at 755-6888.
- To obtain campus status information, call the campus safety and facilities emergency status bulletin telephone number: 831-796-6222. From a campus line, simply dial 6222.

Please visit Hartnell's emergency reporting link here: http://www.hartnell.edu/reporting-emergencies

Students: If you receive an emergency notification, please tell your instructor immediately.

During a campus emergency, you will generally be told to do one of two options, SHELTER IN PLACE or EVACUATE. When either of these are given, vehicle traffic coming onto campus will likely be turned away. Students are required to obey the directions of staff in a timely fashion.

EVACUATION

Please note the exit(s) in the room. In the event of an alarm or safety threat, uniformed Hartnell personnel equipped with two-way radios--including security, and maintenance staff--have up-to-date information; they also have the authority to order either shelter-in-place or immediate building evacuation. For evacuation, immediately heed their directions by proceeding calmly and quickly to an exterior assembly area as indicated by trained staff. Please stay back at least 200 feet from any building until the "all clear" command is issued.

SHELTER IN PLACE

In the event of a safety threat, instructors and staff will lock classroom doors and direct occupants to stay clear of windows. Occupants are requested to remain quiet. During this time, DO NOT access any exits unless directed by first responders or staff. A shelter in place order is also used for severe environmental threats like a thunderstorm.

RUN, HIDE, FIGHT- ACTIVE SHOOTER RESPONSE

In the event of an Active Shooter Event, there are three things you need to know in order to survive: Run, Hide, Fight.

If you see suspicious behavior on campus, please tell someone. Our campus safety officers are trained to investigate suspicious incidents.

EMERGENCY PREPAREDNESS

The first 72 hours of a disaster are often the most difficult, but this period can be less stressful if everyone has extra supplies on hand. The college has a limited amount of emergency supplies, so students and staff should have on campus their own portable emergency kit including snacks, water, and prescription medication; this is especially important for those who may need to shelter on campus. For more information go to http://72hours.org/

STUDENTS

If you have knowledge of an emergency on campus, share it immediately. If you see something suspicious or potentially hazardous, let someone know.

Why Study Plants?- Chapters 1, 2, 7, 21

•Why not?
"To be _____, _____, and _____ is sufficient recommendation of a science to make it pleasing to me." _____ _____ (1811-1866)

How do humans use plants?

Agricultural product as fodder

•Fodder- food that is fed to _____ _____.

•_____ (Zea mays) is the most important crop in the United States.

– _____% of this crop is consumed by animals.

How do animals use plants?

Primary Producers (Food webs and food chains)

Phytoremediation

- The _____ of pollutants or waste by the use of _____ to break down undesirable substances.
  - _____
  - _____
  - _____

_____ _____

- Lemna gibba- duckweed.
- Eichornia crassipes- water hyacinth.

Biodiesel and Bioethanol from Plants

Plants in Space

- _____- a unicellular green alga.
  - _____ _____.
  - Process _____ (urine).
  - Life support system, _____.

Medicine in Ancient Times

- _____(3,350-3,140 BC)- frozen in ice, found in the Alps on the Italian-Austrian border.
  - _____ _____ used as a laxative and as a natural antibiotic.
- The _____ _____ used in Ancient Greece:
  - Anise, black hellebore, cassia, cucumber, wild root of (squirting cucumber), cumin, cyclamen, root of frankincense, germander, lettuce, wild myrrh, olive oil, opium, poppy, parsnip.

Hippocrates (460-380 BC) _____ of medicine

- Ancient Greek physician for the Medical School at _____.
- Wrote _____ _____

Medicine in Modern Times

- _____% of the _____ on the market is derived directly from plants.
- Drugs made from _____ prevent the rejection of transplanted hearts and other organs.
- The active ingredient in _____ was originally derived from _____ bark.
- Paclitaxel, a compound found in the Pacific yew tree, assists in the treatment of some _____.
- The rosy periwinkle helps treat _____.
- _____ _____. Ginkgo biloba is prescribed for depression, mental weakness or confusion, loss of memory, ringing of the ears.

Egyptian Papyrus

The Molecular Composition of Plant Cells - Chapter 2

Chemical Elements

Metabolites

_____**Metabolites-** molecules _____.

_____**Metabolites-** molecules _____ in their distribution, both within the plant and among different plants; important for _____ and _____.

Macromolecule Synthesis and Splitting

Carbohydrates

Lipids

Proteins

Nucleic Acids

Alkaloids

Terpenoids

Phenolics

What is the role of the photosynthetic organism in the carbon cycle?

Global O_2 from photosynthesis

- _____% comes from marine cyanobacteria.
  - Synechococcus
  - Synechocystis
- _____% comes from terrestrial systems.
  - _____ % of this comes from tropical rainforests.

Photosynthetic organisms evolved 3.4 BYA and are responsible for the biological revolution

- Increases in O_2 from photosynthesis had 2 consequences:
  - 1) _____- O_2 molecules in atmosphere converted to ozone (O_3).
    - 2.5 BYA
  - 2) _____
    - Respiration- break down of molecules by oxidation.
    - Eukaryotic cells- appearance and proliferation of cells.
      - 2.1 BYA

Photosynthesis

Photosynthesis

Nitrogen Cycle

Phosphorus Cycle

Systematics- The Science of Biological Diversity Chapter 12

•<u>Systematics</u>- the scientific study of biological _____ and its evolutionary history.

Theophrastus (370-285 B.C.)

•Father of _____, student of Aristotle.

•Classified plants based on form.

- –_____
- –_____
- –_____
- –_____

Carol von Linné (1707-1778)

•Swedish naturalist.

•_____ _____.

–Plant descriptions.

–Plant _____ - a two-term system of nomenclature.

- •_____ and _____ (specific epithet).
- •Example- catnip.
  - –*Nepeta cataria* L.
  - –"*Nepeta floribus interrupte spicatus pedunculatis*"

Taxonomy

•<u>Taxonomy</u>- (gr. *taxis*- _____, *nomos*- _____) the science of the classification of organisms.

–Identifying, naming, classifying organisms.

- •Domain
- •Kingdom
- •_____- phyta
- •_____- phyceae
- •Order- ales
- •_____- aceae
- •Genus
- •_____

Prokaryotes and Eukaryotes

3 Domains and 6 Kingdoms

Eukaryote Lineages

Origin of Cells

Origin of Eukaryotic Cells

Species Concepts

Morphological Species Concept-

Biological Species Concept-

Phylogenetic Species Concept-

•**International Code of Nomenclature for _____, _____, and _____.** Aim- to provide a _____ method of naming taxonomic groups.

–Principle I- botanical nomenclature is _____ of zoological and bacteriological nomenclature.

–Principle II- names of taxonomic groups are determined by means of nomenclatural _____.

–Principle III- nomenclature of a taxonomic group is based upon _____ of publication.

•Naming- the purpose of giving a name to a taxonomic group is not to indicate its characters or history, but to _____ and to indicate its_____.

Taxonomic Terminology

- _____- a taxonomic group of any rank (plural: taxa).
- _____- two or more names that apply to the same taxon.
- _____- the original name of a taxon.
- Author/s- the _____ person or persons to _____ a taxon.
- Revisionary author/s- the person or persons that _____.
- _____- the derivation, origin, or history of a word.
- Type Specimen- a specimen designated to serve as a reference point for a scientific name.
  - –Holotype- _____.
  - –Lectotype- _____.

Chondracanthus exasperatus (Harvey et Bailey) Hughey 1996
Gigartina exasperata Harvey et Bailey 1851

Mazzaella laminarioides (Bory) Fredericq et Hommersand 1993
Iridaea laminarioides Bory 1828
Iridaea cornucopiae Postels et Ruprecht 1840
Iridaea boryanum Setchell et Gardner 1936

Mazzaella parksii (Setchell et Gardner) Hughey, Silva, et Hommersand 2001
Iridophycus parksii Setchell et Gardner 1937

Taxonomic Names

- Species names consist of the genus name, plus the specific epithet.
- Members of a species may be grouped into _____ or _____.

How do you identify plants?

- Ask an _____.
- Use a _____.
- Compare plant with a written _____.
- Use books to picture I.D. specimens.
  - –Photographs and _____.
- Use a _____ _____.

Dichotomous Keys

- A method employed for _____.
- A dichotomous key is constructed of a series of _____, each consisting of two separate statements.

1. Flowers white ..... Plant A
1. Flowers _____ or _____ 2
   2. Petals red ..... Plant B
   2. _____ yellow ..... Plant C

Writing Dichotomous Keys

1) Start each statement with a subject.

Correct	Wrong
1. Leaves opposite.	1. Opposite leaves.
1. Leaves alternate.	1. Alternate leaves.

2) Avoid unnecessary words.

Correct	Wrong
1. Leaves opposite.	1. Plants with opposite leaves.
1. Leaves alternate.	1. Plants with alternate leaves.

3) Avoid negatives.

Correct	Wrong
1. Flowers purple.	1. Flowers purple.
1. Flowers white or pink.	1. Flowers not purple.

4) Use absent in place of "not present." Use "without" in place of "not with."

5) Use measurements rather than "large", "small", "tall", "short", "big", "small."

6) Use features that are constant in preference to variable or overlapping features.

Good	Bad
1. Flowers purple.	1. Leaves 8-12 cm long.
1. Flowers white.	1. Leaves 6-10 cm long.

7) No trichotomies!

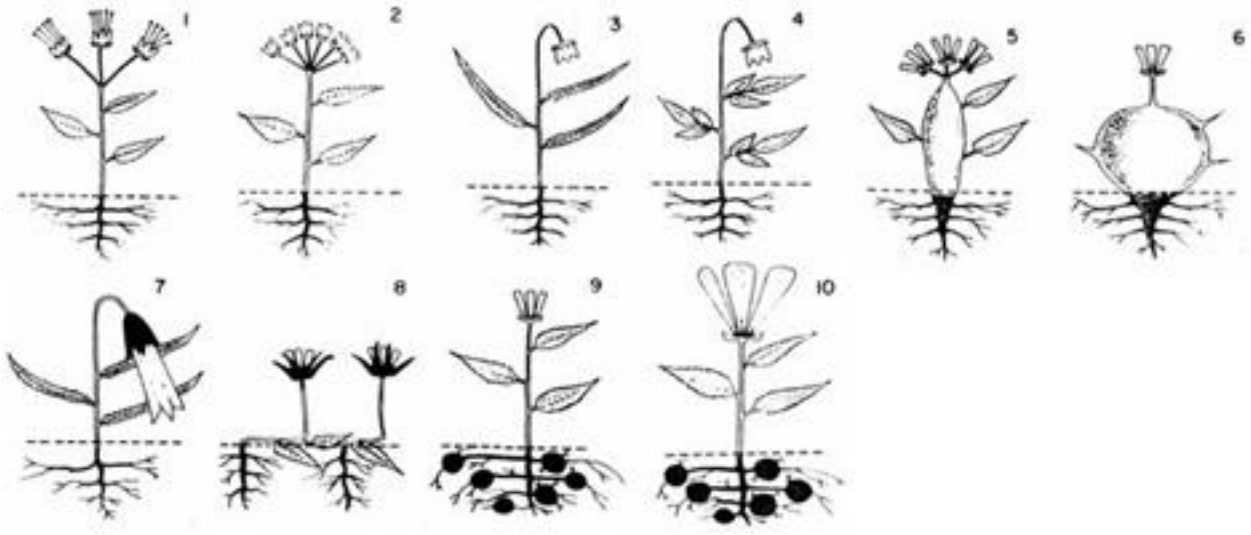
Correct	Wrong
1. Flowers white ..... Plant A	1. Flowers white ..... Plant A
1. Flowers red or yellow 2	1. Flowers red ..... Plant B
2. Petals red ..... Plant B	1. Flowers yellow ..... Plant C
2. Petals yellow ..... Plant C	

8) Use different words to start successive pairs of key statements. See above #7 use of Flowers and Petals.

Using Dichotomous Keys

1. Always read both choices.
2. Be sure you understand the meaning of the terms involved, do not guess.
3. When measurements are given, use a calibrated scale, do not guess.
4. Do not base your conclusion on a single observation, if possible examine other specimens.
5. If you get stuck, try both divisions and see which one makes sense.
6. After arriving at an answer in a key, read the description to see if your plant is in agreement.

Write a dichotomous key based on the following 10 species. Once you complete your dichotomous key show it to Dr. Hughey. The following terms will help you construct your key, if you do not know the definition of these terms ask the instructor or use your textbook glossary: leaves, roots, tap root, tuber, rhizome, elongate, lanceolate, simple, compound, stem, sepals, petals, dichotomous, umbel.



Systematics#2- The Science of Biological Diversity Chapter 12

Phylogeny

- Phylogeny- the evolutionary relationships among organisms.
  - Natural classification.
- Phylogenetic tree- a _____ diagram that represents a _____ of the _____ _____ of a species or group of related organisms.

Hominid Evolutionary Tree

Tree of Homo sapiens L.

Tree Terminology

Root- _____.

Branch- _____.

Outgroup- _____.

Ingroup- _____.

Taxon- _____.

Node- _____.

Phylogenetic Groups

Monophyletic **Paraphyletic** **Polyphyletic**

Phylogenetic trees

- Cladogram
  - _____
  - _____
- _____- shows divergence distances between taxa.

Cladistics

- Cladistics- a method of _____ organisms on the basis of _____ characters.
  - Characters- _____, chemical, developmental, and _____.
    - Homologous characters- _____ of different species that are similar because they were inherited from a _____ _____.
  - Outgroup- a closely related taxon _____ the group that is being analyzed.
  - _____- the branching point on a tree.

Molecular Characters (Data)

Endosymbiotic Theory and the Evolution of Chloroplasts

- Photosynthetic eukaryotes and their _____ _____ from the _____ of a _____ by a _____.
  - A phagocytotic protozoan took up a cyanobacterium into a food vesicle.
  - Instead of being digested, the cyanobacterium was retained as an endosymbiont.
  - The protozoan provided the alga with protection, a stable environment, and mineral nutrients.
  - The cyanobacterium produced carbohydrates for the protozoan.
  - The cell wall of the cyanobacterium was lost through evolutionary selection.
  - Food vesicle membrane= outer chloroplast membrane.
  - Plasma membrane of cyanobacterium= inner chloroplast membrane.

Support for the Endosymbiotic Theory

- Chloroplasts are about the _____ _____ as cyanobacteria.
- Evolve _____ in photosynthesis.
- _____S ribosomes.
- _____ is the primary photosynthetic pigment in cyanobacteria and plants.
- Circular prokaryotic DNA without histones.
- _____

Endosymbiosis in _____ and _____

The current plant classification suggests that red algae are placed in Kingdom _____.

Cladistics

This laboratory provides a brief introduction to the philosophy, methodology, and implications of cladistic analysis. Cladistics is a method of organizing organisms on the basis of synapomorphic characters.

Cladistics is a method used to hypothesize relationships among organisms. Like other methods, it has its own set of assumptions, procedures, and limitations. The idea behind cladistics is that members of a group share a common evolutionary history, and are "closely related", more so to members of the same group, than to other organisms. These groups are recognized by sharing unique features (anatomical, chemical, molecular traits) which were not present in distant ancestors. These shared derived characteristics (traits) are called synapomorphies.

Note that it is not enough for organisms to share characteristics; in fact two organisms may share a great many characteristics and not be considered members of the same group. For example, consider a jellyfish, starfish, and a human; which two are most closely related? The jellyfish and starfish live in the water, have radial symmetry, and are invertebrates, so you might guess that they belong together in a group. This would be incorrect because this arrangement does not reflect evolutionary relationships. The starfish and human are deuterostomes (they have radial, indeterminate cleavage) and coelomates (they have true coeloms). Jellyfish are cnidarians.

It is not just the presence of shared characteristics that is important, but the presence of shared derived characteristics. In the example above, all three characteristics are believed to have been present in the common ancestor of all animals, and so are trivial in determining relationships, since all three organisms in question belong to the group "animals." While humans are different from the other two organisms, they differ only in characteristics which arose newly in an ancestor which is not shared with the other two. As you shall see, choosing the right characters is one of the most important steps in a cladistic analysis.

There are three basic assumptions in cladistics:

1. Groups of organisms are related by descent from a **common ancestor** (= organism at node).
2. There is a **bifurcating** pattern of cladogenesis.
3. **Change** in characteristics occurs in lineages over time.

The first assumption is a general assumption made for all evolutionary biology. It suggests life arose on earth only once, and therefore all organisms are related. We can take any collection of organisms and determine a pattern of relationships, provided we have the right kind of information. Again, the assumption states that all the diversity of life on earth has been produced through the reproduction of existing organisms.

The second assumption is perhaps the most controversial; that is, that new kinds of organisms may arise when existing species or populations divide into exactly two groups. There are many biologists who hold that multiple new lineages can arise from a single originating population at the same time, or near enough in time to be indistinguishable from such an event. The other objection raised against this assumption is the possibility of hybridization (interbreeding) between distinct groups. This, however, is a general problem of reconstructing evolutionary history, and although it cannot currently be handled well by cladistic methods, no other system has yet been devised which accounts for it.

The third assumption that characteristics of organisms change over time is the most important assumption in cladistics. When characteristics change we are able to recognize different lineages or groups. The convention is to call the "original" state of the characteristic plesiomorphic and the "changed" state apomorphic. The terms "primitive" and "derived" have also been used for these states.

HOW TO CONSTRUCT CLADOGRAMS

Imagine four species, A, B, C, and D. These four species are related to each other, but we are not sure how. Perhaps A and B are more closely related to each other than A and C, A and D, B and C, B and D, or C and D. Maybe all four are equally related.

Outline of the steps necessary for completing a cladistic analysis.

1. List the taxa. The taxa (species) in this example will be A, B, C, and D.

2. Determine the characters. Chlorophyll A, Starch stored in the chloroplasts, and roots.

3. Determine the character states for your taxa. Construct a data matrix, like the one shown below.

	Characters		
Taxon	**Chlorophyll A**	**Starch in chloroplast**	**Roots**
A	-	-	-
B	+	-	-
C	+	+	-
D	+	+	+

+ indicates presence of a trait
- indicates absence of a trait

4. Determine the polarity of characters (whether each character state is original or derived in each taxon). The best technique for determining polarity is to use an outgroup (which in this example is taxon A).

5. Group taxa by synapomorphies (shared derived characteristics) not plesiomorphies (original or "primitive" characteristics) or autapomorphies (traits unique to a single taxon).

6. Work out conflicts that arise by some clearly stated method, usually parsimony (minimizing the number of conflicts).

Construct a cladogram given the following morphological data:

		Characters		
Taxon	**Xylem/Phloem**	**Wood**	**Seeds**	**Flowers**
Mosses	-	-	-	-
Ferns	+	-	-	-
Gymnosperms	+	+	+	-
Angiosperms	+	+	+	+

+ indicates presence of a trait
- indicates absence of a trait

Construct a cladogram given the following DNA sequences:

					Characters					
Taxon	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
A	A	T	T	G	C	C	C	G	T	A
B	A	**A**	T	**C**	C	**G**	C	**C**	T	A
C	A	T	T	G	C	C	C	G	T	A
D	A	T	T	G	C	C	C	**C**	T	A
Outgroup	A	**A**	T	**C**	C	**G**	C	**C**	T	A

Construct a cladogram given the following data:

		Characters		
Taxon	**Vessel Elements**	**Motile Sperm**	**Pollen Tube**	**2nd Fertilization**
Cycads	-	+	-	-
Ginkgos	-	+	-	-
Conifers	-	-	+	-
Gnetophytes	+	-	+	+
Angiosperms	+	-	+	+

Construct a cladogram given the following distance matrix. Use Taxon 3 as your outgroup:

	Taxon1	Taxon2	Taxon3	Taxon4	Taxon5
Taxon1	0.00000				
Taxon2	0.01045	0.00000			
Taxon3	0.12744	0.06768	0.00000		
Taxon4	0.09867	0.08679	0.00401	0.00000	
Taxon5	0.00498	0.00978	0.09542	0.09392	0.00000

Search Methods

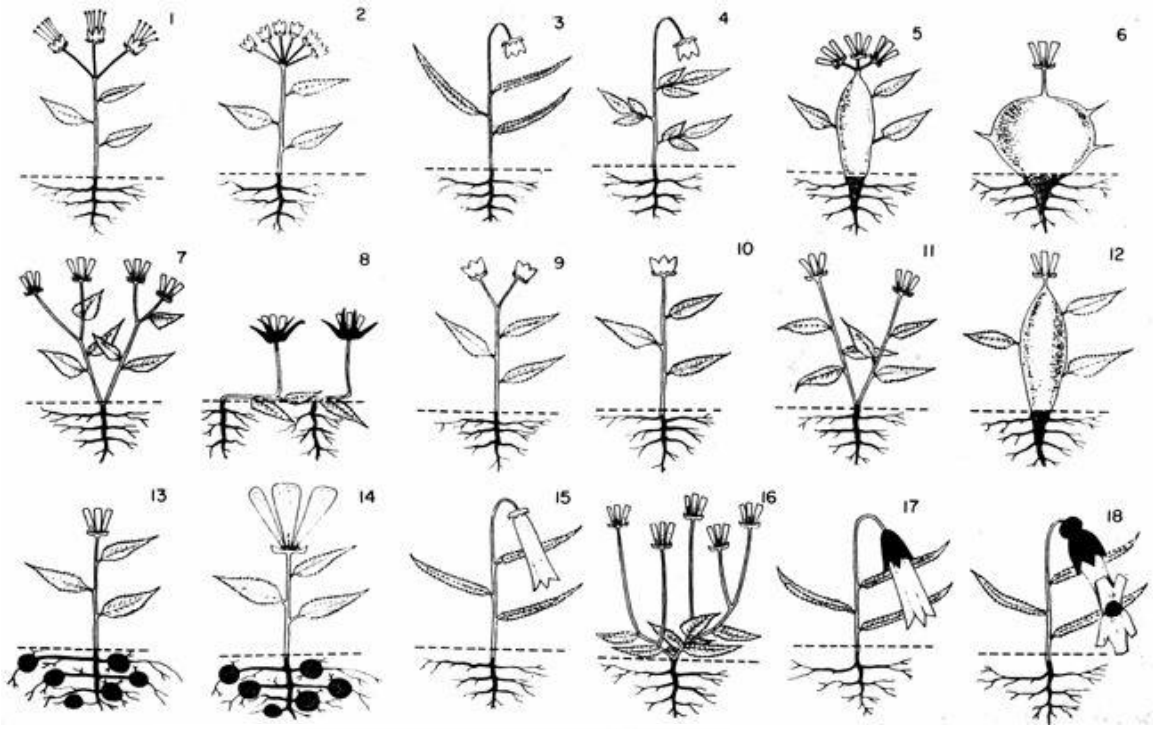
1. Maximum likelihood evaluates a hypothesis about evolutionary history in terms of the probability that the proposed model and the hypothesized history would give rise to the observed data set. The supposition is that a history with a higher probability of reaching the observed state is preferred to a history with a lower probability. The method searches for the tree with the highest probability or likelihood.

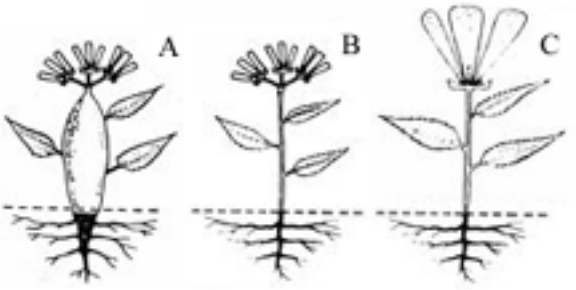
2. Bayesian analysis attempts to assess the probability of a model, bipartition or range of a parameter value, which is in contrast to ML, which assesses the probability of the data given a model. Under some conditions the biased sampling of tree and parameter space converges on the posterior probability. The approach most often used in recent months is Markov Chain Monte Carlo (MCMC) sampling.

3. Maximum parsimony is character-based and uses information itself rather than distance information. The information content used by this method is not necessarily larger than for the distance matrix methods, since there are only a limited number of informative (synapomorphic) sites. Calculates for all possible trees the tree that represents the minimum number of substitutions at each informative site. Does not assume an evolutionary model.

4. Distance matrix uses distance values and a sequential clustering algorithm. This method of tree construction is sensitive to differences in branch length or unequal rates of evolution. Therefore, it should only be used with closely related taxa, or when there is constancy of evolutionary rate. The method is often used in combination with isoenzyme or restriction site data or with morphological criteria. It assumes an evolutionary model.

Extra-credit, due at the next laboratory meeting. Group the following plant species into clades based on the parsimony method.





Outgroups:

Photosynthetic Prokaryotes- Chapter 13

- Kingdom- Bacteria
  - Phylum- _____

Cyanobacteria- Gram _____ Bacteria

- Gram positive- peptidoglycan layer; stains with crystal violet.
- Gram negative- peptidoglycan layer sandwiched by _____ and _____ layers; does not stain with _____ _____.

Cyanobacteria

- Characteristics
  - Chlorophyll _____
  - _____
  - Thylakoids occur _____
  - 70s ribosomes
  - DNA microfibrils _____
  - Polyhedral bodies
  - _____ _____
  - Habitat- _____.
  - Examples- _____, Nostoc, _____, _____, Synechococcus, Synechocystis.

Habits

- Unicells
  - _____ - Synechocystis
  - _____ of unicells- Aphanothece
- Rows of cells
  - _____ filaments w/out sheath (trichome)- Oscillatoria

–Many _____ in 1 large sheath- Microcoleus

–_____ filaments with sheath- Lyngbya

–_____ branched filaments- Mastigocladus

–_____ branched filaments- Stigonema

–_____ -branched filaments- Scytonema

Asexual Reproduction

- _____ - internal division of the protoplast results in a mass of spores.
- _____ - filament breaks into 2 parts, each of which forms a new thallus.
- _____ - short sections of a trichome detach and form a new thallus.
- _____ - resting spores; cells that are resistant to unfavorable conditions.
- _____ - division of a single-celled individual into two new single-celled individuals.

Heterocyst

- Heterocyst- a _____ -walled large cell that _____ atmospheric _____ (diazotroph).
  - –Photosynthetically inactive.
  - –Their formation is _____ related to nitrogen concentration.
  - –_____ - cytoplasmic connections that transfer metabolites and ammonium.

Movement in the Cyanobacteria

- _____ - active movement of an organism in contact with a solid substrate.
  - –Mechanism- mucilaginous layer of microfibrils generates waves.
- _____ - active movement of an organism without contact with a substrate.
  - –Mechanism- unknown.
- Why?
  - –Positively phototactic- _____.
  - –Positively chemotactic- _____.

Symbiotic Associations

- _____ - cyanobacteria occur in about 8% of the species.
- _____ - the water fern; contains Anabaena in the dorsal lobe of its leaf.
- Colonial ascidian- sea squirt.
- Amoeba, protozoa, diatoms, green algae, mosses, liverworts, water molds, and _____.

Prochlorophyceae

- Characteristics
  - –Chlorophylls _____ & _____
  - –_____ phycobilisomes
  - –Thylakoids in stacks of _____
  - –DNA microfibrils _____
  - –Habitat
    - 1) Obligate symbionts, live within _____ _____; 2) Planktonic filaments in _____ lakes.
  - –Example- _____

Stromatolites

- Stromatolite- _____ -like deposition of _____ and trapped _____; formed by _____ and diatoms.
- Age- _____ _____.
- _____-_____-growth-deposition.
- _____-shaped in growth= _____ year.
- _____, Bahamas, _____.

Cyanobacteria Produce Cyanotoxins

- _____- alkaloids that target the nervous system.
  - –Anatoxin and saxitoxin.
  - –_____- staggering, muscle twitching, gasping, and convulsions.
  - –Anabaena, Aphanizomenon, Oscillatoria.
- _____- large compounds that target the liver.
  - –Microcystins and nodularins.
  - –_____- weakness, vomiting, diarrhea.
  - –Anabaena, Microcystis, Oscillatoria, Nodularia, Nostoc.

Fungi- Chapter 14

Fungi

- Eukaryotic
- _____ and _____
- Most are composed of _____ (fungal filaments)
- Nuclei occur in continuous _____
- Heterotrophic _____
- Cell wall _____ and predominantly made of _____
- Reproduction is _____ and sexual
- Life cycles are _____
- Numbers- ~_____ species described
- Habitat- ubiquitous, but _____ _____
- Size- _____scopic and _____scopic.
- Storage product- _____

Phylum Cryptomycota

- _____
- _____ chitin.
- ~1000 species
- Habitat- _____, _____, and _____.
- Example- _____.

Phylum Chytridiomycota

- _____
- ~_____ species.
- Habitat
  - Soil from desert, ditches, and banks of _____ and streams, rumen of large mammals.
- Motile _____ and _____ with a single whiplash flagellum.
- Example- _____.
- Sexual reproduction involves the formation of a _____.
- Asexual by zoospores.

Life Histories

<u>Allomyces</u> life history

Phylum Microsporidia

- Spore forming _____cellular _____.
- ~_____ species.
- Lack _____, _____, and peroxisomes.
- Reproduce by forming _____ that shoot _____ into host cells.
- Example- _____.

Phylum Glomeromycota

- Arbuscular _____.
- ~_____ species so far.
- Occur in about _____% of vascular plants
- _____, _____.
- Asexual, large _____
- Example- _____.

Phylum Zygomycota

- Aseptate
- ~_____ species.
- <u>Habitat</u>
  - Plant and animal tissue in soil, some are _____ on plants, insects, and small soil animals.
- _____.
- Example- _____ <u>stolonifer</u> (common _____ mold).
- Sexual reproduction involves the formation of a _____.
- Asexual by nonmotile spores.

<u>Rhizopus</u> life history

Phylum Ascomycota

- _____
- ~32,000 species.
- Habitat
  - _____, _____, plant _____.
- _____.
- Examples- Neurospora (powdery mildew), Morchella (morel), Saccharomyces (yeast).
- Sexual reproduction involves the formation of _____ on an _____.
- Asexual by budding, _____, _____.

Phylum Basidiomycota

- _____
- ~22,000 species.
- Habitat
  - _____ litter.
- _____.
- Examples- _____ (mushroom), Puccinia (rusts), Ustilago (smuts).
- Sexual reproduction involves the formation of _____ on an _____.
- Asexual by budding, conidiospores, fragmentation.

Gilled mushroom life history

Lichens

- _____biont and _____biont.
- Mycobiont= part Ascomycota & Basidiomycota.
- ~13,000 species.
- Habitat
  - From the desert to the poles.
- _____.
- Examples- Caloplaca (_____), Parmelia (_____), Usnea (_____).
- Reproduction is by _____.

Kingdom 'Protista' Part 1- Chapter 15

Heterotrophic Phyla

•Oomycota- _____.

•Myxomycota- _____.

•Dictyosteliomycota- _____.

Oomycota- water molds

•Characteristics

- –_____cellular, _____ and filamentous.
- –_____ and parasitic.
- –Food reserve- _____.
- –_____karyotic nucleus.
- –Zoospores- 1 _____ and 1 _____.
- –Cell wall _____/cellulose-like.

•Habitat- marine, freshwater, terrestrial.

•_____ species.

•Examples- _____ and _____.

Saprolegnia life history

Phytophthora- sudden _____ disease, Ireland _____ famine, crop destruction.

Myxomycota- plasmodial slime molds

- Characteristics
  - –Streaming _____.
  - –Saprophytic and _____ bacteria, yeast, fungal spores.
  - –Food reserve- _____.
  - –_____karyotic nucleus.
  - –Gametes- 2 unequal, apical, _____.
  - –_____ cell wall.
- Habitat- _____.
- 700 species.
- Examples- _____.

Physarum life cycle

Dictyosteliomycota- cellular slime molds

- Characteristics
  - –_____-like cells that form _____.
  - –_____ bacteria.
  - –Food reserve- _____.
  - –_____karyotic nucleus.
  - –Flagella- _____.
  - –Cell wall _____.
- Habitat- terrestrial.
- 50 species.
- Examples- _____.

Dictyostelium- cellular slime mold

Dictyostelium

Photosynthetic Phyla (the algae)

•Myzozoa- _____.
•Euglenozoa- _____.
•Cryptophyta- _____.
•Haptophyta- _____.
•Chlorophyta- _____ algae.
•Rhodophyta- _____ algae.
•Heterokontophyta- heterokont algae.
  –Phaeophyceae- _____ algae.
  –Chrysophyceae- _____-_____algae.
  –Bacillariophyceae- _____.

Myzozoa- dinoflagellates

•Characteristics
  –_____, colonial.
  –Chlorophylls ____ and _____, _____.
  –Food reserve- _____ in cytoplasm.
  –Thylakoids in _____.
  –_____karyotic nucleus.
  –Flagella- 1 _____ and 1 _____.
  –Cell wall with _____ in thecal plates.
•Habitat- marine and freshwater.
•4,000 species.
•Examples- _____, _____, Dinophysis, _____, Pfiesteria.

Euglenozoa- euglenoids

•Characteristics
  –_____.
  –Chlorophylls _____ and _____, _____.
  –Food reserve- _____ in cytoplasm.
  –Thylakoids _____-3.
  –_____karyotic nucleus.
  –2 unequal flagella, long one with _____.
  –No cell wall, _____ _____.
  –_____.
•Habitat- marine and _____; puddles, ditches, ponds, streams, lakes, rivers.
•1,000 species.
•Example- _____.

Kingdom 'Protista' Part 2- Chapter 15

Cryptophyta- cryptomonads

- Characteristics
  - _____cellular.
  - Chlorophylls A & C, _____.
  - Food reserve- _____ within 2 chloroplast membranes.
  - Thylakoids in _____.
  - Eukaryotic nucleus.
  - 2 flagella, _____ (dbl. & single).
  - _____, proteinaceous periplast plates.
- Habitat- marine & freshwater.
- 200 species.
- Examples- _____.

Haptophyta- haptophytes

- Characteristics
  - Unicellular.
  - Chlorophylls A & C, _____.
  - Food reserve- _____ in vesicles.
  - Thylakoids in 3.
  - Eukaryotic nucleus.
  - 2 whiplash flagella and 1 _____.
  - _____, covered with scales of cellulose or calcium carbonate.
- Habitat- **marine** & freshwater.
- 300 species.
- Examples- _____ & Phaeocystis.

Chlorophyta- green algae

- Characteristics
  - _____cellular and _____cellular.
  - Chlorophylls A & _____, carotenoids.
  - Food reserve- _____ in chloroplast.
  - Thylakoids in 3-6.
  - Eukaryotic nucleus.
  - Highly variable; _____, _____, _____, _____-flagellated; whiplash when present.
  - Cell wall cellulosic.
- Habitat- marine & _____.
- 17,000 species.
- Examples- Ulva, _____, Chlorella, Volvox, Chara, _____, Closterium.

Ulva life history

Charales- Coleochaete

Rhodophyta- red algae

•Characteristics
- –_____cellular.
- –Chlorophylls A & _____, phycobilins.
- –Food reserve- _____ _____in cytoplasm.
- –Thylakoids occur _____.
- –Eukaryotic nucleus.
- –_____ flagella.
- –_____.
- –Cell wall with cellulose & galactans.

•Habitat- _____& freshwater.
•6,000 species.
•Examples- Polysiphonia, _____, Batrachospermum, _____.

Heterokontophyta- heterokonts

Phaeophyceae- _____ algae

- Characteristics
  - _____cellular.
  - Chlorophylls A & C, _____.
  - Food reserve- mannitol & laminarin in _____.
  - Thylakoids in 3.
  - Eukaryotic nucleus.
  - 2 flagella, 1 tinsel & 1 whiplash.
  - Cell wall cellulosic with _____.
- Habitat- _____.
- 2,000 species.
- Examples- Fucus, _____, Laminaria, Nereocystis, Ectocarpus, _____.

Fucus life history

Chrysophyceae- golden-brown algae

•Characteristics

- _____cellular, colonial.
- Chlorophylls A & C, _____.
- Food reserve- chrysolaminarin in _____.
- Thylakoids in 3.
- Eukaryotic nucleus.
- Most= 2 flagella, 1 tinsel & 1 whiplash.
- Cell wall cellulosic, silica, or none.

•Habitat- marine and _____.

•1,000 species.

•Examples- Dinobryon, _____.

Bacillariophyceae- _____

•Characteristics

- _____cellular, _____.
- Chlorophylls A & C, _____.
- Food reserve- chrysolaminarin in _____.
- Thylakoids in 3.
- Eukaryotic nucleus.
- No flagella, _____ 1 tinsel on male gamete.
- Cell wall is silica and made of _____ _____.

•Habitat- _____ and freshwater.

•100,000 species.

•Examples- Acnanthes, Bacillaria, Licmophora, _____, _____.

Frustule Morphology

Bryophytes- Chapter 16

•What is the name of the group we are studying today and tomorrow?

–A) flowering plants
–B) fungi
–C) bacteria
–D) mosses
–E) don't care, where are the snacks?

•<u>True or false</u>.

_____ Bryophytes are plants.

_____ Bryophytes grow only in the water, but not on land.

•Which of the following is not true of plants?

–A) they are mostly autotrophic
–B) they are primarily terrestrial
–C) they have the same photosynthetic pigments as brown and red algae
–D) they are multicellular
–E) still don't care, where is the popcorn?

Kingdom Plantae- _____

•_____trophic (mostly).
•_____ with advanced tissue differentiation.
•_____ alternation of generations, where the
–Diploid phase (_____phyte) includes an embryo.
–Haploid phase (_____phyte) produces gametes by mitosis.
•Chlorophylls _____ & _____, carotenoids.
•Starch stored inside chloroplasts.
•<u>Habitat</u>- primarily _____.
•_____present.
•Male and female gametangia present.
•Photosynthetic tissues produced by an _____ meristem.
•Sporangia with a _____ _____ .
•_____ present.
•~330,000 species.

•<u>True or false</u>.

_____ '*Bryo*' is greek for moss.

_____ Liverworts and hornworts are bryophytes.

_____ The moss sporophyte is nutritionally dependent on the female gametophyte.

_____ Water is not required for fertilization in mosses.

Bryophytes
•Bryo- *gr.* _____.
•Liverworts, hornworts, and mosses.
•_____ dominant.
•Sporophyte matrotrophic and _____ _____ (6-16 weeks).
•_____ required for fertilization.
•Sexual reproduction involves _____ and _____.
•Biflagellated sperm.
•Asexual reproduction by _____ and _____.
•Plasmodesmata present.
•Rhizoids in most.
•_____ in most (not the hornworts).
•_____ or stomata-like structures present.
•~16,000 species.

•**True or false.**
_____ Liverworts because they are shaped like a liver and look glandular were used to treat liver disease in earlier times.
_____ The specimen marked 'A' is a leafy liverwort and the one marked 'B' a thalloid liverwort.

Marchantiophyta- _____
•Sporophytes _____ stomata, but have pores.
•Specialized conducting tissue _____.
•Gametophytes thalloid or leafy.
•Rhizoids _____ celled.
•_____ of all living plants.
•Sporangium with _____ capsule, elaters present in some to disperse spores.
•Most cells contain _____ chloroplasts.
•Habitat- _____, some aquatic, temperate and tropical.
•6,000 species.
•Examples- Marchantia and _____.

Marchantia Antheridia

Marchantia Archegonia

•**True or false.**

_____ Below you can see male gametophytes.

Life history of Marchantia- Heteromorphic, heterothallic, homosporous, sporic alternation of generations. You will study the life history stages of this plant in the lab.

Anthocerotophyta- _____
•Antho- *gr.* _____, keras- *gr.* _____.
•Sporophytes _____ stomata.
•Specialized conducting tissue _____.
•Gametophytes _____.
•Rhizoids _____ celled.
•Sporangia dehisce to disperse spores, elater-like structures present.
•Most cells contain a _____ chloroplast.
•Sporophyte with basal intercalary _____.
•Habitat- moist temperate and tropical.
•100 species.
•Example- _____
•**Hornwort sporophytes _____.**
- –A) are nutritionally dependent on the female gametophyte
- –B) are primarily terrestrial
- –C) lack stomata
- –D) contain a sporangium
- –E) all of the above

•**True or false.**

_____ Anthoceros is an example of a true moss (Phylum Bryophyta).

_____ Hornwort gametophytes are thalloid.

Bryophyta- _____
•Sporophytes _____ stomata.
•Specialized conducting tissue- _____ and nonlignified _____.
•Gametophytes _____.
•Rhizoids _____.
•Sporangia with dehiscent capsules.
•Most cells with _____ chloroplasts.
•Habitat- _____ and _____, temperate and tropical, some aquatic.
•9,500 species.
•Example- Polytrichum, Sphagnum, _____.

3 Moss Classes
•Bryidae- _____ mosses, Polytrichum.
–Protonema with a _____ of cells with slanted cross walls.
–Leafy gametophytes develop from minute budlike structures.
•Sphagnidae- _____ mosses, Sphagnum.
–Protonema with _____ of cells that is one layer thick.
–Gametophytes with clusters of branches, 5 per node.
–_____ capsular operculum.
•Andreaeidae- _____ mosses, Andreaea.
–Protonema with _____ of cells.
–Capsule dehisces by splitting in four.
–Rhizoids occur in 2 rows.
–_____ or _____ regions on _____.

Moss life history

•**Moss sporophytes _____.**

–A) are nutritionally dependent on the female gametophyte
–B) are aquatic and terrestrial
–C) have multicellular rhizoids
–D) include Polytrichum, Sphagnum, and Mnium
–E) all of the above

•**True or false.**

_____ Moss sporophytes contain stomata.

_____ Moss gametophytes are thalloid and leafy.

Seedless Vascular Plants- Chapter 17

- True or False.
  - Nonvascular plants include the algae and bryophytes.
  - Vascular plants include lycophytes, ferns, gymnosperms, and flowering plants.
  - Xylem and phloem are the names of musical instruments from Istanbul.

Vascular Tissue System

- _____- plant tissue that conducts water and minerals.
  - Tracheary elements
    - _____
    - _____ _____
- _____- plant tissue that conducts food (mainly _____).
  - _____elements

Vascular Plant Terminology #1

- Leaves- photosynthetic, principal _____ _____ of the stem.
  - _____- small leaves that contain a single strand of vascular tissue.
  - _____- large leaves that contain multiple strands of vascular tissue.

Vascular Plant Terminology #2

- Homosporous- production of one type of spore from _____ kind of sporangium.
- Heterosporous- production of two types of spores from _____ different kinds of sporangia.

Vascular Plant Terminology #3

- _____- a modified leaf that bears sporangia.
  - _____- a structure that produces spores.

Vascular Plant Terminology #4

- _____- a modified leaf that bears microsporangia.
  - Microsporangia- a _____.
- _____- a modified leaf that bears megasporangia.
  - Megasporangia- a sporangium that produces _____.

Vascular Plant Terminology #5

- _____- a reproductive structure consisting of nonphotosynthetic sporophylls; a _____.
  - _____- a microsporangiate cone.
  - _____- a megasporangiate cone.

_____Seedless Vascular Plants

- Representatives (425-370 MYA)
  - _____
  - _____
  - _____

_____Seedless Vascular Plants

- Phyla (Living today)
  - _____- club mosses, resurrection plant, quillworts.
  - _____- ferns and the fern allies (whisk ferns and horsetails).

Lycopodiophyta- lycophytes

- Lykos- *gr.* _____, pous- *gr.* _____.
- _____present.
- Plants + or - _____ branched.
- Sporangia on or in the _____ of sporophylls on strobili.
- _____sporous & _____sporous.
- Distribution- global.
- Habitat- _____, deserts, aquatic.
- ~1,200 species.
- Examples- Lycopodium, _____, _____.

Life history of Lycopodium (Lycopodiaceae)- Heteromorphic, homothallic, homosporous, sporic alternation of generations. You will study the life history stages of this plant in the lab.

Selaginella- the resurrection plant (Selaginellaceae) is _____sporous.

Isoetes- the quillwort (Isoetaceae) is _____sporous.

- Match spore type on the right to lycophyte family on the left.

1. Lycopodiaceae (Lycopodium) a. Homosporous
2. Selaginellaceae (Selaginella) b. Heterosporous
3. Isoetaceae (Isoetes)

Monilophyta- ferns and fern allies.

- Monilo- *gr.* _____.
- Leaves- _____phylls, scalelike, & _____phyll-like.
- _____branching patterns.
- Sporangia in _____, lateral, or on sporangiophores in strobili.
- Heterosporous & homosporous.
- Distribution- global, _____.
- Habitat- all habitats, > species in _____.
- ~11,000 species.
- Examples- Polypodium, _____, _____.

Spore development- two types

_____-

_____-

Class Psilotopsida
Order Psilotales- _____.

- Psilos- *gr.* _____.
- Leaves- _____-like or _____-like.
- Eusporangiate.
- Sporangia lateral.
- _____branched.
- Homosporous.
- _____ roots, but they have aerial stems.
- Distribution- _____ & subtropical.
  - –Alabama, _____, Florida, Louisiana.
- Habitat- epiphytic or on rich soils.
- Example- _____ (2 spp.), and _____ (13 spp.).

Tmesipteris

Class Psilotopsida
Order Ophioglossales- _____.

- Ophio- *gr.* _____. Gloss- gr. _____.
- Leaves- _____ phylls.
- _____ in 2 rows.
- Sporangia on _____ or _____.
- _____ or __ branched.
- _____
- Roots, stems, and leaves.
- Distribution- tropical and _____.
- Habitat- epiphytic or _____.

•~_____ species.
•Examples- _____and _____.

Class Marattiopsida
Marattio- *gr.* _____.
•Leaves- _____ phylls, complex, pinnately branched.
•Sporangia _____sporangiate, _____.
•Sporangia on _____ of _____.
•Distribution- tropical and _____.
•Habitat- epiphytic and _____.
•~_____ species.
•Example- _____.

Class Polypodiosida- ferns
•Poly- *L.* _____. podio- *gr.* _____.
•Leaves- _____phylls, fronds.
•Sporangia _____sporangiate, **homosporous** and heterosporous.
•Sporangia usually in _____.
•_____ branching, but not dichotomous.
•Roots, stems, and _____.
•Distribution- global, _____.
•Habitat- all habitats, > species in _____.
•~_____ species.
•Examples- Polypodium.

Polypodium (Typical Fern) life history

Class Equisetopsida- horsetails

- Equus- *L.* _____, saeta- *L.* _____.
- Leaves- microphyll-like, scaly.
- Homosporous.
- Sporangia on sporangiophores in a strobilus.
- _____ leaves, but not dichotomous.
- Roots and stems (ribbed and jointed).
- Distribution- global.
- Habitat- along streams in moist sites.
- ~_____ species.
- Example- _____.

Gymnosperms- Chapter 18

Naked versus Enclosed Seed Plants

- Gymnosperms
  - –Gymno- *gr.* _____.
  - –Sperma- *gr.* _____.
- Angiosperms
  - –Angeion- gr. _____.
  - –_____- *gr. seed.*

Extant Gymnosperms

- Match the common name on the right to the phylum on the left.

–1) Cycadophyta	a. ginkgo
–2) Ginkgophyta	b. conifers
–3) Coniferophyta	c. cycads
–4) Gnetophyta	d. gnetophytes

Cycadophyta

- Cycas- *gr.* _____.
- _____, but _____ vessel elements.
- Sperm present, _____.
- _____ leaves.
- Pollen tube _____ with the egg cell.
- Ovulate (megasporangiate) & microsporangiate cones simple & on _____ plants.
- 11 genera & 140 species.
- Examples- _____ & _____.

Ginkgophyta

- Yin- *ch.* _____, hing- *ch.* _____.
- _____, but _____ vessel elements.
- Sperm present, _____.
- _____ leaves.
- Pollen tube _____ with the egg cell.
- Ovulate & microsporangiate cones on _____ plants; _____ seeds.
- ____ genus & _____ species.
- Examples- _____ = maidenhair tree.

Coniferophyta

- Con- *gr.* _____, fer- *L.* _____.
- _____, but no vessel elements.
- _____.
- _____ like or _____ like leaves.
- Pollen tube _____ with egg cell.

•Ovulate & microsporangiate cones on _____ plant; ovulate cones compound.
•70 genera & 630 species.
•Examples- _____, Picea, _____, Abies, Cupressus.

Pinus- pine (Pinaceae), life history.

Metasequoia- _____.

Wollemia nobilis- _____.

Gnetophyta

- Gneto- *Malay gnenom*.
- _____ and _____ elements.
- Sperm _____ motile.
- Scalelike, leaflike, broad and _____ leaves.
- Pollen tube _____ with egg cell.
- Ovulate & microsporangiate cones compound & mostly borne on separate plants.
- 3 genera & 70 species.
- Examples- _____, _____, Welwitschia.

Gnetum

Ephedra

_____

Introduction to the Angiosperms- Chapter 19

Angiosperms- Anthophyta

- _____, but parasitic and saprophytic representatives.
- Enclosure of ovules within _____.
- Ovule- the structure in seed plants that contains the _____, with _____ cell; including nucellus and integuments.
- Presence of _____ in seeds.
- Flower present with _____ (microsporophylls) & _____ _____ (megasporophylls).
- Species- 300,000-450,000

Class Monocotyledonae- _____

- Flower parts- _____s.
- Pollen- _____aperturate.
- Cotyledons- _____.
- Leaf venation- _____.
- 1° vascular bundles in stem- _____.
- 2° growth _____ vascular cambium.
- Examples- _____, lilies, irises, _____, cattails, palms.

Class Eudicotyledonae- _____

- Flower parts- _____s & _____s.
- Pollen- _____aperturate.
- Cotyledons- _____.
- Leaf venation- _____.
- 1° vascular bundles in stem- _____.
- 2° growth _____ vascular cambium.
- Examples- _____, _____, _____.

Flower Anatomy

Sepals-

Petals-

Pedicel-

Stigma-

Style-

Ovary-

Receptacle-

Anther and filament-

Ovary Position

- _____ - whorls attached below the ovary.
- _____ - stamens and petals adnate to the calyx, forming a tube (hypanthium) at the base of the ovary.
- _____ - whorls attached above the ovary.

Epigyny in <u>Malus</u> (apple) flower

Mature Anther with 4 Microsporangia

Mature Embryo Sac- 8 nuclei, 7 celled structure

Double Fertilization

Glycine- soybean lifecycle.

_____- tissue that contains stored food that is digested by the sporophyte before or after maturation of the seed.

Evolution of Angiosperms- Chapter 20

Rafflesia arnoldii

•Flower- the reproductive structure of angiosperms; a _____ shoot that bears sporophylls.

Evolutionary Trends Among Flowers

•Flowers have gone from _____ indefinite parts to having _____ parts that are definite in number.

•Floral _____ have _____ over time.

•Floral parts have become _____.

•Floral _____ has become _____.

•Carpels have gone from _____ and incompletely closed to pistil-shaped and sealed.

•Ovary has gone from _____ to _____.

•Perianth has gone from having indistinct sepals and petals to having a distinct calyx and corolla.

•Flowers have gone from _____ (actinomorphic) to _____ (zygomorphic) symmetry.

Floral Evolution

•_____ and _____ have coevolved.

–Coevolution- the _____ _____ of adaptations in 2 or more interacting populations.

•Insect pollination is _____ efficient than passive pollination.

•_____, flies, _____.

•_____ are the most important group of visiting insects.

Bird and bat-pollinated flowers

•Produce copious _____.

•Usually bright _____ and _____ in color.

–Birds have a good sense of color.

•Flowers usually have very _____ _____.

–Smell not developed in birds.

Flavonoids

•_____ soluble phenolic compounds with two six-carbon rings linked by a three-carbon unit.

•Occur in the _____ of plant cells.

•The most important pigments in floral coloration are the _____ (red, violet, and blue) and the _____.

Wind pollinated flowers _____ produce nectar.

_____

•Water soluble _____ compounds with two six-carbon rings linked by a three-carbon unit.

•Occur in the _____ of plant cells.

•The most important pigments in floral coloration are the _____ (red, violet, and blue) and the _____.

Asteraceae and Orchidaceae

- Asteraceae
  - _____ have flowers closely bunched together in a head.
    - _____ species.
    - Ovary with _____ ovule
    - _____ and _____ flowers.
- Orchidaceae
  - Orchid flowers are showy and zygomorphic.
    - _____ species.
    - Ovary with _____ of ovules.
    - Cuplike lower petal.

Fruit Related Terminology

- Fruit- a _____.
- _____ - the enlarged basal portion of a carpel.
- _____ - the vessel that encloses the ovule/s; forms the gynoecium.
- _____ - the structure that contains the female gametophyte with egg cell, including the nucellus and integuments.
- _____ - a mature ovule.
- _____ - chambers in the ovary that contain the ovules.

3 types of Placentation

Fruit Classification

- Fruit derived from _____ than 1 pistil
  - _____ fruit- develop from a cluster of mature ovaries produced by a cluster of mature flowers.
    - _____.
  - _____ fruit- develop from several separate carpels of a single flower.

•Raspberry, strawberry, _____.

Simple Fruit Types- fruit derived from _____ pistil

- _____
  - –Berries- fleshy inner layer. Tomatoes, banana, grapes.
    - •_____ - a berry with a thick, leathery, inseparable rind. Cucurbitaceae.
    - •_____ - a berry with a thick, leathery, separable rind. Citrus.
  - –_____ - fleshy hypanthium. Pear, apple.
  - –_____ - stony endocarp. Peach, cherry, olive.
- _____
  - –_____ - tissue of the mature ovary wall splits open, freeing the seeds.
    - •Legume- dehisces along 2 sutures.
  - –_____ - tissue of the mature ovary wall remains sealed with seeds remaining in the fruit.
    - •Nut- hard pericarp, usually one-seeded.
    - •Achene- small. dandelion.

Fruits and seeds have evolved in relation to their dispersal agents

- Wind-borne fruits & seeds.
- _____.
- Fleshy for animal dispersal.
- Attachment to _____.

Early Development of the Plant Body- Chapter 22

True or False

_____ Embryogenesis is the formation of an embryo.
_____ The developing embryo in angiosperms is photosynthetic.

Embryogenesis

- Embryogenesis- formation of an embryo.
- The first two divisions are _____ and establish embryo _____.
  - _____ - chalazal pole.
    - Consists of an _____ _____ that gives rise to an _____ _____, which will eventually give rise to the mature embryo.
  - _____ - micropylar pole.
    - Consists of a _____ _____ that gives rise to a _____.
- Establishment of polarity fixes the structural axis on which the lateral appendages will be later arranged.

Embryo Proper and the Primary Meristems

- The embryo proper is tissue that differentiates to form _____ primary meristems.
- Primary Meristems
  - _____- forms the epidermis of the plant by periclinal divisions of the outer cells of embryo proper.
  - _____- forms the vascular tissue of the plant by vertical divisions.
  - _____- forms the ground tissue of the plant by vertical divisions.

_____ The apical meristem in angiosperms _____.

A) is a region of tissue at the tip of shoots and roots that is responsible for programmed cell death.
B) is a region of tissue at the tip of shoots and roots that forms new cells.
C) coordinates hormone production much like the brain in mammals
D) produces the bark we see on trees
E) none of the above

Apical Meristems

- Apical Meristem- _____.
- As the embryo matures new cell formation gradually becomes restricted to the apical meristems.
- Shoot Apical Meristem- positioned _____ the two embryonic leaves in _____ and _____ in _____.
- _____ - embryonic root.

Seed Terms

- Hypocotyl- _____.
- Hypocotyl-root axis- an undistinguished radicle.
- _____- stemlike axis above the cotyledons.
- _____- the first bud of an embryonic shoot.
- _____- the fruit wall, which develops from the wall of the ovary.

Garden Bean- food is stored in _____.

Castor Bean- food is stored in _____.

Onion and Maize- food is stored in _____.

_____ Which of the following effects seed germination?

A) water
B) oxygen
C) light and temperature
D) hormones
E) all of the above

Seed Germination

- Dependent on _____ and _____ factors.
  - –External (_____)
    - •Water
    - •Oxygen
    - •Temperature
    - •Light
  - –Internal (_____)
    - •Hormones- gibberellins.
- _____ - cotyledon/s are carried above ground level.
- _____ - cotyledon/s remain underground.

Examples-

True or False

_____ The onion has an epigeous type of seed germination.

Cells and Tissues of the Plant Body- Chapter 23

Origin of Primary Tissues

- Primary growth- formation of _____ _____.
  - –Primary plant body.

Growth and Development

- _____- the sum total of events that lead to the formation of the plant body.
- Growth- an _____ _____ in size.
  - –Cell _____
  - –Cell _____
- _____ _____- regions of tissue at the tips of shoots and roots that forms new cells.
  - –Meristematic tissue.
- Much of the plant undergoes unlimited or prolonged growth of the apical meristems=_____.

Morphogenesis and Differentiation

- Morphogenesis- the _____.
- _____- a process by which a relatively unspecialized cell undergoes a progressive change to form a more _____ cell.

Internal Organization of the Plant Body

- Tissue- a group of _____ _____ organized into a structural and functional unit.
- Tissue System- a tissue or _____ organized into a structural and functional unit; larger units of the plant body.
- There are _____ Tissue Systems
  - _____
  - _____
  - _____

Ground Tissue

- _____
  - –Polyhedral to round in shape.
  - –Occur throughout the plant body.
  - –Photosynthesis, storage, and secretion.
- _____
  - –Elongate in shape.
  - –Occur beneath the epidermis in young stems.
  - –Support young growing tissues.
- _____- fibers and sclereids.
  - –Long or stellate in shape.
  - –Occur throughout the plant body.
  - –Support (strengthen) and storage.

Vascular Tissue #1

- Xylem- principal _____tissue in vascular plants; _____ at maturity; lignified.
- Tracheary Elements
  - –_____- elongate and tapering; pits, but no perforations; seedless vascular plants, gymnosperms, and some angiosperms.
  - –_____element- elongate; pits and perforations; angiosperms.

Vascular Tissue #2

- Phloem- principal _____tissue in vascular plants; living at maturity; not lignified.
- Gymnosperm Sieve Elements
  - Sieve cell- elongate & tapering; with sieve areas.
  - _____cell- elongate & tapering; delivers substances to sieve cells.
- Angiosperm Sieve Elements
  - Sieve-tube element- elongate & tapering; with a sieve plate.
  - _____cell- variable; delivers substances to sieve-tube elements.

Dermal Tissue

- _____- outermost cell layer of the _____ plant body.
  - Variable in shape; guard cells and trichomes.
  - _____of plant body.
  - Protective (cuticle and water loss) and aeration (stomata).
- _____- _____ protective tissues.
  - Rectangular in shape; cork cells.
  - _____epidermis.
  - Protective and aeration (lenticels); replaces epidermis.

The Root: Structure and Development- Chapter 24

Roots

•Root- the _____, normally occurs below ground.

•Root Functions

– _____.
– _____ of water, minerals, inorganic ions.
– _____.
– _____.

•Two types of root systems

– _____- a stout, tapering main root from which smaller lateral roots arise; deep; gymnosperms & dicots.
– _____- arise from stem similar to lateral roots; shallow; monocots.

Root Penetration

•Root depth and distance depend on _____:

– _____
– _____
– _____

•_____- those involved in uptake of water and minerals occur usually in the upper 1 meter of the soil.

•Rootcap- a thimble like mass of _____ cells that covers the root and _____ mucigel.

•The _____ in young roots absorbs _____ and _____.

•Root Hairs- _____ _____ of epidermal hairs that facilitate absorption.

Primary Development of the Root Tip

•Region of cell_____

–~1 mm in length.
–Apical meristem.

•Region of cell_____

–~2 mm in length.
–Cells elongate, functional xylem starts to develop and phloem is mature.

•Region of_____

–~2 mm-variable in length.
–Root hairs are produced, functional xylem and phloem are present.

Name the 3 primary meristems scene on this slide: _____, _____, _____

Eudicot versus Monocot Roots

- Eudicots
  - Vascular cylinder _____.
  - Cortical cells sometimes retained for life, but some shed due to secondary growth.

- Monocots
  - Vascular cylinder in _____ with _____.
  - Cortical cells retained for life, because they lack secondary growth.

Cortex and Vascular Cylinder

Match the following cortical and vascular terminology to their definitions.

1. Cortex	a. 1 or more layers of nonvascular cells surrounding the vascular tissue of the root.
2. Vascular cylinder	b. empty spaces among cortical cells; essential for aeration of the root cells.
3. Pericycle	c. a region of the primary wall containing suberin that is impermeable to water and ions.
4. Intercellular spaces	d. the innermost layer of the cortex.
5. Epidermis	e. contains xylem, phloem, and pericycle.
6. Exodermis	f. consists mostly of ground tissue that occupies the greatest area of the root.
7. Endodermis	g. the outermost layer of cells.
8. Casparian Strip	h. the outermost layer of the cortex that is one or more cell layers in depth.

Lateral Roots Arise from the _____

Effects of Secondary Growth on the Primary Body of the Root

- Secondary Growth in roots consists of:
  - 1) Secondary vascular tissues (secondary xylem and phloem) from _____.
  - 2) Periderm, mostly cork tissue from _____.

Root Modifications

- _____- roots produced from aboveground structures.
- _____- negatively gravitropic roots that aerate the root system.
- _____- specialized storage organs consisting of parenchyma and vascular tissue. Carrot, sweet potato, sugarbeet.

The Shoot: Primary Structure and Development- Chapter 25

The Shoot

- Shoot- the _____, consisting of stem and leaves.
  - Stem- the above ground _____ of vascular plants.
  - Leaf- the principle _____ _____ of the stem.
    - Foliage leaf- photosynthetic organ.
- _____- the part of the stem where one or more leaves are attached.
- _____- the region of the stem between two successive nodes.
- _____- an embryonic shoot protected by young leaves.

Primordium- _____

Pith- _____

Modified Stems

- _____- modified leaves that spirally coil and aid in stem support.
- _____- runners; stems that grow horizontally on the soil surface, often giving rise to new plants at the nodes.
- _____- hard, woody, sharp-pointed modified stems, arise from the axils of leaves.
- _____- hard, woody, sharp-pointed modified leaves or leaf-parts.
- _____- a small non-woody, sharp-pointed outgrowth of bark or the epidermis.

Underground Stems

- _____- a horizontal stem that grows at or below the soil surface.
- _____- an enlarged, short, fleshy underground stem, forms at the tip of a rhizome. i.e. Potato.
- _____- a shortened underground stem covered by enlarged fleshy storage leaves. i.e. Onion and garlic.
- _____- a thickened underground stem with small papery leaves. i.e. Gladiolus and Crocus.

Leaf Arrangement

- _____- the arrangement of leaves on a stem.
  - _____- leaves are attached to an underground stem or rhizome.
  - _____- 2 leaves attached at each node, borne on opposite sides of the stem.
  - _____- 1 leaf attached at each node.
  - _____- 3 or more leaves at each node.

Leaf Morphology

- Blade- _____.
- Petiole- _____ portion.
- _____- scalelike or leaflike appendages at the base of leaves.
- _____ vs. _____ Leaves
  - Simple- blades _____.
  - Compound- blades _____ into leaflets.
    - _____compound- leaflets arising from both sides of the axis.
    - _____compound- leaflets diverge from the tip of the petiole.

Leaf Histology

- _____- the _____ tissue of the leaf specialized for photosynthesis.
  - _____parenchyma- upper cells.
  - _____parenchyma- lower cells.

Leaf Abscission

- Abscission- _____.
- Structural and chemical (ethylene) changes result in the formation of an abscission zone:
  - _____layer
  - _____layer
- Magnesium ions, sugars, amino acids.

Secondary Growth in Stems- Chapter 26

Seasonal Growth Cycles

- _____- a plant whose life cycle is completed in a single growing season.
- _____- a plant whose life cycle is completed in two growing seasons; flowering and fruiting occurs in the second year.
- _____- a plant whose vegetative portion of the life cycle lives year after year.

Secondary Growth

- At the beginning of each growing season primary growth is resumed and secondary tissues _____.
- Secondary Growth- an _____ in thickness (_____) to the plant body as a result of the activity of _____ lateral meristems:
  - _____ Cambium
  - _____ Cambium

Vascular Cambium

- Vascular cambium- a cylindrical sheath of _____ cells that produces secondary xylem & phloem.
- Consists of two forms of highly vacuolated cells:
  - _____ initials
  - _____ initials

- Vascular rays
  - Pathways for the movement of _____ substances and water.
  - Storage of starch, protein, and lipids.

Wood- Secondary Xylem

- Wood uses- shelter, fire, weapons, furniture, tools, paper, boats, wheels.
- Wood is classified as:
  - _____wood- magnoliids and eudicots.
  - _____wood- _____.

Conifers- softwoods

- Tracheary elements- _____ only.

Magnoliids and Eudicots- hardwoods

- Tracheary elements- tracheids and _____ _____.

Periderm

- Periderm- outer tissue that replaces the epidermis as the protective covering of the plant.
  - _____ - meristem that produces the periderm.
  - _____ (phellem)- secondary tissue that cuts toward the outside of the cork cambium; dead at maturity; suberin; impermeable to water and gases.
  - _____ - secondary tissue that is cut towards the inside of the cork cambium; living at maturity; no suberin; permeable.

- Lenticel- spongy regions on the cork surfaces of stems, _____, and other plant parts that allow for _____ exchange.

- Bark- collective term for all tissues outside the _____ cambium.
  - _____ phloem
  - _____

External Features of Woody Stems

Heartwood vs. Sapwood

- Heartwood- the part of the wood in a living tree that contains _____ cells; nonconducting wood.
- Sapwood- the part of the wood in a living tree that contains _____ cells and reserve materials; _____ wood.

Growth Rings Result from the Periodic Activity of the Vascular Cambium

- _____ rings- a layer of growth in secondary xylem or phloem.
- _____ rings- a growth layer that represents one season's growth.
- Early wood
  - –Less dense than late wood.
  - –Produced during period of rapid growth.
  - –Wide cells with thin walls.
- _____ wood
  - –_____.
  - –Produced during periods of _____ growth.
  - –_____ cells with _____ walls.

Bristlecone Pine (Pinus longaeva)

- Oldest living tree
  - –_____ years in age- oldest living.
  - –_____ years in age- oldest.
- Native to the White Mountains of eastern California.
- The bristlecone pine is a sensitive _____ gauge.
  - –3,500 B.C.- 1,300 B.C. warm summers.
  - –1,300 B.C.- 200 B.C. cold summers.
- _____- the study of growth rings and historical time.

Ecology- Chapters 31 and 32

Environmental Science-

Ecological Definitions

- Ecology- the study of the _____ between _____ and the _____.
  - Interactions (or _____) determine the abundance and distribution of organisms.
    - _____- the size, shape, and location that a population occupies.
    - _____- the number of individuals in a given area and their density.

Quadrat-

Transect-

GIS and GPS

Ecology Deals with 4 Levels

- _____- a single organism.
- _____- a group of individuals of the same species occupying a given area.
- _____- all the organisms inhabiting a common environment and interacting with one another.
- _____- a community and its physical environment.

Population Distributions

_____ _____**- How many in California?** _____

- **Coastal Sage Scrub= CSCR** (Little summer heat), 12-25 inches of precipitation.
  - Summer fog/overcast is common. Summer temperatures from 80-100°F. Winter temperatures drop to 27-30°F.
  - Common Plants
    - Buckwheat (*Eriogonum* spp., notably *E. fasciculatum*), California Lilac (*Ceanothus* spp.), Manzanita (*Arctostaphylos* spp.), Monkey flowers (*Diplacus* spp., the drought tolerant types), Gooseberry and Currant (*Ribes* spp.), Coyote Brush (*Baccharis* spp.).
  - Soil and climate notes
    - A mixture of diverse soils, from acidic sand on hard pan (Manzanita country) to alkaline clays (largely converted to annual weeds).

•**Ecosystem**- _____.

•**_____- the major regional ecosystems.**

Abiotic and Biotic Factors

•Abiotic- characterized by the absence of life; _____.
- –_____
- –_____
- –_____
- –_____
- –_____- ph, texture, gas exchange, salinity, leaching.
- –_____

•Biotic- of or relating to life; _____.
- –_____- space, substrate, light, nutrients.
- –_____

Latitude

Elevation

Principle of Competitive Exclusion

Plant-Herbivore Interactions

Succession

•Succession- _____.
- –_____succession- the initial _____ of _____ _____ or bedrock by pioneer species (lichens, mosses, ferns, herbaceous plants).
- –_____succession- _____ in the plants and animals that live in a community after the initial colonization.

Opportunistic vs. Late Successional Forms

•r-selected
- –Colonizers on newly-cleared surfaces.
- –Life history- ephemerals, annuals, simple veg. life history.
- –Size- _____.
- –Growth- _____.
- –Reproduction- high output, _____ offspring, low cost/unit.
- –Energy storage- uniform throughout.

•K-selected
- –Invade pioneer communities on predicatable basis.
- –Life History- complex, perennials, seasonal reproduction.
- –Size- _____.
- –Growth- _____.
- –Reproduction- low output, _____ offspring, high cost/unit.
- –Energy storage- _____ distributed

Population Growth

Population Explosions

Regulating Growth and Development- Chapter 27

Hormones

•Hormone- *gr. to* _____. _____ substances produced in _____ amounts that regulate and coordinate metabolism, growth, and morphogenesis.

Darwin and Darwin **Boysen-Jensen**

_____ Major Classes of Plant Hormones

•_____
- –Leaf primordia, young leaves, developing seeds.
- –Polarly (unidirectionally) and nonpolarly.

•_____
- –Root tips.
- –From roots to shoots via xylem.

•_____
- –Most tissues in response to stress.
- –Diffusion from site of synthesis.

•_____ acid
- –Mature leaves and roots, seeds.
- –From leaves in phloem and from the roots in the xylem.

•_____
- –Young tissues of the shoot and developing seeds.
- –Xylem and phloem.

•_____
- –Young tissues and throughout the plant.
- –They act locally.

•_____ is the only plant hormone known to be transported polarly.

•Polar transport is _____ (toward the base).

Auxin Provides Chemical Signals That Communicate Information Over Long Distances

•_____ _____- inhibitory influence of the apical bud upon lateral buds.

Auxin Plays a Role in the _____ and _____ of Vascular Tissue

Auxin _____ _____ Development

Auxin _____ the Formation of Lateral and Adventitious _____

Auxin _____ Abscission

_____ Auxins Kill Weeds- Herbicides
Ethylene Plays a Role in _____ _____

Ethylene May _____ or _____ Cell Expansion

Cytokinins _____ Cell Division

Cytokinins _____ Leaf Senescence

Cytokinins _____ the Growth of Lateral Buds

Abscisic Acid (ABA) _____ Seed Germination

Abscisic Acid Plays a Role as a _____-to-_____ Signal

Abscisic Acid is Responsible for _____ _____

- Gibberellin (GA) causes _____ mutants to grow _____.
- Gibberellin causes _____ of _____ by stimulating cell division and elongation.

Gibberellin Plays Multiple Roles in

1) Breaking _____ _____
2) In _____

Gibberellin Can Cause _____
Gibberellin Affects _____ Development

Brassinosteroids

Additional Chemical Signals

- _____- signal in defense responses to plant pathogens.
- _____- plant growth regulation and defense.
- _____- growth and development; mitosis and meiosis.
- _____- long-distance signal that activates chemical defenses against herbivores.
- _____- signal in hormonal and defense responses.

External Factors and Plant Growth- Chapter 28

•Tropism- _____.

•Phototropism- the curving of a growing shoot _____ _____.
  – _____?

•Gravitropism- the response of shoot or root to _____.
  – 1st _____
  – 2nd _____

•Thigmotropism- the response to _____ with a solid object.

•Heliotropism- the orientation of _____ and _____ to the _____.
  – Turgor pressure changes of the _____.

•Pulvinus- _____ thickening at the base of the petiole or petiolule.

Growth response unrelated to the direction of the external stimulus

• _____ Movement- gr. *nastos*= closed-pressed.
  – _____
  – _____

• _____ morphogenesis

•Nyctinasty- the _____ and _____ movement of leaves in response to daily rhythms (night and day).

•Thigmomorphogenesis- the _____ in response to mechanical stimuli.

Plant Nutrition, Soils, and Disease- Chapters 13 and 29

Plant Nutrition

•Plant Nutrition- _____ from _____ of all raw materials required for essential biochemical processes.

•More than _____ _____ have been identified in plants.

•1880s- ten chemical elements were designated as _____ for plant growth.
–Carbon, hydrogen, oxygen, potassium, calcium, magnesium, nitrogen, phosphorus, sulfur, iron.

•1900s- manganese, zinc, copper, chlorine, boron, molybdenum, and finally nickel.

Essential Elements

Three criteria are used to judge essentiality

1) If it is needed for the plant to _____.
2) If it is part of _____ _____ or constituent of the plant that is itself essential.
   a. Magnesium in chlorophyll molecule.
   b. Nitrogen in proteins.
3) If _____ _____ appear in the absence of the element.

2 Types of Essential Elements

• _____- required in large amounts.
_____ mg/kg or > of dry matter.

• _____ (trace elements)- required in very small amounts.
100 mg/kg of dry matter.

Certain plants contain unusually high and low amounts of specific elements.

Macronutrient Functions

_____ Sulfur	a. ATP, nucleic acids, phospholipids.
_____ Phosphorus	b. chlorophyll molecule.
_____ Magnesium	c. amino acids and coenzyme A.
_____ Calcium	d. cell walls, cofactors, cellular membrane.
_____ Potassium	e. almost all chemical molecules, 96% of the plant.
_____ Nitrogen	f. amino acids, proteins, nucleotides, nucleic acids, chlorophylls.
_____ Oxygen, Carbon, and Hydrogen	g. osmosis and ionic balance, stomatal activity.

Micronutrient Functions

• _____- nitrogen fixation and nitrate reduction.
• _____- enzyme functioning in nitrogen metabolism.
• _____- involved in some REDOX reactions.
• _____- activator or component of many enzymes.
• _____- enzyme activator, membrane integrity, oxygen release in PSN.
• _____- Ca^{2+} utilization, nucleic acid synthesis, membrane integrity.
• _____- chlorophyll synthesis.
• _____- osmosis and ionic balance.

Sulfur

Phosphorus

Magnesium

Calcium

Potassium

Nitrogen

Molybdenum

Copper

Chlorine

Zinc

Manganese

Boron

Iron

Global Nitrogen and Phosphorus Use

Nitrogen Losses

Eutrophication

Soil

- Soil- primary _____ (inorganic ions), _____, suitable _____ _____, and _____ for plants.
  - Provides a chemical and physical environment for plant growth.
  - Minerals- naturally occuring inorganic compounds that are usually composed of two or more elements. i.e.- Quartz (SiO_2), Calcite ($CaCO_3$).

Soil Layers (Horizons)

- Soils consists of at least 3 _____ (layers)
  - A Horizon= _____soil.
  - B Horizon= _____soil.
  - C Horizon= _____.
  - _____= below the horizon layers.

Soils Are Composed of Solid Matter and Pore Space

- Solid Matter- fragments of rock and minerals in the soil.

_____ 1. Coarse Sand	a. < 2 µm
_____ 2. Fine Sand	b. 2-20 µm
_____ 3. Silt	c. 200-2000 µm
_____ 4. Clay	d. 20-200 µm

- Pore Space- the space around the soil particles.
  - _____
  - _____

Genetics- Chapter 8

Mendel Studied 7 Characters in the Garden Pea (Pisum sativum)

- Flower _____ Pod _____
- Flower _____ Pod _____
- Seed _____ Stem _____
- Seed _____

Mendel's Methods

- Cross-pollination- the transfer of _____ from one plant to the _____ of another.
  - –Self-pollination
  - –Artificial cross-pollination
- Monohybrid crosses- an experimental cross between individuals that _____.
- First (_____) and second (_____) generations.

Mendel's F_1 Observations

- One of the traits could be seen in the F_1 generation= _____
- One of the traits could not be seen in the F_1 generation= _____

Genetic Terminology

- _____- an organisms traits.
- _____- an organisms genetic makeup.
- _____- identical alleles for a gene.
- _____- two different alleles for a gene.

Genetic Terminology #2

- _____- one of 2 or more alternative forms of the same gene.
- _____- a sequence of DNA that codes for a protein.
- _____- the position on a chromosome occupied by a gene.

Mendel's F_2 Observations

- Flower color

–Purple:white 705:224 _____

Mendel's Dihybrid Cross

- 315:108:101:32 = _____

Mendel's Work Yielded These Genetic Rules

- Alternative versions of genes (different _____) account for variations in inherited characters.
- For each character an organism inherits _____ alleles, _____ from each parent.
- If two alleles differ, then one, the _____ allele is fully expressed in the organism's appearance.
- The two alleles for each character _____ during gamete production.
- Alleles of a gene segregate _____ of the alleles of other genes.

Punnett Squares and the Testcross

- Punnett square- a _____.
- Testcross- a genetic experiment used to determine an organisms genotype.

Codominance

- Codominance- the effects of both alleles are apparent.

Incomplete Dominance

- Incomplete dominance- type of inheritance in which the F_1 is _____ in phenotype between the parents.
- Neither allele is dominant.
- Self-pollination of the F_1 yields a _____ F_2 population.

Continuous Variation

- Continuous variation- a _____ in phenotype; indicates that a trait is controlled by _____ or more genes.

Linkage

- Linkage- the tendency for certain genes to be _____ _____, owing to the fact that they are located on the same chromosome.
- Linked genes- genes that are inherited _____.

Genetically Engineered Rice- what does it contain? _____

Genetic Engineering

•Genetic Engineering- the technique of _____, _____, or _____ genes to a DNA molecule.

–Improvements in crops

•_____

•Resistance to _____

•Resistance to _____

Transgenic Plants

•Tomato with _____ and without.

•Transgenic tomatoes with and without _____.

•Petunia with and without _____.

•Tobacco with and without a _____.

Transfer of Genes

Tissue Culture

Agrobacterium tumaefaciens

•**Genomics**- a field of genetics that attempts to understand the _____, _____, function, and _____ of genetic information in a whole organism.

Arabidopsis thaliana
Why is it an ideal model organism?

•**Genome- all of the genetic information of an organism.**

Arabidopsis thaliana (L.) Heynh. is a flowering plant in the mustard family Brassicaceae and is native to Europe, Asia, and northwestern Africa. It is an annual that typically grows to 20–25 cm in height. The leaves form a rosette at the base of the plant, with a few leaves also on the flowering stem. The basal leaves are green to slightly purplish in color, 1.5–5.0 cm long and 2–10 mm broad, with an entire to coarsely serrated margin; the stem leaves are smaller, unstalked, usually with an entire margin. Leaves are covered with small unicellular trichomes. The flowers are 3 mm in diameter, arranged in a corymbose fashion; their structure is that of the typical Brassicaceae. The fruit is a siliqua 5–20 mm long, containing 20–30 seeds. Roots are simple in structure, with a single primary root, and smaller lateral roots. *Arabidopsis* completes its life cycle in six weeks. The central stem that produces flowers grows after about three weeks, and the flowers naturally self-pollinate. In the lab *Arabidopsis* may be grown in petri dishes or pots, under fluorescent lights or in a greenhouse.

Use as a model organism

By the beginning of 1900s, *A. thaliana* had begun to be used in developmental studies. The first collection of its mutants was made around 1945. The species is now widely used for studying plant sciences, including genetics, evolution, population genetics, and plant development. *Arabidopsis* plays the role for agricultural sciences that mice and fruit flies (*Drosophila*) play in animal biology. Although *A. thaliana* has little direct significance for agriculture, it has several traits that make it a useful model for understanding the genetic, cellular, and molecular biology of flowering plants.

The small size of its genome makes *A. thaliana* useful for genetic mapping and sequencing, with 125 million base pairs and 5 chromosomes, *Arabidopsis* has one of the smallest genomes among plants. It was the first plant genome to be sequenced, completed in 2000 by the *Arabidopsis* Genome Initiative. The current version of the genome is maintained by The *Arabidopsis* Information Resource (TAIR). Much work has been done to assign functions to its 25,498 genes and the 35,000 proteins they encode.

The plant's small size and rapid life cycle are also advantageous for research. Having specialized as a spring ephemeral, it has been used to found several laboratory strains that take about six weeks from germination to mature seed. The small size of the plant is convenient for cultivation in a small space and it produces many seeds. Further, the selfing nature of this plant assists genetic experiments. Individual plants produce several thousand seeds.

Plant transformation in *Arabidopsis* is routine, using *Agrobacterium tumefaciens* to transfer DNA to the plant genome. The current protocol, termed "floral-dip", involves simply dipping a flower into a solution containing *Agrobacterium*, the DNA of interest, and a detergent. This method avoids the need for tissue culture or plant regeneration.

The *Arabidopsis* gene knockout (a technique in which one of an organism's gene is made inoperative) collections are a unique resource for plant biology made possible by the availability of high-throughput transformations. The site of T-DNA insertions has been determined for over 300,000 independent transgenic lines, with the information and seeds accessible through online T-DNA databases. Through these collections, insertional mutants are available for most genes in *Arabidopsis*.

Finally, the plant is well suited for light microscopy analysis. Young seedlings on the whole, and their roots in particular, are relatively translucent. This, together with their small size, facilitates live cell imaging using both fluorescence and confocal laser scanning microscopy. By mounting seedlings in water or in culture media, plants may be imaged uninvasively, eliminating the need for fixation and sectioning and allowing time-lapse measurements. Fluorescent protein constructs can be introduced through transformation as well. The developmental stage of each cell can be inferred from its location in the plant or by using fluorescent protein markers, allowing detailed developmental analysis.

TAIR and NASC (Nottingham *Arabidopsis* Stock Centre) are curated sources for diverse *Arabidopsis* genetic and molecular information, and also provide numerous links, for example, to databases that store the results of hundreds of genome-wide gene expression profile experiments. Seed and DNA stocks can be obtained from NASC or the *Arabidopsis* Biological Resource Center.

History of *Arabidopsis* research

The first mutant in Arabidopsis was documented in 1873 by Alexander Braun, describing a double flower phenotype (the mutated gene was likely *Agamous (without stamens or carpels)*, cloned and characterized in 1990). However, it was not until 1943 that Friedrich Laibach (who had published the chromosome number in earlier proposed *Arabidopsis* as a model organism. His student Erna Reinholz published her thesis on *Arabidopsis* in 1945, describing the first collection of *Arabidopsis* mutants that they generated using x-ray mutagenesis. Laibach continued his research by collecting a large number of ecotypes. With the help of Albert Kranz, these were organized into the current ecotype collection of 750 natural accessions of *A. thaliana* from around the world.

In the 1950s and 1960s John Langridge and George Rédei played an important role in establishing *Arabidopsis* as a useful organism for biological laboratory experiments. Rédei wrote several scholarly reviews introducing this model to the scientific community. The start of the *Arabidopsis* research community dates to a newsletter called *Arabidopsis* Information Service (AIS), established in 1964. The first International *Arabidopsis* Conference was held in 1965, in Göttingen, Germany.

In the 1980s *Arabidopsis* started to become widely used in plant research laboratories around the world. It was one of several candidates that included maize, petunia, and tobacco. The latter two were attractive since they were easily transformable with current technologies, while maize was a well established genetic model for plant biology. The breakthrough year for *Arabidopsis* as the preferred model plant came in 1986 when T-DNA mediated transformation was first published and this coincided with the first gene to be cloned and published.

Characterized ecotypes and mutant lines of *Arabidopsis* serve as experimental material in laboratory studies. The most commonly used background lines are L*er*, or Landsberg erecta, and Col, or Columbia. Series of mutants, named L*er*-x, Col-x, have been obtained and characterized; mutant lines are generally available through stock centers, of which best known are the NASC and the *Arabidopsis* Biological Resource Center in Ohio, USA. The Col or Columbia ecotype was selected, as an agronomically performant line, by Rédei, within a (nonirradiated) population of seeds named Landsberg he received from Laibach. Columbia is the ecotype sequenced in the *Arabidopsis* Genome Initiative. The L*er* or Landsberg erecta line was selected by Rédei from within a Landsberg population on which he had performed some X-ray mutagenesis experiments.

Curiosity Kit with five known *Arabidopsis* mutants

Today you will be identifying five *Arabidopsis* mutants based on your examination or comparison with the wild type (L*er*, Landsberg erecta). The mutants include the following:

1) brevipedicellus- short, downward-pointing flowers and a compact inflorescence architecture
2) eceriferum- brighter green stems and siliques
3) chlorina- pale green in color, plant does not produce Chlorophyll b
4) clavata- excess undifferentiated cells in the shoot and floral meristem, bigger shoot meristems
5) glabra- trichomes absent

Identify the mutants above and present your answers to Hughey for confirmation that you matched them accurately.

Most of the above text was taken verbatim from the following resource:
http://en.wikipedia.org/wiki/Arabidopsis_thaliana, accessioned online 2011 April 5.

Washington Park Fungi

Kingdom Fungi
Phylum- Basidiomycota
Class- Basidiomycetes (Hymenomycetes)
Order- Agaricales
Agaricus hondensis
Amanita ocreata- death angel, or destroying angel.
Amanita phalloides- death cap.
Boletus zelleri
Chroogomphus vinicolor
Clitocybe nuda
Cortinarius sp.
Dermocybe phoenicea
Dermocybe sanguinea
Gymnopilus ventricosus
Hebeloma crustuliniforme- poison pie.
Hygrophoropsis aurantiaca
Hygrophorus subalpinus
Lactarius fragilis
Lactarius xanthogalactus
Naematoloma fasciculare- sulfur tuft.
Russula albidula- white cap.
Russula emetica- red cap.
Suillus caerulescens
Suillus granulatus
Suillus tomentosus
Order- Aphyllophorales
Crytoporus volvatus- cryptic globe fungus.
Laetiporus sulphureus
Stereum hirsutum
Trametes versicolor- turkey tail.
Trichaptum abietinus- violet-pored bracket fungus.
Order- Tremellales
Tremella mesenterica
Phylum- Ascomycota
Class- Ascomycetes
Order- Pezizales
Helvella lacunosa

Lichens- symbiotic fungi that contain a fungal component, mycobiont (basidomycete and ascomycete) and a photosynthetic component, the photobiont (green algae or cyanobacterium). They are photosynthetic.

Fruticose- *Ramalina farinacea, R. menziesii, Usnea arizonica, U. rubicunda, Hypogymnia imshaugii, Evernia prunastri*.
Foliose- *Peltigera canina, Xanthoparmelia, Parmotrema chinense.*
Crustose- *Xanthoria elegans, Caloplaca, Rhizocarpon, Chrysothrix candelaris, Xanthoria tenax.*

Checklist of some seaweeds from Monterey, California

Kingdom Plantae

Phylum Anthophyta- flowering plants.

Class Monocotyledones- monocots.

Phyllospadix scouleri- surf grass.

Kingdom Protista

Phylum Chlorophyta- green algae.

Grass green in color.

Chaetomorpha linum- no common name.
Cladophora columbiana- no common name.
Codium fragile- dead man's fingers.
Enteromorpha intestinalis- no common name.
Ulva lactuca- sea lettuce.

Phylum Heterokontophyta- heterokonts.

Class Phaeophyceae- brown algae.

Yellow, brown, to black in color due to carotenoid (fucoxanthin) and tannins.

Costaria costata- no common name.
Egregia menziesii- feather boa.
Fucus gardneri- rock weed.
Laminaria setchellii- no common name.
Macrocystis pyrifera- kelp.
Nereocystis luetkeana- bull-whip kelp.
Pelvetiopsis limitata & P. arborescens- no common names.
Silvetia compressa- no common name.

Phylum Rhodophyta- red algae.

Green, brown, black, blue, and red in color.

Calliarthron cheilosporioides- coralline algae.
Calliarthron tuberculosum- coralline algae.
Chondracanthus corymbiferus- turkish towel.
Chondracanthus exasperatus- turkish towel.
Corallina officinalis- no common name.
Corallina vancouveriensis- coral weed.
Endocladia muricata- sea moss.
Mastocarpus jardinii- no common name.
Mastocarpus papillatus- turkish washcloth.
Mazzaella flaccida- no common name.
Mazzaella oregona- no common name.
Mazzaella splendens- no common name.
Microcladia coulteri- no common name.
Palmaria mollis- dulse.
Pyropia perforata- nori.
Prionitis andersonii- bleach weed.
Prionitis lyallii- bleach weed.
Prionitis sternbergii- bleach weed.

How To Press Marine Algae

blotter paper
cardboard
wax paper
seaweed
herbarium paper
blotter paper
cardboard

Gymnosperms of Hartnell College

Kingdom Plantae- ginkgos, conifers, gnethophytes, cycads.

Phylum- Coniferophyta

Family- Podocarpaceae

Species- Afrocarpus gracilior

Common name- fern pine.

Family- Taxaceae

Species- Taxus brevifolia

Common name- yew tree.

Family- Cupressaceae

Species- Cupressus macrocarpa

Common name- monterey cypress.

Species- Juniperus chinensis

Common name- chinese juniper.

Species- Thuja occidentalis

Common name- american arborvitae or eastern white cedar.

Species- Sequoia sempervirens

Common name- redwood.

Family- Pinaceae

Species- Pinus densiflora

Common name- japanese red pine.

Species- Pinus densiflora 'umbraculifera'

Common name- tanyosho pine.

Species- Pinus canariensis

Common name- canary islands pine.

Species- Pinus radiata

Common name- monterey pine.

Species- Picea pungens

Common name- colorado blue spruce.

Species- Larix decidua

Common name- larch.

Species- Abies alba

Common name- European silver fir.

Phylum- Ginkgophyta

Family- Ginkgoaceae

Species- Ginkgo biloba

Common name- maidenhair tree.

Phylum- Cycadophyta

Family- Cycadaceae

Species- Cycas revoluta

Common name- sago palm.

Respresentative Angiosperms of Hartnell College

Kingdom Plantae
Phylum- Anthophyta
Class- Eudicotyledones
Family- Hamamelidaceae
Species- Liquidambar styraciflua
Common name- sweetgum tree
Family- Betulaceae
Species- Alnus rhombifolia
Common name- white alder
Family- Sterculiaceae (chocolate family)
Species- Brachychiton diversifolius
Common name- bottle tree
Family- Apocyanaceae
Species- Trachelospermum jasminoides
Common name- star jasmine
Family- Fabaceae (Leguminosae)
Species- Robinia ambigua
Common name- purple locust
Family- Oleaceae
Species- Olea europea
Common name- olive tree
Family- Myrtaceae
Species- Melaleuca quinquenervia
Common name- paperbark tree
Species- Eucalyptus polyanthemos
Common name- silver dollar gum
Family- Celestraceae
Species- Maytenus boaria
Common name- mayten tree
Family- Rosaceae
Species- Prunus serrulata
Common name- flowering cherry
Species- Prunus blireana
Common name- purple leaf plum
Species- Pyrus kawakamii
Common name- evergreen pear
Species- Rosa sp.
Common name- rose
Species- Rhaphiolepis indica
Common name- India Hawthorn
Species- Photinia serrulata
Common name- red tips
Family- Magnoliaceae
Species- Magnolia grandiflora
Common name- southern magnolia.
Family- Fagaceae
Species- Quercus ilex
Common name- holly oak
Family- Berberidaceae
Species- Nandina domestica
Common name- heavenly bamboo.
Family- Lauraceae
Species- Cinnamomum camphora
Common name- camphor tree
Family- Solanaceae
Species- Solanum aviculare
Common name- kangaroo apple
Family- Malvaceae
Species- Zauschneria californica
Common name- California fuchsia.

Family- Pittosporaceae
Species- Pittosporum undulatum
Common name- sweet Pittosporum
Family- Araceae
Species- Philodendron selloum
Common name- lacy Philodendron
Family- Araliaceae
Species- Fatsia japonica
Common name- fatsi
Family- Elaeagnaceae
Species- Elaeagnus pungens
Common name- silverthorn
Family- Asteraceae
Species- Senecio cineraria
Common name- dusty miller
Family- Salicaceae
Species- Xylosma congestum
Common name- shiny Xylosma
Family- Caprifoliaceae
Species- Abelia grandiflora
Common name- glossy Abelia
Family- Theaceae
Species- Camellia japonica
Common name- Japanese Camellia
Family- Lamiaceae
Species- Salvia leucantha
Common name- Mexican sage
Family Geraniaceae
Species- Pelargonium hortorum
Common name- geranium
Family Verbenaceae
Species- Lantana montevidensis
Common name- trailing Lantana

Class- Monocotyledones
Family- Liliaceae
Species- Cordyline australis
Common name- cabbage palm
Family- Arecaceae
Species- Trachycarpus fortunei
Common name- windmill palm
Family- Strelitziaceae
Species- Strelitzia reginae
Common name- bird of paradise
Family- Agapanthaceae
Species- Agapanthus africanus
Common name- lily of the nile
Family- Asparagaceae
Species- Asparagus densiflorus
Common name- asparagus fern
Family- Araceae
Species- Zantedeschia aethiopica
Common name- calla lily
Family- Strelitziaceae
Species- Strelitzia reginae
Common name- bird of paradise
Family- Alliaceae
Species- Tulbaghia violacea
Common name- society garlic

Biology 3, General Botany **Name _____**

Lecture Examination

1-20. Multiple Choice. Select the single best possible answer for each question.

1. Global oxygen production from photosynthesis _____.
   a. comes mainly from marine cyanobacteria, namely Synechococcus and Synechocystis
   b. comes mostly from terrestrial systems
   c. comes mainly from the rainforest
   d. comes mainly from the pine trees in North America
   e. comes mainly from a singing bush from Soledad named 'Fredericq'

2. Which of the following is not true of Euglenozoa?
   a. they contain chlorophylls A and B, plus carotenoids
   b. about ½ of the species are autotrophic and about ½ of the species are heterotrophic
   c. they are unicellular
   d. they have a eukaryotic nucleus
   e. they have a proteinaceous pellicle

3. The increase in oxygen from photosynthesis _____.
   a. led to the formation of ozone about 2.5 billion years ago
   b. led to the formation of an aerobic atmosphere
   c. led to the appearance and proliferation of eukaryotic cells about 2.1 billion years ago
   d. is responsible for the biological revolution
   e. all of the above

4. Phytoremediation is _____.
   a. an intervening agency that solves disputes between arguing plant species
   b. a plant structure that produces spermatia
   c. the treatment of pollutants or waste by the use of plants to break down undesirable substances
   d. the substrate or foundation to which an organism is attached
   e. a bundle of microtubules that extends from kinetochores of cells

5. Which of the following is not true of medicine and plants?
   a. 80% of the medicine on the market is derived directly from plants
   b. drugs made from fungi prevent the rejection of transplanted hearts and other organs
   c. the active ingredient in aspirin was originally derived from willow bark
   d. a compound found in the Pacific yew tree assists in the treatment of some cancers
   e. Ginkgo biloba is prescribed for depression, mental weakness, memory loss, and other ailments

6. A mutualistic association between the roots of plants and fungi is termed _____.
   a. haustoriosis
   b. plasmodesmata
   c. parasitism
   d. endosymbiosis
   e. mycorrhizae

7. Which of the following is not true of Carol von Linné?
   a. he is Swedish
   b. he wrote '*Systema Naturae'* and '*Species plantarum'*
   c. he is considered the father of classification
   d. he studied under his mentor Aristotle
   e. he used a binomial naming system

8. Which of the following is false in regards to fungi?
   a. most are composed of hyphae
   b. they function as decomposers
   c. they have a cell wall that is predominantly made of chitin
   d. they reproduce sexually and asexually
   e. they are photosynthetic

9. Which of the following was not one of Theophrastus's four classifications of plants?
   a. herb
   b. shrub
   c. undershrub
   d. fern
   e. tree

10. What is a stromatolite?
   a. pigments in the stroma of green algae that catalyze the dark reaction
   b. the floating structure in cyanobacteria
   c. a resting spore in cyanobacteria
   d. a rock-like deposition of carbonates and trapped sediments
   e. a thick-walled large cell that fixes atmospheric nitrogen

11. Which of the following is not true of Basidiomycota?
   a. they include Agaricus, Puccinia, and Ustilago
   b. they include the bread molds
   c. they reproduce by forming basidia
   d. they asexually reproduce by budding, conidiospores, and fragmentation
   e. they are nonmotile throughout their life history

12. Cryptophytes _____.
   a. are multicellular
   b. have chlorophylls A and C, as well as phycobilins
   c. have a mesokaryotic nucleus
   d. lack flagella
   e. occur only in freshwater systems

13. Which of the following is not true of Rhodophyta?
   a. they are multicellular
   b. they store floridean starch in the cytoplasm
   c. they have 2 whiplash flagella
   d. they form pit connections
   e. they are predominantly marine

14. The Chrysophyceae _____.
   a. lack flagellated cells
   b. include Acnanthes, Bacillaria, and Navicula
   c. have chlorophylls A and B, and fucoxanthin
   d. are dinoflagellates
   e. are predominantly freshwater and include the genus Dinobryon

15. The phylum Microsporidia is best characterized as _____.
   a. being arbuscular endomycorrhizae
   b. aseptate, endophytic organisms, example- Glomus
   c. fungi that reproduce by forming basidiospores
   d. spore forming unicellular animal parasites that shoot polar tubes into host cells
   e. fungi that reproduce by forming ascospores

16. Cladistics _____.
    a. requires designating an outgroup and ingroup
    b. is a method of organizing organisms on the basis of synapomorphic characters
    c. compares homologous characters
    d. uses morphological, chemical, developmental, and molecular characters
    e. all of the above

17. The brown algae _____.
    a. are predominantly freshwater organisms
    b. use pheromones to attract heterokont male gametes
    c. have thylakoids that occur in stacks of two
    d. are plants
    e. gave rise to the green algae

18. Lichens _____.
    a. contain a mycobiont
    b. reproduce by fragmentation
    c. consist predominantly (90%) of fungal cells
    d. contain a phycobiont
    e. all of the above

19. The Cryptomycota _____.
    a. lack chitin
    b. are unikonts
    c. are ubiquitous
    d. are a newly described fungal phylum
    e. all of the above

20. Some Rhodophyta have a _____ type of life cycle.
    a. triphasic
    b. monophasic
    c. bimodal
    d. heterokontal

21-40. True or False. Mark A on your answer sheet if the statement is true, Mark B if it is false.

21. Identifying, naming, and classifying are all part of the field of taxonomy.
22. Mycology is the study of mosses.
23. All fungi are multicellular and eukaryotic.
24. Fodder is food that is fed to domestic animals.
25. Endospores are asexual spores that result from an internal division of the protoplast.
26. Phylogenetic trees are diagrams that represent a hypothesis of the evolutionary history of a species.
27. Konstantin Mereschkowski and later Lynn Margulis proposed the theory of endosymbiosis.
28. Cyanobacteria are gram negative bacteria.
29. Red algae deposit alginate and cellulose in their cell walls.
30. Dinoflagellates have 2 longitudinal flagella and 1 transverse flagellum.
31. The food reserve in oomycetes, myxomycetes, and dictyosteliomycetes is glycogen.
32. Zooxanthellae are symbiotic dinoflagellates found in some sponges, anemones, and corals.
33. Secondary metabolites are molecules found in all plant cells.
34. Macromolecules are made through a process called dehydration synthesis.
35. Triglycerides consist of a phosphate group, glycerol, and two fatty acid tails.
36. Cryptophyta contain chlorophylls A and B, and carotenoids.
37. The outer shell of a haptophyte is termed the ‘amphisema’.
38. Phytophthora is a plant pathogen that causes sudden oak death and attacks potatoes.
39. Dictyosteliomycota form slugs that aggregate through attraction of the biomolecule cyclic AMP.
40. Algae are currently being studied for their potential use as a source for biodiesel.

41-45. Match the definitions on the right to the terms on the left.

41. Taxon	a. a taxonomic group of any rank
42. Synonym	b. the original name of a taxon
43. Etymology	c. the derivation, origin, or history of a word
44. Basionym	d. two or more names that apply to the same taxon
45. Type specimen	e. the original collection from which a species is based

46-53. Match the phyla on the right to the traits on the left.

46. Form slugs
47. Streaming protoplasm, no cell wall
48. Physarum
49. No flagella
50. Causes sudden oak disease
51. Caused the Irish potato famine of 1846-47
52. Form sclerotia
53. The main body is called a plasmodium

a. Myxomycota
b. Dictyosteliomycota
c. Oomycota

54-60. Match the taxonomic group on the right to the characteristics or genera on the left.

54. Sporic meiosis, isomorphic, aseptate
55. Forms an ascus
56. Agaricus, gilled or pored mushrooms
57. Rhizopus
58. Soft molds, found on bread and fruits
59. Perforated septae
60. Dolipore septae

a. Chytridiomycota
b. Zygomycota
c. Basidiomycota
d. Ascomycota

61-69. Match the phylum or class on the right to the characteristics on the left.

61. Causes most red tides, peridinin pigment present
62. Paramylon, chlorophylls A & B, mesokaryotic nucleus
63. Prymnesium, $CaCO_3$ scales, coccoliths
64. Chlorophylls A & C, silica cell wall, frustules
65. No cell wall, phycobilins, both flagella with hairs, nucleomorph
66. Proteinaceous pellicle with S-shaped, overlapping segments
67. Haptonema
68. Paraflagellar swelling and eyespot (=stigma) used to detect light
69. Bioluminescent, Noctiluca

a. Euglenozoa
b. Cryptophyta
c. Haptophyta
d. Bacillariophyceae
e. Myzozoa

70-78. Match the phylum or class on the right to the characteristics or names on the left.

70. Synura and Dinobryon
71. Coleochaete, Ulva, diverse flagella, 17,000 species
72. Kelps, rockweeds
73. Chlorophylls A & D, phycobilins
74. Chlorophylls A & B, carotenoids
75. Gave rise evolutionarily to land plants (bryophytes)
76. Alginate in cell walls, predominantly marine, multicellular
77. Non-motile (no flagella) and pit connections present
78. Golden brown algae

a. Rhodophyta
b. Chlorophyta
c. Phaeophyceae
d. Chrysophyceae

79-85. Match the type of meiosis on the right to the organism on the left.

79. Allomyces, chytrid
80. Rhizopus, bread mold
81. Coprinus, basidiomycete mushroom
82. Saprolegnia, oomycete water mold
83. Physarum, typical plasmodial slime mold
84. Ulva, see lettuce
85. Fucus, rockweed

a. isomorphic, sporic
b. heteromorphic, sporic
c. gametic
d. zygotic

86-150. Short and long answer questions.

86. What is an Egyptian papyrus? _____

87-88. What are 4 diagnostic differences between eukaryotes and prokaryotes?

89-90. What are 3 diagnostic differences between Domains Bacteria and Archaea?

91-93. Illustrate (draw), name, and give an example of the four diatom forms.

94-96. Describe and illustrate the nitrogen cycle. Include the 3 principal stages of the cycle as well as the chemistry.

97-102. What are the four primary metabolites (macromolecules) and what are their functions? Give examples of each and illustrate their chemistry.

103-108. What are the 3 major secondary metabolites found in plants, and what are examples of each? Also illustrate their chemistry and list their functions in the space below.

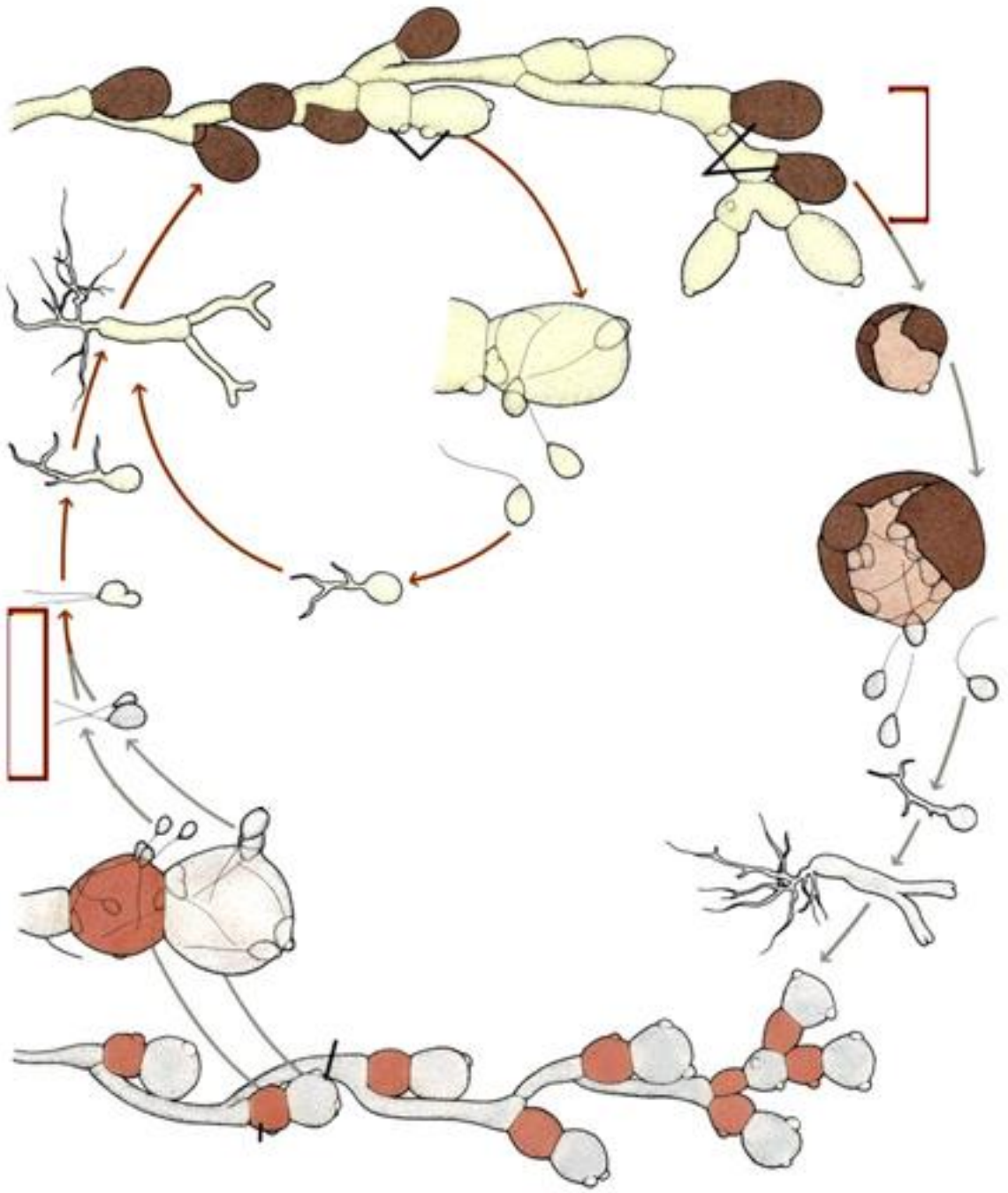
109-110. Beginning with the largest taxonomic unit, place the following in correct hierarchical order:
phylum, domain, order, genus, species, kingdom, family, class, subspecies

111-114. What are 5 key evolutionary similarities between the green algae and land plants?

115-117. How do humans use plants? (List 6 uses)

118-123. In as much detail as Jeff's lecture or your textbook, illustrate and label the life history of *Agaricus* (=a typical basidiomycete), *Saprolegnia* (= water mold) or *Ulva* (= sea lettuce). Select only one.

124-128. For the Allomyces life cycle below, label all of the processes, structures, and generations.



129-132. Illustrate and label the current hypotheses that explains how the first prokaryotic cells formed.

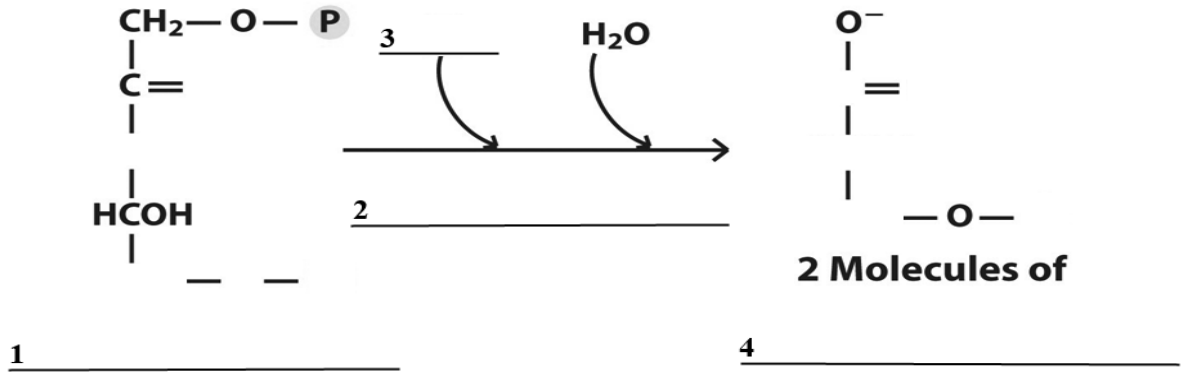
133-138. Illustrate and label the primary endosymbiotic event that gave rise to the type of chloroplast found in Chlorophyta, Rhodophyta, and land plants. Below that, list three pieces of information or data that support the endosymbiotic hypothesis.

139-142. Construct a phylogeny of the superkingdoms, as outlined in the lecture. Include the names of the organisms that that we discussed, that fit into each of these superkingdoms:

Alveolata, Amoebozoa, Archaeplastida, Excavata, Hacrobia, Opisthokonta, Rhizaria, Stramenopila

143-146. Illustrate and label the light dependent reaction (Z-scheme). Include in your illustration water photolysis and the location of this series of reactions.

147-150. Below is the C3 carbon fixation reaction. Label the 4 molecules and/or enzymes on the lines below as well as fill-in the missing atoms in the molecules.



Biology 3, General Botany **Name _____**

Lecture Examination

1-25. Multiple Choice. Select the single best possible answer for each question.

1. In vascular plants the _____ dominates the life history and produces _____.
   a. gametophyte, gametes
   b. gametophyte, spores
   c. sporophyte, gametophytes
   d. sporophyte, spores
   e. none of the above

2. Microsporophylls _____.
   a. are modified leaves that bear microsporangia
   b. are modified leaves that bear megasporangia
   c. are modified roots that bear microsporangia
   d. are modified roots that bear megasporangia
   e. are modified stems that bear microsporangia

3. The Equisetopsida _____.
   a. includes horsetails
   b. are homosporous
   c. have whorled leaves
   d. have ribbed and jointed stems
   e. all of the above

4. Which of the following is not true of the angiosperm life history?
   a. it involves a dominant gametophyte generation
   b. it involves a megagametophyte and microgametophyte
   c. it includes an embryo with polar nuclei, antipodals, egg cell, and synergids
   d. it involves double fertilization
   e. it involves pollination

5. Cycadophyta _____.
   a. contain vessel elements
   b. lack motile sperm
   c. have needlelike and scalelike leaves
   d. germinate a pollen tube that does not fuse with the egg cell
   e. are the most diverse gymnosperms (contain the most species)

6. Gnetophyta _____.
   a. contain tracheids and vessel elements
   b. lack motile sperm
   c. germinate a pollen tube that fuses directly with the egg cell
   d. are considered the most evolutionarily advanced gymnosperm group
   e. all of the above

7. The apical meristem in angiosperms _____.
   a. is a region at the tip of shoots and roots that is responsible for programmed cell death
   b. is a region at the tip of shoots and roots that forms new cells
   c. is a region at the tip of shoots and roots that is responsible for ethylene synthesis
   d. is a region at the tip of shoots and roots that is used to sense circadian rhythms
   e. is a region at the tip of shoots and roots that detects photonic energy

8. Which of the following is not a fleshy fruit?
   a. berry
   b. pepo
   c. pome
   d. nut
   e. drupe

9. Seed germination is dependent on _____.
   a. temperature
   b. light
   c. water
   d. hormones
   e. all of the above

10. Which of the following is not an evolutionary trend among flowers?
   a. flowers have gone from radial (actinomorphic) to bilateral (zygomorphic) symmetry
   b. floral parts have become fused
   c. floral axes have become shortened
   d. carpels have gone from pistil-shaped and sealed to leaflike and incompletely closed
   e. ovaries have gone from superior to inferior in position

11. Selaginella _____.
   a. is heterosporous
   b. has a dominant sporophytic and short lived gametophyte generation
   c. requires water for fertilization to be successful
   d. is classified in the phylum Lycopodiophyta
   e. all of the above

12. Which of the following is not true of the Pinus life cycle?
   a. pine trees contain megastrobili and microstrobili
   b. meiosis yields 4 megaspores of which only 1 is functional
   c. fertilization occurs shortly after the pollen grain embeds within the micropyle
   d. microsporangia are found on microsporophylls
   e. the pollen tube fuses with the egg cell

13. Which of the following is not involved in flower pollination?
   a. bees
   b. bats
   c. beetles
   d. birds
   e. reptiles

14. The epicotyl _____.
   a. is the fruit wall, which develops from the wall of the ovary
   b. is the first bud of an embryonic shoot
   c. is the stemlike axis above the cotyledons
   d. is a stemlike axis below the cotyledons
   e. is an undistinguished radicle

15. With reference to seed germination, epigeous is used to describe _____.
   a. cotyledons that are carried above ground level
   b. cotyledons that remain underground
   c. cotyledons that are fleshy
   d. cotyledons that are photosynthetic
   e. cotyledons that wither away below ground level

16. Eusporangia _____.
    a. develop from more than one superficial initial
    b. develop from one superficial initial
    c. are protected by an annulus
    d. catapult their spores when the lip cells of the wall crack
    e. none of the above

17. The evolution of large leaves with many veins involves a transformation from microphylls to megaphylls. This hypothesis is known as the _____ theory.
    a. stele
    b. telome
    c. systems
    d. tracheary
    e. branch

18. Heterosporous is defined as _____.
    a. a plant that produces two types of spores from two different types of sporangia
    b. a plant that produces two types of spores from one kind of sporangium
    c. a plant that produces three types of spores from two different kinds of sporangia
    d. a plant that produces one type of spore from one kind of sporangium
    e. none of the above

19. Which of the following is not extinct?
    a. Rhyniophyta
    b. Bennettitales
    c. Trimerophytophyta
    d. Zosterophyllophyta
    e. Monilophyta

20. Plant seed dispersal is aided by _____.
    a. the wind
    b. attaching to animals
    c. floating on water
    d. being fleshy and thus eaten by animals
    e. all of the above

21. Which of the following is <u>not true</u> of plants?
    a. they are mostly autotrophic
    b. they are primarily terrestrial
    c. they have the same photosynthetic pigments as the green algae
    d. they are multicellular
    e. they store starch reserves outside the chloroplast

22. Marchantiophyta _____.
    a. require water for fertilization
    b. lack specialized conducting tissue
    c. have rhizoids that are single celled
    d. includes <u>Marchantia</u> and <u>Riccia</u>
    e. all of the above

23. Which of the following is <u>not true</u> of the granite mosses (<u>Adreaeidae</u>)?
    a. they grow in mountainous or arctic regions on rocks
    b. their capsules dehisce in rows of two
    c. protonema have two or more rows of cells
    d. the rhizoids have two rows of cells
    e. they are classified in the phylum Bryophyta

24. The moss life cycle _____.
    a. is a sporic meiosis
    b. includes archegonia and antheridia
    c. includes protonemata
    d. requires karyogamy and plasmogamy
    e. all of the above

25. The sporophyte generation in bryophytes _____.
    a. is matrotrophic and short lived (6-16 weeks)
    b. has rhizoids
    c. produces biflagellated spores
    d. consists of haploid tissue
    e. is dominant

26-43. True or False. Mark A on your answer sheet if the statement is true, Mark B if it is false.

26. Xylem conducts water and minerals.
27. Sporophylls are modified roots that contain sporangia.
28. Bird pollinated flowers produce copious nectar.
29. Bird pollinated flowers are usually bright red and yellow in color.
30. Flowers are the reproductive structures of gynosperms.
31. Flowers are determinate shoots that bear sporophylls.
32. Coevolution is the simultaneous evolution of adaptations in 2 or more interacting populations.
33. Insect pollination is more efficient than passive pollination.
34. Bird pollinated flowers are aromatic (they produce lots of odor).
35. Ovules are structures in seed plants that contain the male gametophyte.
36. There are an estimated 9,000-9,500 species of angiosperms on the planet.
37. Primary growth is defined as the formation of secondary tissues.
38. The radicle is the embryonic leaf.
39. Endosperm is tissue that contains stored food.
40. Corn seeds are exalbuminous.
41. Mosses are classified in the kingdom Plantae.
42. Water is required for fertilization in liverworts.
43. The moss sporophyte is nutritionally dependent on the female gametophyte.

44-49. Match the phylum or class on the right to the characteristics or names on the left.

44. Rhizoids multicellular
45. Thalloid thallus, intercalary meristem, single chloroplast
46. Thalloid and leafy, elaters present
47. Leptoids and hydroids
48. Gemmae present
49. Pores for gas exchange

a. Anthocerotophyta
b. Marchantiophyta
c. Bryophyta

50-57. Match the tissue type on the right to the cells on the left.

50. Sieve cells
51. Parenchyma cells
52. Sclerenchyma cells
53. Companion cells
54. Periderm and epidermis
55. Tracheids
56. Collenchyma cells
57. Vessel elements

a. Ground tissue
b. Vascular tissue
c. Dermal tissue

58-60. Match the definition on the right to the term on the left.

58. Hypogynous — a. whorls attached below the ovary
59. Perigynous — b. whorls attached above the ovary
60. Epigynous — c. stamens and petals adnate to the calyx, forming a tube at the base of the ovary

61-63. Match the fruits to the placentation types below.

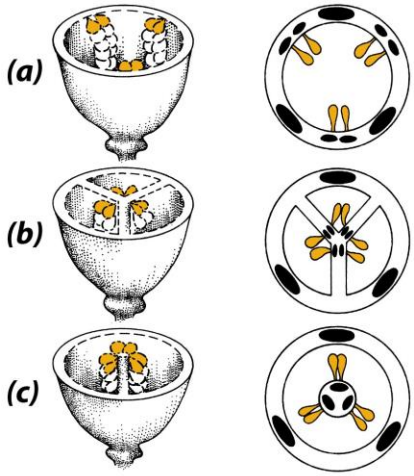


Figure 19-9
Biology of Plants, Seventh Edition

61. Axile
62. Parietal
63. Free central

64-77. Match the phylum on the right to the characteristic on the left.

64. Flowerlike reproductive structures
65. Metasequoia and Wollemia
66. One genus and one species
67. Its members have tracheids and vessel elements
68. Sperm multiflagellated with about 40,000 flagella
69. Needlelike leaves
70. Maidenhair tree, once thought to be extinct
71. Palmlike leaves
72. Scalelike, leaflike, broad and leathery leaves
73. Cycas and Zamia
74. 70 genera & 630 species
75. Pinus
76. Ovulate and microsporangiate cones on same plant; ovulate cones compound
77. Ovulate and microsporangiate cones on separate plants; fleshy-coated seeds

A) Ginkgophyta
B) Cycadophyta
C) Gnetophyta
D) Coniferophyta

78-86. Match the taxonomic group on the right to the characteristics on the left.

78. Flower parts in 4s and 5s
79. Flower parts in 3s
80. Vascular bundles in stem form a ring
81. Pollen- triaperturate
82. Vascular cambium present
83. Two cotyledons present
84. Leaf venation is netted
85. Grasses, lilies, irises, orchids, cattails, palms
86. Trees, shrubs, herbs

a. Eudicotyledones- eudicots
b. Monocotyledones- monocots

87-91. Match the definition on the right to the fruit related term on the left.

87. Ovule	a. the enlarged basal portion of a carpel
88. Carpel	b. mature ovary
89. Ovary	c. the vessel that encloses the ovule/s
90. Fruit	d. mature ovule
91. Seed	e. the structure that contains the female gametophyte with egg cell, including the nucellus and integuments

92-96. Match the definition on the right to the developmental term on the left.

92. Protoderm	a. forms epidermis of the plant
93. Procambium	b. regions of tissue at the tip of shoots and roots that forms new cells
94. Ground meristem	c. positioned between the two embryonic leaves in eudicots
95. Apical Meristem	d. forms vascular tissue of the plant
96. Shoot Apical Meristem	e. forms ground tissue of the plant

97-100. Match the characteristics on the left to the correct taxonomic group on the right.

97. Megaphylls, leptosporangiate, sori present	a. Psilotales, Psilotum
98. Homosporous, no roots, dichotomously branched	b. Polypodiopsida, Polypodium
99. Microphylls, sporophylls on strobili, club moss	c. Lycopodiophyta, Lycopodium
100. Sporangiophores, homosporous, horsetails	d. Equisetopsida, Equisetum

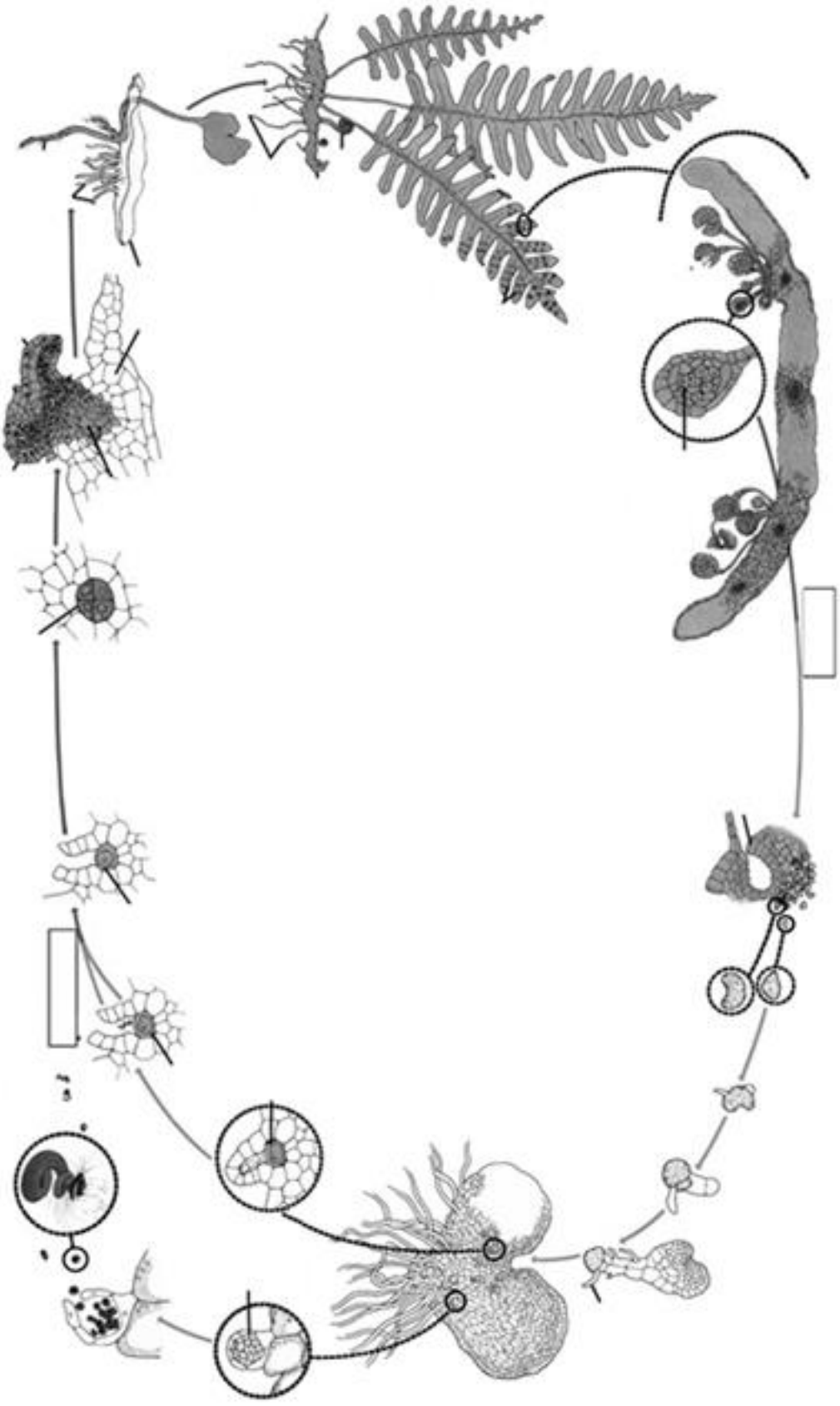
101-110. Match the description on the right to the correct taxonomic group on the left. Write your answer in the space provided on the left.

_____ 101. Coniferophyta	a. requires water for fertilization
_____ 102. Monilophyta	b. does not require water for fertilization
_____ 103. Ginkgophyta	
_____ 104. Rhyniophyta	
_____ 105. Eudicotyledones	
_____ 106. Lycopodiophyta	
_____ 107. Cycadophyta	
_____ 108. Trimerophytophyta	
_____ 109. Gnetophyta	
_____ 110. Anthocerotophyta	

111-115. Match the taxonomic group on the right to the characteristics on the left. Write your answer in the space provided on the left.

_____ 111. Synecium, grow on lime-rich soils	a. Psilotales
_____ 112. Eusporangia in 2 rows, leaves dissected or unbranched	b. Polypodiopsida
_____ 113. Whisk ferns	c. Ophioglossales
_____ 114. Strobilus and whorled leaves	d. Equisetopsida
_____ 115. Larget group of ferns (10,500 species)	e. Marattiopsida

116-125. For the *Polypodium* life cycle below, label <u>all</u> of the processes, structures, and generations.



126-135. Illustrate and label in as much detail as in the lecture or in your textbook, the life history of *Pinus* or *Selaginella*.

136-140. Define, illustrate, and label in as much detail as in the lecture, the three main types of steles. Also list where, and in which plants the stele types are found.

141-145. In the space below, compare leptosporangia to eusporangia.

146-150. In the space below construct a table that compares 10 traits that differ or are similar between the life history of a green alga, moss, gymnosperm, and angiosperm.

Trait	Green Alga	Moss	Gymnosperm	Angiosperm

Study Guide For Final Lecture Examination

1-13. Multiple Choice. Select the single best possible answer for each question.

1. The function of roots is/are _____.
   a. anchorage
   b. absorption of water, minerals, and inorganic ions
   c. conduction
   d. storage
   e. all of the above

2. Root depth and width depends on _____.
   a. soil moisture
   b. soil temperature
   c. soil composition
   d. the species
   e. all of the above

3. Lateral roots arise from the _____.
   a. intercellular spaces
   b. casparian strip
   c. pericycle
   d. epidermis
   e. endodermis

4. Which of the following is not a character Gregor Mendel studied in the garden pea?
   a. flower color
   b. flower position
   c. root length
   d. seed color
   e. pod shape

5. The shoot _____.
   a. is the below ground portion of the plant and consists of stem and leaves
   b. contains a pericycle
   c. contains vascular and ground tissue, but not epidermal tissue
   d. contains stems, leaves, nodes, internodes, and buds
   e. in dicots has scattered vascular bundles

6. Leaf abscission _____.
   a. occurs in evergreen plants
   b. is a normal process resulting from structural and chemical changes
   c. is caused by the formation of four divisional layers that excise the petiole
   d. is instantaneous and occurs before sugars and amino acids are removed from the leaf
   e. none of the above

7. Secondary growth is _____.
   a. defined as an increase in thickness to the plant body
   b. formed by the activity of the vascular, cork, and leaf meristems
   c. defined as an increase in height to the plant body
   d. found in monocots
   e. found in herbaceous dicots

8. The periderm _____.
   a. is the outer tissue that replaces the epidermis as the protective covering of the plant
   b. includes the cork cambium
   c. includes cork, which are cells that are cut toward the outside of the cork cambium
   d. includes phelloderm, which are cells that are cut towards the inside of the cork cambium
   e. all of the above

9. The bristlecone pine _____.
   a. was thought to be extinct, but was recently found growing in Australia
   b. was found in China in the 1940s, but earlier had been described from the fossil record
   c. is considered by some botanists to the be the fastest growing tree alive
   d. is a gnethophyte, not a pine
   e. is thought to be the oldest living tree on the planet, at about 4,900 years old

10. Which of the following is not a criterion for judging the essentiality of elements?
   a. if it is needed for the plant to complete its life cycle
   b. if it is part of any molecule or constituent of the plant that is itself essential
   c. if deficiency symptoms appear in the absence of the element
   d. if it occurs in unusually high concentrations in any plant

11. Which of the following is not a macronutrient?
   a. manganese c. carbon e. nitrogen
   b. sulfur d. calcium

12. Tropism _____.
   a. explains the phenomenon of nyctinasty in leaves
   b. is the directional growth in response to an external stimulus
   c. explains the phenomenon of thigmonasty in leaves
   d. is the alteration of plant growth patterns in response to mechanical stimuli
   e. is unrelated to the direction of the external stimulus

13. Auxin is involved in all of the following except:
   a. apical dominance
   b. differentiation and regeneration of vascular tissue
   c. fruit development
   d. preventing abscission
   e. inhibiting the formation of lateral roots

<u>14-22. True or False. Mark A on your answer sheet if the statement is true, Mark B if it is false.</u>

14. Abscisic Acid is responsible for stomatal closure.
15. Silt consists of fragments of rock and minerals that range in size from 2-20 μm.
16. Macronutrients are required in large amounts, which equates to 1 mg/kg of dry matter.
17. Ear length in corn is an example of incomplete dominance.
18. Tomato shape is due to polygenic inheritance.
19. Phloem conducts water and minerals.
20. The radicle is the embryonic shoot.
21. Ethylene delays leaf senescence.
22. Cytokinins inhibit cell division in plant shoots.

<u>23-27. Match the hormone on the right to its function or action on the left.</u>

23. Apical Dominance	a. Auxins
24. Breaking seed dormancy	b. Cytokinins
25. Fruit ripening	c. Ethylene
26. Responsible for stomatal closure	d. Abscisic acid
27. Promote cell division	e. Gibberellins

28-32. Match the definition on the right to the plant structure on the left.

28. Corm — a. stems that grow horizontally on the soil surface, giving rise to new plants at the nodes
29. Stolons — b. enlarged, short, fleshy underground stem, forms at the tip of a rhizome
30. Rhizome — c. thickened underground stem with small papery leaves
31. Tuber — d. shortened underground stem covered by enlarged fleshy storage leaves
32. Bulb — e. horizontal stem that grows at or below the soil surface

33-37. Match the term on the right to its definition on the left.

33. An organism's traits — a. Homozygous
34. An organism's genetic makeup — b. Heterozygous
35. Identical alleles for a gene — c. Phenotype
36. Two different alleles for a gene — d. Genotype
37. Position on a chromosome occupied by a gene — e. Locus

38. Ecology _____.
    a. deals with the impact of humans on the environment
    b. is the study of the interactions between organisms and their environment
    c. is the study of natural resources
    d. is the study of classification
    e. none of the above

39. Which of the following two words best describes ecology?
    a. mortality and herbivory
    b. reproduction and biosynthesis
    c. distribution and abundance
    d. obligate and facultative
    e. hans and franz

40. Which of the following levels is <u>not</u> typically dealt with by ecologists?
    a. individual
    b. population
    c. community
    d. ecosystem
    e. all of the above are typically studied by ecologists

41. Biotic factors _____.
    a. are biological
    b. include competition for space
    c. include competition for light
    d. include herbivory
    e. all of the above

42. Succession _____.
    a. is a process in biology that involves humankind's cultural heritage
    b. is the component of the environment created by humans
    c. is a predictable process of recovery that occurs after a disturbance
    d. is an evolutionary hypothesis derived from genetic data
    e. none of the above

Short answer questions

In the spaces below list 5 abiotic and 2 biotic factors.

Abiotic- _____, _____, _____

_____, _____,

Biotic- _____, _____

Define the principle of competitive exclusion.

In the space below draw and label the trophic levels found in a typical food chain/web.

Describe the difference between r-selected and K-selected species. In your answer, include a table comparing 6 differences outlined in class between the two types of species.

In the space below, illustrate and label the logistic and exponential growth curves. Include the two formulas for each.

List six types of symptoms found in plants that have nutrient deficiencies.

Scientific Method Laboratory

Be able to:
-Define the scientific method
-Describe 1 everyday situation and 1 botanical example of how the scientific method is used
-Outline the 4 major steps to the scientific method
-List and define the 3 variables defined in all experiments
-Write a hypothesis, experiment, and define the variables of an experiment given a mock experiment
-Name and define the 4 major biological theories

Microscopes Laboratory

What did the spectacle maker from Holland, Zacharias Janssen construct in 1595 AD? Describe it.
The English scientist _____ described and named _____ in his 1665 publication in *Micrographia*.
What is Antony Van Leeuwenhoek (1632-1723) known for?
Define magnification and resolution.
What is parfocal?
Be able to identify all of the parts of the microscope as well as list their functions. The parts are: light source, condenser, condenser knob, stage, iris diaphragm, objective lens, nosepiece (turret), eyepieces, stage clips, coarse-adjustment, fine-adjustment, base, arm.
Be able to:
-Distinguish between a dissecting microscope and a compound microscope, and list 3 reasons why you know this
-Calculate total magnification on the compound microscope
-Calculate the field of view given an equation and some numbers
-Convert from mm to µm, and from µm to mm

Exit Quiz, Microscopes BIO 3
What type of microscope is this? _____
List 3 reasons for your answer above:
_____, _____, _____

What are the names and functions of the labeled microscope parts?

	Structure	Function
A)	_____	_____
B)	_____	_____
C)	_____	_____
D)	_____	_____
E)	_____	_____
F)	_____	_____

Given this equation and numbers, what is the field of view at 40X in µm? Show your work below.

Magnification A= 4, diameter of A= 4.25 mm

$$\frac{\text{Magnification A}}{\text{Magnification B}} \times \text{diameter A (mm)} = \text{diameter B (mm)}$$

Biochemistry Laboratory Study Guide

At the end of today's lab you should be able to:
-describe the four methods used in this lab to identify the macromolecules
-identify primary and secondary metabolites based their chemistry (i.e. by looking at their chemistry you should be able to identify a chemical structure as a carbohydrate, nucleic acid, protein, lipid, alkaloid, phenolic, or terpenoid)

Systematics Laboratory Part I Study Guide

At the end of today's lab you should be able to: Write and use a dichotomous key

Systematics Laboratory Part II Study Guide

At the end of today's lab you should be able to: Construct cladograms given a data matrix

Cyanobacteria Laboratory

Phylum Cyanobacteria (Topic 11)
Using a microscope be able to identify the following genera, also be able to recall the name of the phylum they are classified to (Phylum= Cyanobacteria): *Aphanothece (*see Wasserbluthe slide*), Anabaena, Gloeocapsa, Spirulina, Nostoc, Stigonema, Scytonema, Lyngbya, Oscillatoria.* You should also be able to name the habit (unicell, colony of unicells, trichome, many trichomes in large sheath, uniseriate branched filament, multiseriate branched filament, pseudo-branched filament) of each of these genera.
Be able to identify and list the function of the following: heterocyst, akinete, and hormogonia.
Be able to identify the cytology of a cyanobacterium as illustrated on figure 11.9 of your lab manual: mucilaginous sheath, cyanophycean granules, thylakoids, cytoplasm, and cell wall.
Be able to list the photosynthetic pigments of a cyanobacterium.

Fungi Part 1 Laboratory Topic 12

Phylum Chytridiomycota
Be able to identify *Allomyces* to genus and phylum. You should also be able to identify if the specimen of *Allomyces* on a given slide represents the gametophyte or sporophyte phase, and the chromosomal state of the phase, gametophytes are haploid (=N) and sporophytes are diploid (=2N). Know where meiosis and mitosis occur in the life history, and that this is a sporic meiosis.

Be able to identify and define the following terms: coenocytic, aseptate, zygote, anisogamous, isogamous, oogamous, gametangium, sporangium, zoospore, gametes, karyogamy, plasmogamy, mycology, mycelium.

Phylum Zygomycota
Be able to identify *Rhizopus* to genus and phylum. You should also be able to identify if the specimen of *Rhizopus* on the slide represents the gametophyte (N) or sporophyte (2N). Know where meiosis and mitosis occur in the life history, and that this is a zygotic meiosis.

Be able to identify and define the following terms: sporangium, gametangium, aseptate, zygote, zygosporangium, asexual and sexual reproduction, rhizoids, stolon, and sporangiophore.

Phylum Glomeromycota
Be able to identify *Glomus* to genus and phylum. This slide is simply labeled Endomycorrhizae. It doesn't state it on the slide, but this is the genus *Glomus*. You should know the difference between endomycorrhizae and ectomycorrhizae.

Additional Slides
Ectomycorrhizae. Be able to identify Ectomycorrhizal fungi from the slide.

Fungi Part II Laboratory Topic 12

Phylum Ascomycota- the sac fungi
Be able to identify *Saccharomyces, Schizosaccharomyces, Aspergillus, Penicillium,* and *Peziza* to genus and phylum.

Be able to identify and define the following terms: septate, asci (singular= ascus), ascospores, ascoma (= ascocarp), budding, conidia, and conidiophores. Know that meiosis takes place in the ascus.

Phylum Basidiomycota- the club fungi
Be able to identify *Coprinus, Puccinia,* and *Ustilago* to genus and phylum.

Be able to identify and define the following terms: basidioma (= basidiocarp), basidium, cap (=pileus) and stalk (= stipe) of a mushroom fruiting body. Know that meiosis takes place in the basidium.

Additional Slide
Lichen. Be able to identify the photobiont (= phycobiont) and mycobiont layers/portions of the thallus. Know and be able to identify the three forms of lichens: foliose, fruticose, and crustose.

Additional Materials
Dried lichen specimens, various dried and pickled fungi.

Heterotrophic 'Protista' Laboratory Topics 13 and 14

Phylum Oomycota
Be able to identify *Saprolegnia* and *Plasmopara* to genus and phylum. You should also be able to identify if the specimen of *Saprolegnia* on a given slide represents the haploid (=N) or diploid (=2N) phase. Know where meiosis and mitosis occur in the life history, and that this is a gametic meiosis.

Be able to identify and define the following terms: coenocytic hyphae, antheridium, oogonium, male nuclei, eggs, fertilization tube, zygote, oospores, zoosporangium, zoospore.

Phylum Myxomycota
Be able to identify *Physarum, Stemonitis, Dictydium,* and *Fuligo* to genus and phylum. You should also be able to identify a sclerotium and the two phases of the life history, the diplophase (=2N) and haplophase (=N). Know where meiosis and mitosis occur, and that this is a sporic meiosis.

Be able to identify and define the following terms: plasmodium, sporangium, sclerotium.

Phylum Dictyosteliomycota
Be able to identify *Dictyostelium* to genus and phylum.

Be able to identify and define the following terms: myxamoebas, pseudoplasmodium, slug, sporocarp.

Phylum Myzozoa
Be able to identify *Ceratium* and *Peridinium* to genus and phylum. Also be able to identify living marine dinoflagellates if you saw them on a slide. You should be able to describe their anatomy, epicone and hypocone, two flagella (1 transverse, 1 longitudinal), list their photosynthetic pigments (Chl. A, C, peridinin), and know they have a mesokaryotic nucleus. They show positive phototaxis to dim light.

Phylum Euglenozoa
Be able to identify *Euglena* to genus and phylum. You should be able to identify and define: eyespot (stigma), pellicle, paramylon starch, and know they show positive phototaxis to dim light. List their photosynthetic pigments (Chl. A, B, carotenoids) and know they have a mesokaryotic nucleus.

Note- you should be able to identify these organisms using the prepared slides, dried, pickled or the fresh materials.

Autotrophic 'Protista' Laboratory Topics 13 and 14

Phylum Chlorophyta (Superkingdom Archaeplastida, Kingdom Plantae)
Be able to identify *Chara, Coleochaete, Chlamydomonas, Chlorella, Spirogyra, Volvox, Hydrodictyon, Scenedesmus, Ulothrix, Codium,* and *Ulva* to genus and phylum.

Be able to identify and define the following terms: antheridium (plural- antheridia), oogonium (plural- oogonia), thallus, zygote, isogamous, anisogamous. You should know that the photosynthetic plant pigments for this group are Chlorophylls A, B, and carotenoids. Also, know that most species have flagellated cells (either the cell itself has flagella or the gamete or spore has flagella), and the flagella are of the whiplash (no hairs) type. It is not necessary to learn the other bold terms in your lab manual.

Phylum Rhodophyta (Superkingdom Archaeplastida, Kingdom Plantae)
Be able to identify *Polysiphonia* and *Pyropia* (previously classified as *Porphyra*) to genus and phylum.

Be able to identify and define the following terms: tetrasporophyte (2N free-living), male gametophyte (N free-living), female gametophyte (N free-living), carposporophyte (2N lives on female gametophyte), triphasic life history. You should know that the photosynthetic plant pigments for this group are Chlorophylls A, D, and phycobilins. Red algae do not have flagella. It is not necessary to learn the other bold terms in your lab manual.

Phylum Heterokontophyta (Superkingdom Stramenopila)

Class Phaeophyceae
Be able to identify *Fucus, Laminaria,* and *Undaria* to genus and phylum.

Be able to identify and define the following terms: holdfast (function is attachment), stipe (structural and conduct nutrients), blade (reproduction and photosynthesis), sporophyll (= modified blade that contains sporangia), eggs (=female gamete), sperm (= male gamete), antheridium, cortex, medulla, paraphyses, oogonium, unilocular sporangium, zoospores, sporophyte (2N), gametophyte (N), monoecious (= homothallic) vs. dioecious (= heterothallic). Most have sporic life histories (the kelps), but *Fucus* has a gametic life history. Be able to identify the receptacles and conceptacles in *Fucus*, as well as its midrib. You should know that the photosynthetic plant pigments for this group are Chlorophylls A, C, and fucoxanthin. Brown algae have heterokont flagella, one is whiplash and the other is tinsellated (=hairy). It is not necessary to learn any of the other bold terms in your lab manual, just focus on those in this paragraph.

Class Bacillariophyceae
Be able to identify a diatom if you saw it, and be able to name its phylum. You should also know that the photosynthetic plant pigments for this group are Chlorophylls A, C, and fucoxanthin, and that the shell is called a frustule and is mostly composed of silicon dioxide=glass (SiO_2). Be able to illustrate (= draw) the four diatom forms (centric, pennate, gonoid, trellisoid).

Class Synurophyceae
Be able to identify *Synura* to genus and phylum. You should know that the photosynthetic plant pigments for this group are Chlorophylls A, C, and fucoxanthin.

Note- you should be able to identify these organisms using the prepared slides, dried, pickled, or the fresh materials.

Bryophytes Laboratory Topic 15

Phylum Marchantiophyta
Be able to identify *Marchantia* from a slide, pickled, or fresh material to genus and phylum. You should be able to identify and know the functions of the thallus, female and male gametophytes, gemmae cups, gemmae, rhizoids, air pores, antheridiophore, antheridial head, antheridia, sperm, spermatogenous tissue, sterile jacket, paraphyses, archegoniophore, archegonial head, archegonia, egg, venter, neck canal cells, calyptra, embryo, sporophyte, sporangium (=capsule), spores, seta, foot, placenta, elaters. Meiosis occurs in the sporangium. You should be able to identify the sporophyte (2n) and gametophyte (N) generations. This group has a heterothallic, heteromorphic, sporic alternation of generations.

Phylum Anthocerotophyta
Be able to identify *Anthoceros* from a slide, pickled, or fresh material to genus and phylum. You should be able to identify and know the functions of the female and male gametophytes (some are homothallic), rhizoids, stomata (on sporophyte), spores, sporangium (=capsule), seta, foot, placenta. Meiosis occurs in the elongate horn-like sporangium. You should be able to identify the sporophyte (2n) and gametophyte (N) generations. This group has a heterothallic, heteromorphic, sporic alternation of generations.

Phylum Bryophyta
Be able to identify *Mnium* and *Sphagnum* from a slide, pickled, or fresh material to genus and phylum. You should be able to identify and know the functions of the female and male gametophytes, protonemata, gemmae, rhizoids, stomata, antheridial head, antheridia, sperm, spermatogenous tissue, sterile jacket, paraphyses, archegonial head, archegonia, egg, venter, neck canal cells, calyptra, embryo, sporophyte, sporangium (=capsule), spores, seta, foot, placenta, peristome. Meiosis occurs in the sporangium. You should be able to identify the sporophyte (2n) and gametophyte (N) generations. This group has a heterothallic, heteromorphic, sporic alternation of generations.

Note- you should be able to identify these organisms using the prepared slides, dried, pickled or the fresh materials as stated above.

Lycopodiophyta Laboratory Topic 16

Phylum Lycopodiophyta

Be able to identify *Lycopodium, Isoetes,* and *Selaginella* from a slide, pickled, or fresh material to genus and phylum. You should be able to identify and know the functions of the the following terms:

Strobilus (plural=strobili)
Microphylls
Aerial stem
Rhizome
Root
Sporophyte (2N)
Sporangium
Microsporangium
Megasporangium
Sporophyll
Megasporophyll
Microsporophyll
Microspores
Megaspores
Ligule
Rhizoids
Gametophyte (N)
Archegonia
Antheridia
Egg (=female gamete)
Sperm (=male gamete)
Megagametophyte (=female gametophyte)
Microgametophyte (=male gametophyte)
Zygote
Fertilization
Embryo
Stem
Corm

You should be able to identify the sporophyte (2n) and gametophyte (N) generations. This group has a heterothallic, heteromorphic, sporic alternation of generations. **Note- you should be able to identify these organisms using the prepared slides, dried, pickled or the fresh materials as stated above.**

Monilophyta Laboratory Topic 16

Phylum Monilophyta

Be able to identify *Equisetum, Polypodium, Pteris,* and *Psilotum* to genus and phylum. You should be able to identify and know the functions of the following:

Strobilus (plural=strobili)
Sorus (plural=sori)
Prothallus (=gametophyte of a fern)
Rachis
Rhizome
Root
Stem
Sporophyte (2N)
Sporangium
Sporophyll
Megaphyll
Fiddlehead
Rhizoids
Gametophyte (N)
Archegonia - Egg (=female gamete)
Antheridia - Sperm (=male gamete)
Sporangiophore
Node
Internode
Zygote
Fertilization
Embryo
Protostele
Siphonostele
Eustele
Xylem
Phloem

You should be able to identify the sporophyte (2n) and gametophyte (N) generations. This group has homothallic and heterothallic representatives, heteromorphic, sporic alternation of generations. **Note- you should be able to identify these organisms using the prepared slides, dried, pickled or the fresh materials as stated above.**

Gymnosperm Laboratory Topic 17

Phylum Cycadophyta
Be able to identify *Cycas* and *Zamia* to genus and phylum based on leaves, microstrobili, and megastrobili. Distinguish between cycad microstrobili (male cones) and megastrobili (female cones).

Phylum Ginkgophyta
Be able to identify *Ginkgo* to genus and phylum based on leaf, seed, ovule, and pollen strobili.

Phylum Gnetophyta
Be able to identify *Ephedra* to genus and phylum based on its leaves, microstrobilus, and megastrobilus. Distinguish between *Ephedra* microstrobili (male cones) and megastrobili (female cones).

Phylum Coniferophyta
Be able to identify *Pinus* to genus and phylum. Be able to label all the figures in your lab manual (Figures 17-1 to 17-5). Be able to identify and know the functions of the following:

Megastrobilus (= ovulate cone) with seed-scale complex (sterile bract and ovuliferous scale)
Integuments and micropyle
Megasporangium (= nucellus) (2N)
Megasporophyll (2N)
Megasporocyte (2N) and megaspores (N)
Archegonium
Microstrobilus (= microsporangiate cone, male cone)
Microsporangium (2N)
Microsporophyll (2N)
Microsporocyte (2N), tetrad of microspores (N), microspores (N)
Pollen grain and its cells (2 prothallial cells, generative cell, tube cell)
Mature microgametophyte (sterile cell, two sperm nuclei, pollen tube)
Embryo with suspensors
Seed with shoot apex, root apex, root cap, hypocotyl, cotyledons, and seed coat
Sporophyte (2N) with taproot system
Pinus older stem (= siphonostele)

Be able to identify in any gymnosperm if a strobilus is a megastrobilus or microstrobilus
Refer to bold terms in your lab manual for these key terms and their functions

Angiosperm Laboratory Part 1 Topic 18

Phylum Anthophyta

Be able to identify *Lilium* to genus and phylum based on the slides presented. Also be able to define and identify all of the bold terms in the manual, including the following from slides or fresh materials:

Integuments
Micropyle
Megasporangium (= nucellus)
Megasporocyte (2N) or megaspore mother cell
Megaspore (N)
Embryo sac
Chalaza
Antipodals
Polar nuclei
Egg with synergids
Placenta
Funiculus
Ovary wall
Pollen sacs (=Microsporangia)
Microsporophyll
Microsporocyte (2N) or microspore mother cell
Tapetum
Pollen grain with vegetative cell and generative cell that divides to give rise to sperm cells
Pollen tube
Pollination
Double fertilization
Zygote (2N) and 3N tissue = endosperm
Flower- stamens (anther and filament), androecium
Carpel=pistil (stigma, style, ovary), gynoecium
Sepals, collectively calyx
Petals, collectively corolla
Perianth

Connate vs. adnate, superior, inferior, epigynous, perigynous, hypogynous, complete vs. incomplete, perfect vs. imperfect, receptacle, pedicel, inflourescence, actinomorphic vs. zygomorphic

You should be able to name the botanical classification of any fruit presented in the laboratory

Early Development of the Plant Body: Topic 20

Phylum Anthophyta

Be able to:

-Label the figures in your lab manual (Figures 20-1 and 20-2).

-Define and identify epigeous versus hypogeous and exalbuminous versus albuminous for *Phaseolus* (=bean), *Pisum* (=pea), and *Zea* (=corn).

-Define and identify all of the bold terms in the manual, paying particular attention to: proembryo, suspensor, cotyledon, protoderm, procambium, ground meristem, embryo sac, endosperm, basal cell, radicle, shoot and root apical meristems, root cap, seed coat, hypocotyl, epicotyl, plumule, pericarp, micropyle, hilum, foliage leaves.

-Identify the primary meristems: protoderm, procambium, ground meristem.

-Identify the three stages of eudicot embryo development: globular, heart, torpedo.

Cells and tissues of the Plant Body: Topic 21

Phylum Anthophyta

Be able to:

-Label the figures in your lab manual (Figures 21-1 and 21-4).

-Complete the Summary of Tissue Systems, Tissues, and Cell Types table on page 21-7 of your lab manual.

-Identify the primary meristems: protoderm, procambium, ground meristem.

-Identify all cells and tissues of the plant body and know their functions, this includes: ground tissues (parenchyma, collenchyma, and sclerenchyma (sclereids and fibers), vascular tissues (xylem= tracheids and vessel elements, parenchyma, sclerenchyma and phloem in gymnosperms= sieve cells and albuminous cells, phloem in angiosperms= sieve-tube elements and companion cells, parenchyma, sclerenchyma), dermal tissues (epidermis, guard cells, root hairs, and periderm= cork cells, cork cambium, phelloderm)

The Root: Topic 22

Phylum Anthophyta

Be able to:

-Label figures 22-1, 22-2 and 22-3 in your lab manual

-Define and identify all of the bold terms in the lab manual

-Distiguish between the fibrous and taproot systems

-Identify and describe roots hairs

-Identify all of the labeled terms on pages 566 and 567 of your textbook in figures 24-10 and 24-11

-Identify all of the labeled terms on pages 571 of your textbook in figure 24-16c

-Identify lateral roots and their origin via a slide of *Salix* (= willow)

-Identify a storage root, as shown on page 577 of your textbook in the beet in figure 24-23

Primary Structure of the Stem and Leaves: Topics 23 and 24

Phylum Anthophyta

Be able to:

-Label the figures in your lab manual (Figures 23-1, 23-2, 23-3, 24-2 24-4 and 24-'4'=24-5)

-Define and identify all of the bold terms in the lab manual

-Identify the leaf abscission layers as seen in Figure 25-35 page 604 of you textbook

-Identify the main leaf types and features, and know all of the terms on the "Scavenger Hunt for Leaves" handout

-Identify and name the three types of vascular organizations in the stem: siphonostele, eustele, and scattered (=complex), as seen in Figures 25-8 to 25-13 of your textbook

-Identify all of the structures in the mesophyte, hydrophyte, and xerophyte leaves as shown in Figures 25-21 to 25-23 on pages 594 and 595 of your textbook

Wood: Secondary Xylem: Topic 26

Phyla Coniferophyta and Anthophyta

Be able to:

-Label the figures in your lab manual (Figures 26-2 and 26-3)

-Define and identify all of the bold terms in the lab manual

-Distinguish hardwood (oak) from softwood (pine) in slide view and using the paper blocks

-Distinguish heartwood from sapwood

-Distinguish storied from non-storied vascular cambia

-Label all of the structures in Figures 26-9, 26-10, 26-11, 26-12, 26-14, 26-16, 26-20 to 26-25 of your textbook

-Identify and describe the function of a lenticel

-Identify and name the three sections of wood: transverse, radial, and tangential, as seen in slides and paper blocks

-Accurately estimate the age of a piece of wood by counting growth rings in transverse section

Growth Regulators and External Factors: Topics 27 and 28

Topic 27, Exercise I, be able to:

-Identify the 4 plants used in this experiment (Part A)

-Identify the 3 plants used in this experiment (Part B)

-Identify 2,4-D treated plants and describe the effects of the compound (Part C)

Topic 27, Exercise II, be able to:

-Identify and describe the effects of plants treated with gibberellin

Topic 27, Exercise III, be able to:

-Identify callous tissue treated with IAA and cytokinin (=kinetin), or both

Topic 28, In Exercise I, be able to:

-Identify phototropism and know that the curvature toward light is caused by auxin (Part A)

-Identify positive and negative gravitropisms in roots and shoots (Parts C & D) and know the hormones responsible for them

-Identify thigmotropism if you saw it (Part E)

Topic 28, In Exercise IV, be able to:

-Identify nastic movements and the pulvinus in *Mimosa*

Inorganic Nutrients and Soils: Topic 29 and Handout

Be able to:

-List symptoms shown by plants with nutrient deficiencies

-Identify plants lacking nitrogen, phosphorous, magnesium, potassium, calcium, sulfur, iron using the dichotomous key on page 29-2 of your lab manual

-Identify soil type using the texture by feel analysis on page S-11 of the handout

-List the three main types of weathering: Biological, Chemical, and Mechanical

-Draw and label the soil horizons

-Predict the rate of nutrient flow through soil given three different soil profiles (desert, prairie, temperate rainforest)

Genetics: Topic 10

Be able to:

-Define the terms in **bold font** terms in your lab manual on page 10-14

-Complete a monohybrid and dihybrid cross (Punnett square) given genotypic information similar to that presented in your lab manual (see Exercises I, II, III)

-Estimate the results (genotypic and phenotypic percentages) for monohybrid and dihybrid genetic crosses

-Identify monohybrid and dihybrid genotypes and phenotypes based on ears of corn

-List the reasons why *Arabidopsis thaliana* was such an excellent model organism for plant genetics