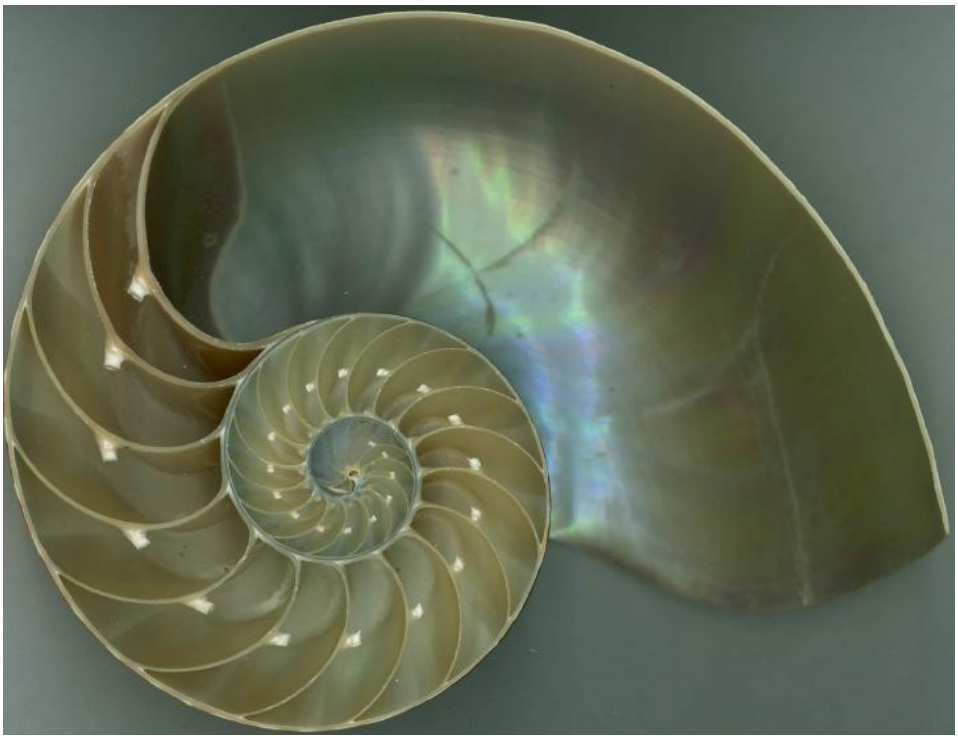
BIO 30 MARINE BIOLOGY LECTURE & LABORATORY MANUAL

Section 5054

Fall 2011



Instructor- Dr. Jeffery R. Hughey

BIO 30 MARINE BIOLOGY LECTURE AND LABORATORY MANUAL
Section 5054, Fall 2011

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Front cover is a scan of a sagittal section of a *Nautilus* shell.

Marine Biology- Biology 30

Lecture and Laboratory Schedule- Section 5054

Dr. Jeffery R. Hughey — Fall 2011, Hartnell College
Monday- 2:00-5:15 PM, MER 6 — Wednesday- 2:00-4:50 PM, MER 6

Dates		Lecture and Lab Topics	Reading
August 15		Introduction; The Science of Marine Biology	Chapter 1
August 17		Introduction to the Lab, Scientific Method	Manual
August 22		Fundamentals of Biology	Chapter 4
August 24	**Quiz 1**	Cells and Microscopes	Manual
August 29		The Microbial World	Chapter 5
August 31	**Quiz 2**	Prokaryotes, Algae, Protozoans	Manual
September 5		*Labor Day, College Closed*	---
September 7	**Quiz 3**	Hydrothermal Vents, Project Management, and ROV Missions overview	pp. 35-38, 89-92, 379-381 Manual
September 12		Campus Pool Practice with ROVs (1:40-3:00 PM)	
September 14		*Field trip to MBARI (Arrive at 2:40 PM)*	---
September 19		ROV Mission Competition in Campus pool (1:40-3:00 PM)	
September 21	**Quiz 4**	Seaweeds and Plants	Chapter 6
September 26		Algae and Flowering Plants **ROV Reports Due**	Manual
September 28	**Quiz 5**	Marine Invertebrates Part 1	Chapter 7
October 3		Cnidaria and Mollusca (Dissections)	Handout
October 5		*Field Trip to the Monterey Bay Aquarium (Arrive at 2:40 PM)*	
October 10		**MIDTERM EXAMINATION #1 (Lab and Lecture 2:00-4:50 PM)**	
October 12		Marine Invertebrates Part 2	Chapter 7
October 17		Echinodermata (Dissections)	Handout
October 19		Common Marine Invertebrates of Monterey	Book
October 24		Cartilaginous Fishes	Chapter 8
October 26		Sharks (Dissection)	Handout
October 31		Bony Fishes	Chapter 8
November 2		Pacific Coast Fishes	Book
November 7		Marine Reptiles and Birds	Chapter 9
November 9		**MIDTERM EXAMINATION #2 (Lab and Lecture 2:00-4:50 PM)**	

November 14	*Field trip to Mission Pt., -0.88 ft (4:25 PM) (Depart at 2:00 PM)*	
November 16	Marine Mammals	Chapter 9
November 21	Marine Mammals	Chapter 9
November 23	Marine Mammals, Video	Chapter 9
	Homework due- Common Marine Mammals, Handout	
November 28	*Field trip to Monterey for Mammals/Birds (Depart at 2:00 PM)*	
November 30	Marine Ecology	Chapter 10
December 5	Between the Tides	Chapter 11
	Homework due- Food Web Exercise, Handout	
December 7	Resources from the Sea	Chapter 17
December 14	**COMPREHENSIVE FINAL EXAMINATION (3:00-6:00 PM)**	

COURSE DESCRIPTION

An introduction to the study of marine life. Emphasis on the fundamentals of biology, algae, invertebrates, vertebrates, and ecology. Recommended for non-science majors who desire a general knowledge and appreciation of life in the sea.

COURSE OBJECTIVES

1. identify the traits of a competent marine biologist.
2. use the scientific method to answer questions in marine biology.
3. compare and contrast prokaryotic versus eukaryotic cells.
4. recognize the chemical ingredients of life.
5. analyze a plankton tow.
6. differentiate unicellular algae and protozoans.
7. distinguish between different types of multicellular seaweeds.
8. list reasons to study marine algae.
9. define photosynthesis.
10. name the characteristics of the major marine invertebrate and vertebrate phyla.
11. infer fish habitat from fish form.
12. diagram the countercurrent system of flow in the gills of fishes.
13. evaluate feeding strategies among seabirds.
14. construct a phylogenetic hypothesis based on evolutionary bird data.
15. discuss the life history of sea turtles.
16. describe the migration routes of marine mammals.
17. explain the functions of echolocation.
18. distinguish ecology from environmental science.
19. construct a food web using representative producers and consumers.
20. debate the threats caused by overfishing.
21. develop microscopy skills necessary for the examination of living structures.
22. design an experiment to test the influence of lipids and spines on buoyancy.
23. dissect marine animals for anatomical study.
24. estimate the age of fishes using scales and otoliths.
25. create hypotheses based on observations of marine animal behavior.

INSTRUCTOR INFORMATION

Instructor- Dr. Jeffery R. Hughey
Office- Merrill 26C
Telephone- (831) 770-7054
Email- jhughey@hartnell.edu
Web Address- http://www.hartnell.cc.ca.us/faculty/jhughey/course_doc.htm
Office Hours- Tuesday 5:00-6:00 PM, Wednesday 1:00-2:00 PM, Thursday 1:00-2:00 PM

REQUIRED TEXTBOOKS

- Castro, P. & Huber, M.E. *Marine Biology. 8th ed*. McGraw Hill, New York, 2010.
- Marine Biology Lecture and Laboratory Manual: Section 5054, Fall 2011.
- Steinbeck, J. *Cannery Row*. Any edition. Penguin Books, New York.

GRADING

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

Cannery Row Quizzes	25 pts.
Homework Assignments	25 pts.
ROV Report	50 pts.
First Examination	100 pts.
Second Examination	100 pts.
Final Examination	100 pts.
Total	400 pts.

Grade	Total Points Earned (Percentage)	Definition	Grade Points
A	360-400 pts. (90-100%)	Excellent	4
B	320-359 pts. (80-89%)	Good	3
C	280-319 pts. (70-79%)	Satisfactory	2
D	240-279 pts. (60-69%)	Barely Passing	1
F	239 or fewer (59% or less)	Failing	0

EXAMINATIONS

The lecture portion of the examination 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 examination will focus on material from the lab manual, handouts, and information from lab exercises and field trips. Laboratory questions generally require you to identify organisms and anatomical structures.

CANNERY ROW QUIZZES

There will be five, 5 pt. quizzes that focus on the reading assignments listed below from Steinbeck's *Cannery Row*. The quizzes will be administered at the beginning of class, no make up quizzes will be given. The following shows the schedule and chapters that you will be tested on:

August 24	Quiz1	Chapters 1-6
August 31	Quiz2	Chapters 7-12
September 7	Quiz3	Chapters 13-18
September 21	Quiz4	Chapters 19-24
September 28	Quiz5	Chapters 25-32

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

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 of the class sessions. Any lack of attendance, which leads in my judgment to unsatisfactory progress, may result in being dropped from the course. Absence in excess of two weeks (consecutive or non-consecutive) may result in being 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 November 18th will receive a letter grade based on their total earned points.

CLASSROOM VISITORS

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

COMMUNICATION WITH YOUR INSTRUCTOR

When communicating by email, phone, or in person, do so in a professional manner. Namely, when emailing, include your complete name, course name, and use complete sentences. Do not abbreviate words or use slang.

INSTRUCTIONAL SUGGESTIONS

Course suggestions and requests that you feel will improve comprehension, retention, and cognition are warmly welcomed. Requests for less information, postponement of examinations, or easier examinations are not welcomed.

SUGGESTIONS FOR DOING WELL IN BIOLOGY 30

1. Read the textbook
2. Review your notes before coming to class
3. Study for exams with a partner or in a group
4. Review practice questions
5. Attend class and take complete notes
6. Participate in classroom exercises
7. Outside of class study at least 6 hrs/week

Introduction and Scientific Method- Chapter 1

Introduction to Biology 30: The Science of Marine Biology

History- Minoan Civilization

Phoenicians- _____.

Polynesians- _____.

Geological Oceanography- _____.

Chemical and Physical Oceanography- _____.

Flip- _____.

Cell Biology- _____.

Microbiology- _____.

Phycology- _____.

Invertebrate Zoology- _____.

Ichthyology- _____.

Herpetology- _____.

Ornithology- _____.

Mammalogy- _____.

Ecology- _____.

Humans and the Sea- _____.

- **What are the characteristics of a competent marine biologist?**

The Scientific Method

- A procedure used to _____ _____ or _____ _____.
- A way of thinking and looking at the _____.
- A technique used to gather information and reach _____.

Steps to the Scientific Method

Everyday use of the Scientific Method- Flashlight

Observation-

Hypothesis-

Experiment-

Conclusion-

Interactions between organisms and the Scientific Method- sea stars, mussels, barnacles, algae.

Observation-

Hypothesis-

Experiment-

Conclusion-

Biological interactions and the Scientific Method- sea gull, algae, snails, and crabs.

Observation-

Hypothesis-

Experiment-

Conclusion-

Caging experiments and the Scientific Method- spiny lobster and mussels.

Observation-

Hypothesis-

Experiment-

Conclusion-

Scientific Theory

- Scientific Theory- a _____-ranging _____ for some aspect of the universe that has been _____ confirmed through _____ testing.
  - Theory of _____
  - _____ Theory

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Laboratory #1- The Scientific Method

The scientific method is a procedure used to solve problems or answer questions. It is a technique that can be applied to answer everyday, as well as scientific questions. The scientific method involves four main steps: observation, hypothesis, experiment, and conclusion. Typically the method is initiated with a question. It also usually includes predicting the results of an experiment.

Hermit crabs are decapod crustaceans. As the name implies, decapods (Greek *deca*- ten) have ten legs. The front three pairs of legs function as mouthparts and are referred to as maxillipeds. In many decapods, the first pair of legs comes with enlarged pincers; the claws, which are called chelae. Hermit crabs are scavengers and typically eat algae or other debris. Not all, but most hermit crabs salvage empty gastropod shells and live in them for shelter (some live in coral, stones, wood, bamboo or hollow mangrove roots). The term "hermit" is derived from their tendency to hide in and occupy empty shells for protection. As hermit crabs grow, they will exchange their shell for a larger one. The crabs always select empty shells and never kill the original occupant. Hermit crabs locate a prospective shell with their eyes and then inspect it with the chelae. Since intact gastropod shells are not an unlimited resource, there is frequently strong competition for the available shells, resulting in hermit crabs fighting over shells. The availability of empty shells depends on the abundance of snails and hermit crabs. There are about five hundred known species of hermit crabs in the world, and most of them are aquatic (97%). Hermit crabs live in the wild in colonies of 100 or more, and generally do not thrive in smaller numbers.

Each table in the laboratory will receive 1 hermit crab. **Please handle the crabs carefully.** Your assignment is to design and perform 3 experiments using the crab at your station. You will need to determine the following: 1) What is the biological question/s that you are asking? 2) What is your observation? 3) State a hypothesis. 4) Describe your experiment and list the variables in your experiment. 5) State your conclusion.

Materials

1 hermit crab
1 ruler
1 stop watch
1 hermit crab tray
1 hermit crab hideout
1 small sample of each of the food items

Definitions

Control variable- variable that is held constant.
Dependent variable- variable you measure.
Independent variable- variable you manipulate.
Control group- specimens in an experiment that are processed in parallel with the experimental samples, but do not receive treatment.
Hypothesis- a testable statement.

Research Experiment #1

Question/s- _____.
Observation- _____.
Hypothesis- _____.
Experiment- _____.
Control variables- _____.
Dependent variables- _____.

Independent variables- _____.
Perform your experiment.
Conclusion- _____.

If applicable, graph the results

<u>Research Experiment #2</u>
Question/s- _____.
Observation- _____.
Hypothesis- _____.
Experiment- _____.
Control variables- _____.
Dependent variables- _____.
Independent variables- _____.
Perform your experiment.
Conclusion- _____.

If applicable, graph the results

<u>Research Experiment #3</u>
Question/s- _____.
Observation- _____.
Hypothesis- _____.
Experiment- _____.
Control variables- _____.
Dependent variables- _____.
Independent variables- _____.
Perform your experiment.
Conclusion- _____.

If applicable, graph the results

Laboratory Questions

1) Describe any problems you had carrying out your experiments. How would you correct these problems?

2) Describe an everyday observation, then state a hypothesis to test your observation.

3) Describe the difference between dependent and independent variables. Give an example.

4) Explain why it is important to replicate experiments?

Fundamentals of Biology, Chapter 4

Levels of Organization

_____ Tissue Level
_____ Ecosystem Level
_____ Molecule Level
_____ Individual Level
_____ Organ System Level
_____ Organelle Level
_____ Cellular Level
_____ Community Level
_____ Population Level
_____ Atom Level
_____ Organ Level

Matching. Match the definitions on the right to the levels of organization on the left.

_____ Molecule	a. all the species in an ecosystem that can interact
_____ Cell	b. a single organism
_____ Organ	c. a community and its physical environment
_____ Organ System	d. group of related organs that have a common function
_____ Individual	e. all individuals of the same species that occupy a given area
_____ Population	f. two or more different tissues that perform a common function
_____ Community	g. the basic unit of life
_____ Ecosystem	h. group of similar cells that perform a common function
_____ Tissue	i. combinations of atoms that are bonded together
_____ Atom	j. a subcellular membrane-bound compartment
_____ Organelle	k. the fundamental unit of all matter

The Ingredients of Life

•Elements- substances composed of only one type of atom.
- _____ naturally occurring.
- Carbon, Nitrogen, Hydrogen, and Oxygen account for 90% of the elements in living things.

The Building Blocks

_____
_____
_____
_____

Cells and Organelles

Eukaryotic vs. Prokaryotic Cells

Feature	Eukaryotic	Prokaryotic
Organisms	Animals, plants	Bacteria, Archaea
Size	10-100 µm	____-____ µm
Organelles	_____	No
DNA form	Coiled, linear	_____
DNA location	_____	Cytoplasm
Internal membranes	Yes	_____
Cytoskeleton	Yes	_____

Robert _____ (1635-1703)

Cell Theory

- CELL THEORY- proposed in 1839 by _____ and _____.
  - _____ _____ _____ are composed of cells.
  - The cell is the basic unit of life.
  - New cells _____ only _____ preexisting cells.
  - Cells contain _____ _____ which is passed from cell to cell during cell division.
  - All cells are _____ in chemical _____.
  - All of the energy flow of life occurs within cells.

Invention of the Microscope

- Invented circa 1595 AD by _____ _____ (1580-1638), a spectacle maker from Holland.

4 Types of Microscopes Used to Study Cells

- _____ **microscope-** 4-50X.
  - Light is passed through or reflected on a specimen.
  - Focus with a set of glass lenses.
- _____ _____ **microscope-** 1000X.
  - Light is passed through a specimen.
  - Focus with a set of glass lenses.
- _____ _____ **microscope-** 50,000X.
  - _____ are passed through a specimen.
  - Focus with a set of magnetic lenses.
- _____ _____ **microscope-** 10,000X.
  - _____ are scanned over the surface of a specimen that has been coated with a _____.
  - No Focus, produces a _____-dimensional image collected from electrons that are emitted from the metal.

Dissecting Microscope

Diffusion

- Diffusion- the spontaneous tendency of a substance (solute or solvent) to move from a more concentrated to a less concentrated area.
  - T or F. Diffusion results in the uniform distribution of a substance.

Osmosis

•Osmosis- the diffusion of _____ through a selectively permeable membrane from a region of higher concentration to a region of lower concentration.

When referring to two solutions that are separated by a selectively permeable membrane:

- _____ solutions have the same concentration of solute as the cell.
- _____ solutions have lower solute concentrations than the cell.
- _____ solutions have higher solute concentration than the cell.

3 Domains and 6 Kingdoms

Classifying Living Things

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Laboratory #2- Microscopes and Cells

Rules for Microscope Use

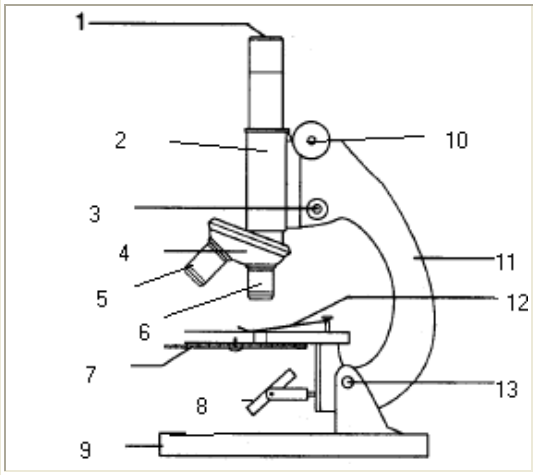
1. Use _____ paper only when cleaning lenses.
2. Keep the stage dry to prevent rust and _____.
3. Do not _____ parts of the microscope.
4. _____ and return your microscope to the locker drawer after use.
5. Report any _____ with your microscope to the instructor.
6. _____ begin focusing with the lowest power objective.
7. Always _____ a microscope with two hands, one on the arm and the other underneath the _____.

Word Bank- Always, Base, Carry, Corrosion, Cover, Lens, Malfunctioning, Remove.

Remove the compound and dissecting microscopes from your locker after obtaining a combination from Dr. Hughey. Write your locker combination here _____.

Examine your dissecting and compound microscopes. What are 3 differences you see?
1) _____
2) _____
3) _____

Based on the image and key below, identify the following parts on your compound microscope:
Oculars (eyepieces)- magnification, lenses are housed in the eyepieces.
Body tube- holds nosepiece and ocular; conducts light.
Arm- supports upper parts of microscope and provides carrying handle.
Nosepiece- holds the objectives.
Objectives- magnification, lenses are housed in the objectives.
Coarse and fine adjustment knobs- focus.
Light source- attached lamp that produces beam of light.
Base- flat surface that rests on the table.
Stage- holds microscope slides.
Stage clips- holds slides on the stage.
Diaphragm- controls the amount of light that travels through the object.



1. ocular or eyepiece
2. body tube
3. fine adjustment
4. nosepiece
5. high power objective
6. low power objective
7. diaphragm
8. mirror (many microscopes have a light here)
9. base
10. coarse adjustment
11. arm
12. stage clip

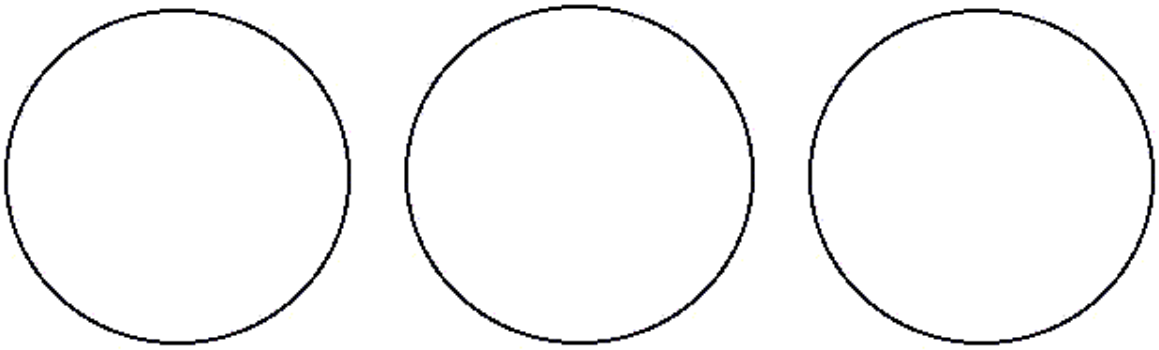
Total Magnification
The total magnification of an object can be determined by multiplying the magnification of the ocular lens by the magnification of the objective lens. For example, if your compound microscope has a 10X ocular lens and you are viewing a specimen with the 4X objective lens, then (10 x 4= 40) the specimen is being viewed at 40 times magnification (= 40X), or in other words 40 times its natural size. Calculate the following total magnifications, assume you are using 10X ocular lenses:

a) 10X objective- _____
b) 40X objective- _____
c) 100X objective- _____

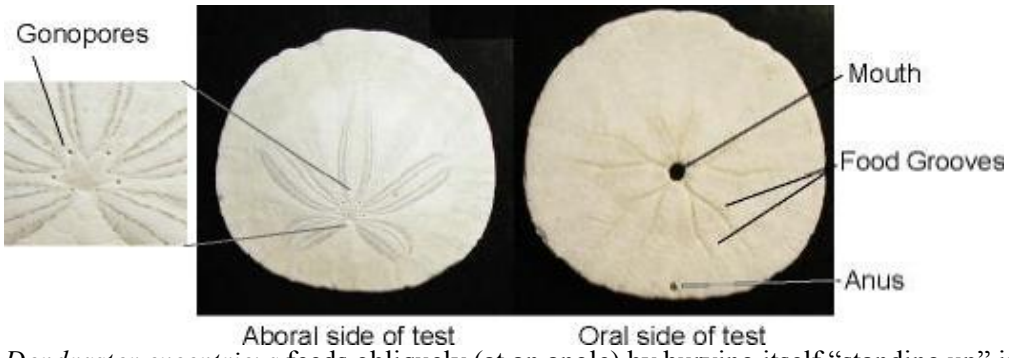
Dissecting Microscope
In the front of the room there is a box filled with sand dollars (*Dendraster excentricus*). *Dendraster excentricus* is a marine invertebrate that lives in the sandy bottoms of sheltered habitats. This species forms dense beds in the low intertidal and subtidal zones (Holzman, 2006).

The body of *D. excentricus* consists of a rigid test (hard external covering) covered with movable spines. It reaches a size of 75 mm in diameter (~ 3 inches), although size varies. It has two surfaces, aboral and oral. The aboral surface is the top side, it is opposite of the mouth, or the oral side. This species has a flower-like pattern on the aboral side of the body composed of pore pairs where specialized tube feet perform gas exchange. At the center is the **madreporite**- a perforated platelike structure that forms the intake for the **water-vascular system** (a system of water-filled canals derived from the internal cavity that connect with tube feet). What do you think are the functions of the tube feet (pg. 142 of text)?
_____, _____, _____.

Using your dissecting microscope, examine the aboral surface of your sand dollar at different magnifications. In the space below, illustrate the flower-like pattern on your echinoderm in the **field of view** (the circle visible through the lens).

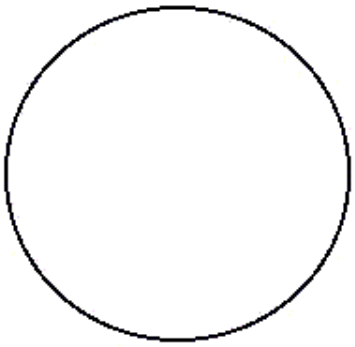


Total Magnification- _____ Total Magnification- _____ Total Magnification- _____



Dendraster excentricus feeds obliquely (at an angle) by burying itself "standing up" in the sand. Its feeding position is parallel to the surge current with the anterior end buried (Lawrence, 1987). By positioning themselves closely together, they may exploit their hydrodynamic shape and influence the current flow past their bodies. It is likely that this is the reason they form densely packed beds of several hundred individuals per square meter. In light currents, they may stand perpendicular, lay flat, or even bury themselves (Jangoux and Lawrence, 1983). They are considered suspension feeders and feed on suspended organic particulate matter from the water. Sand is ingested along with the food by juveniles to act as a "weight belt" for stability in the sand.

Illustrate the mouth and the region around the mouth of your echinoderm.



Total Magnification- _____

References

The above information comes from Dr. Barbara Holzman, 2006, (http://bss.sfsu.edu/holzman/courses/Fall02%20projects/sandollar/sanddollar.html)
Jangoux, Michel and John M. Lawrence. 1983. Echinoderm Studies. Rodderdam: A.A. Balkema.
Lawrence, John. 1987. A Functional Biology of Echinoderms. London & Sydney: Croom Helm.
Mooi, Rich. 1997. "Sand Dollars of the Genus Dendraster (Echinoidea: Clypeasteroida): Phylogenic Systematics, Heterochrony, and Distribution of Extant Species." Bulletin of Marine Science, 61: 343-75.

Compound Microscope

Inversion

Obtain a letter 'e' from the newspaper provided. In the space below, draw the letter 'e' as it appears on your slide. Next to your drawing, draw the 'e' as it appears in view under the microscope using the 4X objective lens.

Do you see any difference? _____. What is the difference?

Convex lenses, which are rounded outward, flip images upside down and backwards. This is termed inversion. Does the lens in the ocular flip the image or is it the lens in the objective that flips the image? _____. Which lens is convex and which is concave? _____ Did the dissecting microscope invert your image? _____

Determining Cell Size

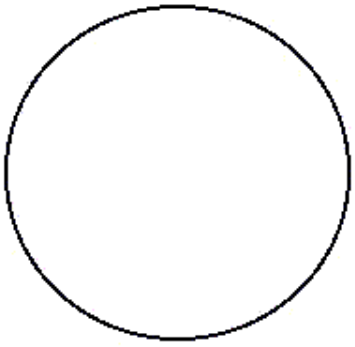
Place a slide with a millimeter (mm) scale across the opening in the stage of your microscope and examine it with the 4X scanning objective in place. Move the scale so that a millimeter line is at one edge of the field of view, then estimate the diameter of the field of view. Diameter of the field: _____mm. The diameter using the 4X objective (A) can be used to calculate the diameter using any other objective (B) with the following equation:

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

Using the equation, calculate the fields of view for the other objectives on your microscope.
Field of view 10X- _____
Field of view 40X- _____

Obtain a slide of the filamentous (hair-like) green alga Spirogyra. Estimate the length of one cell using the 10X objective. Estimated length in micrometers (μm): _____.

Oscillatoria
What is Oscillatoria? _____
What is the approximate size (width) of these cells? _____.

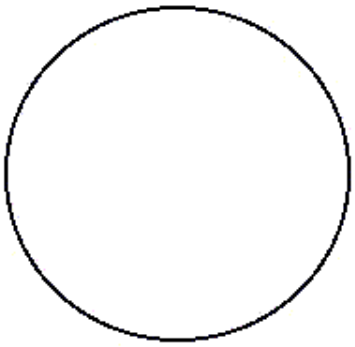


Total Magnification- _____

Ceratium

What is Ceratium? _____

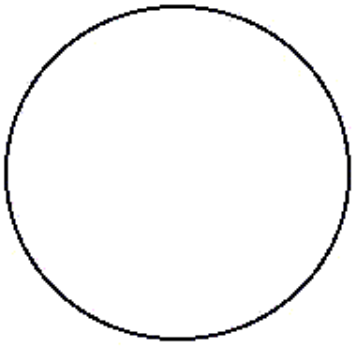
How big are the cells? _____



Total Magnification- _____

Cyclops (Copepod)

What is a Copepod?

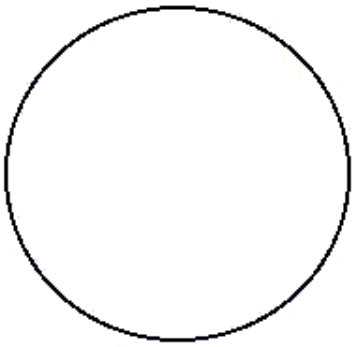


Total Magnification- _____

Pluteus larva

What is a larva? _____

Pluteus larvae develop into a _____ _____.

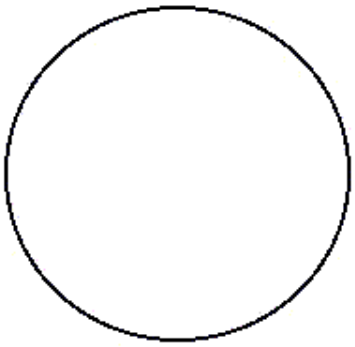


Total Magnification- _____

Fish Blood

What two types of cells do you see? _____

Label the cell types below:



Total Magnification- _____

The Microbial World- Chapters 5, 15

The Marine Environment

Plankton Collection

Plankton Classification

- _____plankton 20-200 cm
- _____plankton 2-20 cm
- _____plankton 0.2-20 mm
- _____plankton 20-200 μm
- _____plankton 2-20 μm
- _____plankton 0.2-2 μm

Metabolism

- Metabolism- _____ _____ reactions that occur in an organism.
- _____- requiring carbon dioxide and a source of energy for the synthesis of organic molecules (glucose).
  - –Photoautotrophs- absorb _____ _____ from the sun.
  - –Chemoautotrophs- derive energy from _____ _____.
- _____- requiring complex organic compounds; obtains energy by consuming organic matter.

Bacteria and Archaea

Photosynthetic Prokaryotes

- Kingdom- Bacteria
  - –Phylum- _____phyta

Cyanophyta

- Characteristics

- Examples- _____, Synechococcus, Synechocystis.

Cyanobacterial Cell

Global O_2 from photosynthesis

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

Archaea

- _____
- _____philes
  - _____ vents
  - Hypersaline basins
  - Highly _____ env.
  - Highly _____ env.

Photosynthetic Protista (the algae)

- Dinophyta- dinoflagellates.
- Haptophyta- haptophytes.
- Heterokontophyta- heterokont algae.
  - Chrysophyceae- golden-brown algae.
  - Bacillariophyceae- diatoms.

Dinophyta- dinoflagellates

- Characteristics

- Examples- _____, Pfiesteria.

Pfiesteria piscicida

Haptophyta- haptophytes

•Characteristics

•Examples- _____, Phaeocystis.

Heterokontophyta- heterokonts

Chrysophyceae- golden-brown algae

•Characteristics

•Examples- Dictyocha, _____.

Bacillariophyceae- diatoms

•Characteristics

•Examples- Coscinodiscus, _____.

Frustule Morphology

The Protozoans

•Granuloreticulosa- _____iniferans.

•Polycystina- _____larians.

•Ciliophora- _____.

Granuloreticulosa- foraminiferans

•Characteristics

•Example- _____.

Polycystina- radiolarians

•Characteristics

•Example- _____.

Various Radiolarians

Ciliophora- ciliates

•Characteristics

•Examples- Strombilidium, Tintinnopsis.

Kingdom Fungi

•Characteristics

•Example- _____.

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Laboratory #3- Identification of Plankton

Part 1. Survey of Phytoplankton and Zooplankton

Examine the following organisms by wet mount or using a prepared slide. Illustrate (draw) each species and describe its color, shape, size, and mode of locomotion.

PROKARYOTES

Domain Archaea

Genus- Halobacterium

Domain Bacteria

Phylum- Cyanophyta- common name cyanobacteria.

Genus- Anabaena

Genus- Spirulina

Genus- Oscillatoria

EUKARYOTES

Domain Eukarya

Phylum- Dinophyta- common name dinoflagellates.

Genus- Amphidinium

Genus- Gymnodinium

Genus- Prorocentrum

Phylum- Heterokontophyta- heterokonts.
Class Chrysophyceae- common name golden-brown algae.
Genus- Synura

Phylum- Heterokontophyta- heterokonts.
Class Bacillariophyceae- common name diatoms.
Genus- Coscinodiscus

Genus- Chaetoceros

Genus- Navicula

Phylum- Haptophyta- haptophytes.
Genus- Coccolithophora

Phylum- Rhizopoda- amoeboids.
Genus- Chaos- amoeba.

Phylum- Ciliophora- ciliates.
Genus- Paramecium

Phylum- Granuloreticulosa- foraminiferans.
Genus- Globigerina

Phylum- Polycystina- radiolarians.
Genus- Hexacontium

Phylum- Arthropoda- arthropods.
Genus- Daphnia- planktonic crustacean.

Phylum- Arthropoda- arthropods.
Class- Ostracoda- ostracods.

Part 2. Identification

Using the plankton illustrations from your Biology 30 Laboratory Manual, identify the phytoplankton and zooplankton present in the sample provided. This sample was taken from the Monterey Harbor docks earlier this morning.

Zooplankton or Phytoplankton (Circle). Name of organism? _____

Zooplankton or Phytoplankton (Circle). Name of organism? _____

Zooplankton or Phytoplankton (Circle). Name of organism? _____

Zooplankton or Phytoplankton (Circle). Name of organism? _____

Zooplankton or Phytoplankton (Circle). Name of organism? _____

Zooplankton or Phytoplankton (Circle). Name of organism? _____

Zooplankton or Phytoplankton (Circle). Name of organism? _____

Zooplankton or Phytoplankton (Circle). Name of organism? _____

Zooplankton or Phytoplankton (Circle). Name of organism? _____

Zooplankton or Phytoplankton (Circle). Name of organism? _____

Hydrothermal Vents- Chapters 2, 5, 16

Hydrothermal Vent

•Hydrothermal vent- a deep-sea _____ _____ where _____ seawater forces its way up through the _____.

•Discovered rich communities in _____.

•Temperatures range from 10-20°C (_____-_____°F) to 350°C (_____°F).

•Mineral particles such as _____ and _____ precipitate to form _____.

Mid-Ocean Ridge

Hydrothermal Vents

Metabolic Reactions in Bacteria

Mid-Ocean Ridges

Hydrothermal Vent Tubeworm

***Vent* crab**
http://www.ocean.udel.edu/deepsea/level-2/creature/crab.html

Zooarcid Fish (Eelpout)

Giant Vent Mussel

***Lepetodrilus*- limpets**

Pompeii Worm
http://www.ocean.udel.edu/extreme2004/creatures/pompeiiworm/index.html

Giant Hydrothermal Vent Clam

Anemones

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ROV (Remotely Operated Vehicle) Overview and Missions

The next two weeks of the course are devoted to studying ROVs and their use in hydrothermal vent biology. The missions you will perform and the content below were taken from the 2008 MATE International ROV Competition (http://www.marinetech.org/rov_competition/index.php). The MATE (Marine Advanced Technology Education) Center's goal is to help prepare America's future workforce for ocean-related occupations. The MATE Center utilizes information from employers to improve and develop educational programs with a focus on marine technology.

Hydrothermal Vents and Their Biology

In 1977, scientists made a stunning discovery on the bottom of the Pacific Ocean that changed our understanding of deep-sea life on Earth. They found seafloor vents gushing warm, shimmering, mineral-rich fluids into the cold, dark depths. And, to their surprise, they found that bacteria and invertebrates densely populated these vents. Hydrothermal vents are located along the ridges of the seafloor where the plates that make up the Earth's crust are either spreading apart (during the creation of new seafloor) or being pushed together (at subduction zones where one plate is sliding beneath the other). The dynamic movement of these plates creates cracks and fissures through which seawater travels into the Earth's interior where it is heated and later emerges as hot water. Temperatures at these sites have reached as high as 403°C (757°F), and the water is laden with minerals and chemicals acquired during its sub-seafloor cycling. It is the precipitation of the minerals and chemicals, such as iron, copper, and zinc sulfides, as the super-hot vent fluid comes in contact with the cold ocean water, that creates the "black smokers." Black smokers are the tall, chimney-like structures. Other minerals, such as barium, calcium, and silicon, mix with seawater to form smaller chimney structures called "white smokers." White smoker fluid is usually cooler (250-300°C) and flows more slowly than black smoker fluid. Hydrothermal fluids do not always flow out of chimneys. In some places, they seep from the ocean floor in what are named "diffuse flows." Diffuse flows are usually much cooler than the fluids emerging from black or white smokers. They also flow far slower, mixing with seawater below the sea floor, so that most of the minerals precipitate before the fluid emerges from the ocean floor.

The biology associated with hydrothermal vents is equally as unique as the geology, geophysics, and chemistry. The four are tied together, since it is the chemicals found in the hot vent fluids that support the oases of life found at these sites. Specialized microbes utilize hydrogen sulfide (H_2S) supplied by the vent fluids as an energy source to synthesize carbohydrates (CH_2O) such as the sugar glucose – and it is these microbes and the sugars they create that sustains the life of the vent communities. Just as algae and plants use sunlight as an energy source to transform atmospheric carbon dioxide (CO_2) into simple sugars during the process of photosynthesis ($CO_2 + 2H_2O$ -----> $CH_2O + O_2 + H_2O$), vent microbes use hydrogen sulfide as an energy source to transform carbon dioxide dissolved in the ocean water into food during the process of – chemosynthesis ($CO_2 + 2H_2S$ -----> $CH_2O + 2S + H_2O$).

The sulfur-oxidizing microbes, so named because sulfide is oxidized during chemosynthesis, are found at vent sites in both free-living and symbiotic forms. In the free-living form, mats of microbes are the first organisms to colonize new vent sites. As symbionts, the microbes are part of a mutualistic relationship with giant, blood-red tubeworms (*Riftia pachyptila*). The tubeworms house the microbial symbionts within a specialized organ called a trophosome. *Riftia* takes in hydrogen sulfide, carbon dioxide, and oxygen through its bright red gill-like plume and delivers these molecules to its symbionts that use them for chemosynthesis. The carbohydrate nourishes the worm and allows it to grow up to 85 cm per year, making it the fastest growing marine invertebrate. The clams (*Calyptogena magnifica*), mussels (*Bathymodiolus thermophilus*), and a few gastropod (snail) species at vent sites also harbor

microbial symbionts within their tissues – namely their gills, where they can ensure an adequate supply of hydrogen sulfide, carbon dioxide, and oxygen for the bacteria.

Vents are also home to other, "non-chemosynthetic" organisms, organisms that do not contain symbiotic microbes within their tissues, but rather feed on (living or dead) tubeworms, clams, mussels, and gastropods. For example, crabs (*Bythograea thermydron*) and several species of fish (Eelpouts) make their homes at vent sites. While these organisms do not rely directly on the microbes for their nutrition, they benefit from the microbial food chain.

In addition to the Pacific, evidence for deep-sea hydrothermal venting has been found along the spreading centers and subduction zones in the Atlantic, Indian, and Arctic oceans. Although they may vary in organism composition, it is the microbes and the process of chemosynthesis that fuels these communities. Although it's been 31 years since their initial discovery, hydrothermal vents and the geological, geophysical, chemical, and biological processes that drive them continue to intrigue scientists, engineers, and technicians from around the world. With persistence and ingenuity, scientists and others will continue to discover the unknown in these unique environments.

Mission Overview

Teams of 3-4 will attempt to complete a single mission that consists of two tasks. Each team will be allotted 15 minutes to complete the mission. Teams may complete the tasks in any order. The scores will be determined by your ability to collect specimens (crabs) near the vent and by accurately placing the ROV's temperature sensor into the vent flow. Your team will receive a time bonus for successfully completing the tasks faster than 15 minutes. Competitions will take place in the Hartnell College pool.

Task #1: Collect 2 samples of the vent crab (*Bythograea thermydron*). Scoring – 25 points per crab

This task involves:

- Locating the crabs.
- Collecting 2 vent crabs.
- Returning the vent crabs to the surface at the edge of the pool where a team member will collect them from your collection net. Crabs can be taken to the surface either individually or 2 at the same time.

Task #2: Measure the temperature of hydrothermal vent fluid. Scoring – 50 points

This task involves:

- Locating the hydrothermal vent.
- Inserting a temperature sensor into the vent. This task requires that Dr. Hughey observes the placing of the sensor into the chimney on your computer screen. Make sure if you are about to insert your sensor into the vent that he sees this on the screen in real-time.

Time bonus

Teams will receive 5 points for every minute under the 15 minute alloted time. Your mission performance period ends when your ROV has successfully 1) completed the mission tasks, 2) returned to the surface under its own power, and 3) a team member at the launch station has physically touched the vehicle.

Additional Rules

No entering the pool. This results in an automatic disqualification.

No pulling on the tether to speed up the recovery of items or to return your vehicle more quickly to the surface. This will result in a 10 point penalty.

No discussion between the pilot and team members at poolside regarding directional or mission information is allowed. The mission is meant to simulate an underwater ocean exercise. Under natural conditions, your monitor would be the only visual source of information. Directional discussion between the pilot and team members of your ROV will result in a 10 point penalty.

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Project Management Guide

Adapted from the Hartnell College Summer Internship Guide

Overview

A project can be described as an "endeavor with a starting point and an ending point in which a product or service is created or put in place." Much of project management is learning how to work efficiently and effectively as a team. As Sidney Sun said, the assistant director for Life Sciences at the NASA Ames Research Center, the most important thing to learn is "how to write...how to communicate...and how to work as a team."

In order to be effective, every component of a project should be carefully planned and documented. Thus, the first task in your project is to write a project plan. You will use this guide to assist you. Attempt to incorporate some of the vocabulary below into your document.

The components of your project plan will include:

- Scope Management Plan
  - define and set main objectives for the project
- Staffing Management Plan
  - define and assign roles for all persons or groups involved in the project
- Schedule Management Plan
  - create a task list
  - determine the approximate duration of each task
  - assign a person or group to the task
- Communication Management Plan
  - create a contact list of team members and other people with a stake in your project
  - determine the best method of communication
- Quality Management Plan
  - set up meeting times to discuss challenges, difficulties, suggestions, and progress of the project
- Risk Management Plan
  - discuss potential risks in the project
  - discuss response methods to address problems when they occur

Although you will be using your plan to guide you through your pool practice and mission next week, you may at any time decide to make changes to it. This is perfectly reasonable and realistic since no project is 100% set in stone. The project plan should be seen as your initial and best attempt to define and set guidelines for you to follow in your project. However, it is important that if you do decide to make changes to the plan, you need to document the changes and inform anyone else who's affected before their implementation.

Scope Management Plan

In this section, you will first identify the ***strategic initiative*** of the program. The strategic initiative is the main goal for implementing the project. What is the most important outcome that should occur as a result of your project? After defining the strategic initiative, you will then list several objectives that will help you support your strategic initiative.

Your scope management plan should also specify the ***deliverables*** of the project – that is, the tangible results are supposed to be produced. For example, the deliverables might include experimental results, documents, or presentations.

Staffing Management Plan
An important component of any project is to define the roles and responsibilities of all the individuals involved in the implementing the project. In your staff management plan, you must discuss the roles of the team members who you will be interacting with, your supervisor or supervisors, and the advisor/s who will be mentoring you.

Some roles are filled automatically; for example, you've been told who your supervisor is going to be, that's Jeff Hughey. For other roles, there may be some leeway to select the person who fills the role. For example, when several individuals work together on the same task, they can define team roles and then fill them from within their ranks.

The process for assigning a team member to a role can be any that is agreed upon by the team. For example, you may all agree that it should be an informal process whereby if a person volunteers for the role, they automatically assume the role, or you may want to formalize the process and put it to a majority vote, etc. You may even draw names out of a hat. In any case, you will document the selection process decided upon in this section.

Here are some roles that would be appropriate when working together as a team over the length of the project. Depending on your own circumstances/project, you may define fewer roles. If you're managing only yourself, then you will be your own chair, secretary, and communications liaison! You may include additional responsibilities to the roles, or define additional roles, as your team deems necessary.

- **Chair.** The chair of the team shall be responsible for calling and overseeing the team meeting/s, if there are any. The chair also assumes responsibility for ensuring that everything runs smoothly in the program.
- **Co-Chair.** The co-chair will assist the chair with the responsibilities and will preside over team meetings when the chair is absent.
- **Secretary.** The secretary will be responsible for taking and distributing notes and any handouts during the meeting.
- **Communication Liaison.** The communication liaison will be responsible for communicating with the supervisor and advisors about the team's progress and plans. If there are changes to the schedules or meetings that will be held, the communication liaison will be responsible for informing all involved parties.

Once you have decided on the roles and have selected the individuals who will assume them through the agreed upon selection process, you will outline the roles and responsibilities of all individuals or groups involved in the program in the staffing management section. This section should also include the name of the individual who was selected for the role.

Schedule Management Plan
This is the heart of your project management plan. As the name suggests, it consists of a schedule that shows what each member of the project team should be working on at each stage of the project, from the beginning to the end.

Your schedule will consist of a list of **tasks** and **milestones**.

A task is simply an activity within the project that has a beginning and an end, such as "Document project requirements" or "Design bridge main span".

Unlike a task, a milestone has zero duration and doesn't have anyone assigned to complete it. It simply indicates that a key part of the project is finished or is about to begin, such as "Training completed" or "First prototype ready for testing."

At a minimum, your schedule should:

- List the tasks that must be carried out in order to meet the assigned project objectives.
- Give the approximate duration for each of those tasks.
- Indicate who is assigned to complete each of those tasks. If other resources, such as pieces of equipment, are required for a task, indicate those resources too.
- List the project's milestones. Any fixed dates or deadlines that affect your project should be included as milestones. For example, if you're told you're giving a presentation on July 20, that should appear as be a milestone on your schedule.

The duration of each task should be supplied by the team member(s) who will be working on the task.

In some cases, one task cannot be started until one or more other tasks are complete. (For example, in building a house, you can't put on the roof until the walls are up.) In those cases, we refer to the tasks that must be completed first as ***predecessors*** of the task that comes after. Your schedule should list the predecessors, if any, of each task. Scheduling software, such as Microsoft Project, can be very useful for entering and displaying this kind of information, but you can also do it in a spreadsheet program such as Excel.

Communication Management Plan

This section of the project plan describes how the team will communicate. You will be communicating among yourselves (internal communication) as well as with your supervisor, and you need to document both forms of communication.

Some suggestions are:

- Create a list of team members, with contact information for each.
- Discuss communication as a group, and decide what your preferred method of communication is (email, phone, etc.).
- Consider putting up a project web site with the project plan, pictures, or whatever else is of interest to the team in general. If you do so, remember to consider privacy issues; in particular, it's not a good idea to publish people's contact information on a public web site.

Quality Management Plan

In this section of your project plan, you need to describe how you will achieve high quality outcomes for your project goals. In other words, this is your strategy for excellence.

One part of your Quality Management Plan should be a statement of your goals with respect to quality. These should be goals that you can measure. For example, instead of something vague like "do a good job at measuring water temperature and picking up crabs," you might say "achieve perfect scores of 50 on the crab and temperature missions in 10 minutes or less."

Of course, no matter how well you plan a project, not everything will go according to plan, so your Quality Management Plan should also describe your process for dealing with challenges and difficulties. For example, you may consider setting up regular meetings to discuss the progress of the project, to discuss challenges and difficulties, and to take suggestions for improvement. Every project in history has had things go wrong, so there's no shame in that; the important thing is to respond appropriately to problems when they occur, and to use them as opportunities to learn what to do, or what to avoid in the future.

Risk Management Plan

In this section of your project plan, you need to describe how you will deal with risk on your project. As discussed in the preceding section, it's almost certain that some things will not go as planned on your project. A team member may be unable to attend at a critical time, a piece of equipment may malfunction, and so on.

Your risk management plan should include:

- A list of reasonably likely problems that could arise.
- A strategy for dealing with each of those problems if it does arise.

For a team performing missions, an example of a reasonably likely problem would be that a team member is ill. One strategy for dealing with that problem would be to cancel the mission, but that would not be a quality outcome! A better strategy would be to have a backup person who's prepared to perform the task if necessary.

Your Risk Management Plan is related to your Quality Management Plan in that both deal with your response to unexpected issues. The difference is that the Quality Management Plan discusses your general process for anticipating and dealing with issues, while the Risk Management Plan describes actual responses to certain specific issues.

Project title: _____ Team Name: _____

Scope Management Plan

_____
_____
_____
_____
_____
_____

Staffing Management Plan

_____
_____
_____
_____
_____
_____
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Schedule Management Plan

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Communication Management Plan

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Quality Management Plan

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Risk Management Plan

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Biology 30- Marine Biology
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ROV Report Instructions

Reports are due March 7th at the beginning of the lab period, no exceptions.

Formatting
Typed using Times New Roman font, size 11, single spaced throughout, 2-4 pages in length

Contents
Your report should include five components.

1) Summarize the geology, chemistry, and biology of hydrothermal vents. Describe how vent systems are studied. Use your textbook, books in the library, handouts, lecture notes, journals, and the internet as sources. 1 of each type of reference below is required. All references should follow the formats shown below.
2) Describe and include a figure (illustrated or use a picture of the ROV) showing the underwater ROV that your team used for the competition.
3) List and explain your project management components- Scope Management Plan, Staffing Management Plan, Schedule Management Plan, Communication Management Plan, Quality Management Plan, and Risk Management Plan.
4) Assess your ROV mission performance. How successful were your practice runs? What type of problems did you encounter? How were they resolved? Were any changes made to your project plan prior to the mission? Describe the effectiveness of your plan? How could you have fixed or constructed your ROV to better perform the tasks?
5) References. In the text give the author's name followed by the year in parentheses: Sago (2000). If there are two authors use 'and': Baskin and Baskin (1998) to link author names. When referencing three or more authors, the first name followed by *et al*. should be used: Powles *et al.* (1998). "*et al*." is defined as "and others." Within parentheses, groups of references should be listed in chronological order. References should be listed at the end of your paper and be in alphabetical order. Personal communication, unpublished data and publications from informal meetings are not to be listed in the reference list but should be listed in full in the text (e.g. Smith A., 2000, unpublished data). References should be listed in the following form:

Journals
Honda, D., Kawachi, M, and Inouye, J. 1995. *Sulcochrysis biplastida* gen. et sp. nov.: Cell structure and absolute configuration of the flagellar apparatus of an enigmatic chromophyte alga. *Phycological Research* **43**: 1-16.

Books
South, G. R. and Whittick, A. 1987. *An Introduction to Phycology*. Blackwell Science, Oxford, 350 pp.

Chapter in a book
Wynne, M. J. 1981. Phaeophyta: Morphology and classification. In Lobban, C. S. and Wynne, M. J. (Eds) *The Biology of Seaweeds*. Blackwell Science, Oxford, pp. 52-85.

Website
Ocean Primary Productivity Team (home page on the internet). 2000. Ocean primary productivity study. Institute of Marine Coastal Sciences, Rutgers University, New Brunswick [updated: 5 October 2000; cited 21 January 2002]. Available from: http:marine.rutgers.edu/opp/

Seaweeds- Chapter 6

Why Study Seaweeds?

•Why not? "To be useless, various, and abstruse is sufficient recommendation of a science to make it pleasing to me."

_____ _____ (1811-1866)

•How do humans use seaweeds?

•How do marine animals use seaweeds?

Photosynthesis

•Photosynthesis- the production of _____ from _____ _____ and water in the presence of _____ using light energy.

$6CO_2 + 12H_2O \rightarrow C_6H_{12}O_6 + 6O_2 + 6H_2O$

Summary of Photosynthesis

Light Penetration vs. Depth

•Albert Einstein- proposed the Particle Model of Light in 1905.

–Light is composed of particles of energy called _____.

–Visible light has _____ photon _____.

Absorption Spectra for Several Plant Pigments

Types of Plant Pigments

Seaweed and Plant Cells

Light Reactions

Calvin Cycle

Chlorophyta- _____ algae

- Characteristics

- Examples- Ulva, _____, Derbesia.

Ulva life history

Rhodophyta- _____ algae

- Characteristics

- Examples- _____, Corallina.

Heterokontophyta- heterokonts

Phaeophyceae- _____ algae

•Characteristics

•Examples- Fucus, _____, Nereocystis.

Nereocystis life history

Phylum- _____phyta

•Characteristics

- _____cellular.
- Chlorophylls A & _____, carotenoids.
- _____ and seed.
- _____, _____, _____.

•5 species from the Pacific coast.

•Examples- Phyllospadix, _____.

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Laboratory #4- Seaweeds

The following laboratory exercises focus on learning to identify green algae (Chlorophyta), red algae (Rhodophyta), brown algae (Phaeophyceae), and flowering plants (Anthophyta).

Exercise 1. Observations on the algal thallus.
Describe and illustrate specimens A-E. Pay particular attention to the following characteristics (traits): color, shape of the thallus, shape of the base, shape of the margins, surface texture and projections, size, and the type of branching pattern.

Specimen A

Specimen B

Specimen C

Specimen D

Specimen E

Exercise 2. Identification of seaweeds based on color of the thallus.

In general, algae that are grass green are likely to be classified in phylum Chlorophyta and if they are yellow brown, classified in the class Phaeophyceae (phylum Heterokontophyta). The red algae however vary considerably in color depending on the species, age of the thallus, time of year, generation (sporophyte or gametophyte), and the location in the intertidal zone (littoral zone). If the thallus is red or pink, then it likely belongs in the Rhodophyta. However, red algae can also be brown and green in color. Flowering plant color is similar to that of the green algae, grass green.

Based on color alone, what taxonomic group do you think the following specimens belong in?

What color is the thallus? _____ Specimen A _____

What color is the thallus? _____ Specimen B _____

What color is the thallus? _____ Specimen C _____

What color is the thallus? _____ Specimen D _____

What color is the thallus? _____ Specimen E _____

Exercise 3. Identification of seaweeds based on spore color.

Using microscopy techniques demonstrated in class, identify the same specimens from above to the Chlorophyta, Rhodophyta, or Phaeophyceae, but this time based on spore color alone.

Specimen A _____

Specimen B _____

Specimen C _____

Specimen D _____

Specimen E _____

Exercise 4. Identification of seaweeds using dichotomous keys.

Today you will use the red algal key provided to identify one species of red algae (Specimen F). Here are some suggestions on how to successfully use a dichotomous key:

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 multiple 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.

	Genus	**Species**
Specimen F	_____	_____

Exercise 5. Identification of seaweeds using a herbarium, picture keying, or asking an expert.
There are additional methods that one can use to identify seaweeds. Using a herbarium, picture keying the alga, or asking an expert are examples. What is a herbarium? _____.

Using herbarium specimens, identify Specimens H and I. What are their scientific names?

	Genus	**Species**
Specimen G	_____	_____
Specimen H	_____	_____

Using the pictures in your lab manual, what are the names of the next two specimens?

	Genus	**Species**
Specimen I	_____	_____
Specimen J	_____	_____

Using the expert in the room, what are the names of the final two specimens?

	Genus	**Species**
Specimen K	_____	_____
Specimen L	_____	_____

The Invertebrates Part 1- Chapter 7

Phylum Porifera- sponges

- _____ organization
  - _____ tissues or organs
  - Types of cells
    - _____cytes and _____cytes
    - _____cytes
    - _____cytes
- _____ feeders
- Reproduction- asexual and sexual.
- ~6,000 species.
- Habitat- predominantly _____.
- Examples- Ophlitaspongia and _____.

Sponge Anatomy

Asexual Reproduction

Sexual Reproduction

Feeding

3 Sponge Classes

- Calcarea- _____ sponges.
- Hexactinellida- _____ sponges.
- Demospongiae- _____ sponges.

Phylum Cnidaria- cnidarians

- _____ level organization
  - _____
    - Cnidocyte with nematocyst
    - _____ cells
  - _____
    - Gland cells
    - _____ -_____ cells
- _____ - jellylike middle layer.
- _____
- Reproduction- asexual and sexual.
- _____ symmetry.
- ~10,000 species.
- Habitat- predominantly marine.
- Examples- Physalia, _____, and _____.

Radial Symmetry

Cnidarians Are Carnivores

Nematocyst Stings

3 Major Cnidarian Classes

- _____ - hydroids and jellies.
- _____ - jellies.
- _____ - anemones and corals.

Colonial Hydrozoans

Colonial Anthozoans

Phylum Mollusca- molluscs

- _____ level organization.
- _____, _____, _____.
- _____.
- All diets.
- Reproduction- sexual, external and internal.
- _____ symmetry.
- ~_____ species.
- Habitat- predominantly marine.
- Examples- Haliotis, Mytilus, and _____.

_____- designed for removing food from surfaces, made of _____.

_____ - snails, limpets, abalone, nudibranchs.

_____ - clams, mussels, oysters.

_____ - squid, cuttlefishes, nautilus, and octopuses.

_____ - chitons.

The Invertebrates Part 2- Chapter 7

Phylum Arthropoda- arthropods
•System level organization.
•Body is _____ with _____ appendages.
•Exoskeleton made of _____ and _____ _____.
–_____
•Two pairs of _____.
•Most have _____ eyes.
•Gills.
•All diets.
•Reproduction- sexual and internal using appendages; _____.
•_____ symmetry.
•~3 million species.
•Examples- _____, Balanus, and _____.

Copepods

Barnacles

Barnacle Habitats

Amphipods

Isopods

Decapods- shrimps, lobsters, and crabs

Hermit Crabs

Sexing Crabs

Fiddler on the Mud- courtship

Planktonic Crustacea

Food Webs and Crustaceans

Phylum Ectoprocta- bryozoans
•System level organization.
•_____- retractible ciliated tentacles for suspension feeding.
•Minute interconnected individuals= _____.
•Zooids occupy vase-like _____.
•_____-shaped gut.
•_____ symmetry.
•~4,500 species.
•Examples- _____ and Watersipora.

Lophophore

Phylum Echinodermata- echinoderms

- System level organization.
- _____.
- _____skeleton.
- Gills.
- Most _____ and extend stomachs inside out.
- Reproduction- sexual into the water and asexual.
- _____ radial symmetry.
- ~7,000 species.
- Examples- _____, Parastichopus, and _____.

Anatomy of a Sea star

Everting the Stomach

Regeneration

Pedicellariae

Class Asteroidea- sea stars

Class Ophiuroidea- brittle stars

Class Echinoidea- sea urchins

Class Holothuroidea- sea cucumbers

Class Crinoidea- sea lilies

Biology 30- Marine Biology
Hartnell College

Laboratory #7- Common Marine Invertebrates of Monterey

The last two weeks we studied some of the major invertebrate groups in lecture and in the laboratory. Today you will use the "Guide to Marine Invertebrates: Alaska to Baja California" by Gotshall (2005) to learn more about some of the invertebrates from our region.

Gotshall organizes the inverts by Phyla. It opens with images and notes on the less complex inverts (Porifera- sponges) and finishes with the Chordates (animals that contain a dorsal nerve cord). In the book's first section there are two useful references, a glossary (Pages 4-5) and a Pictorial Key to the Phyla (Pages 6-9). Using the glossary, what is the definition of a test? _____. What is a chela? _____.
Flip to the key, what page do you find Jellyfish on? _____. What page are the sea urchins located on? _____.

Two additional resources are the indices in the back of the book (Pages 113-117). One is an index of common names and the other a list of scientific names. Referencing these, what page do you find information for the Decorator crab on? _____. Where is the Moon Jellyfish located in this book? _____. What page is *Pandalus platycerus* located on? _____. What is the common name for *P. platycerus*? _____ _____.

<u>Phylum Porifera</u>
What class is the Urn Sponge classified in? _____. What type of spicules does it have? _____. What is the size and color of the Urn Sponge? _____. What is its habitat? _____.

What class is *Neoesperiopsis digitata* classified in? _____. What type of spicules does it have? _____. What is the size and color of *N. digitata*? _____. What is its habitat? _____.

<u>Phylum Cnidaria</u>
What class is the Orange Hydroid classified in? _____. What form is it, a polyp or medusae? _____. Why is it named the "Orange" Hydroid? _____. What is its size? _____. What is its habitat? _____.

What class are the Brown Jellyfish and the Moon Jellyfish assigned to? _____. Read the information of both. What are some similarities and differences between these two jellies?

The most conspicuous anemone in Monterey is the Giant Green Anemone. What is its scientific name? _____ _____. What is the green color due to? _____.
What are zooxanthellae? _____.

Growing on the docks in the Monterey Harbor are large White-Plumed Anemones. What genus are they classified in? _____. Describe the morphology of these anemones. _____.

Phylum Ctenophora
What is the common name of this phylum? _____ _____.
Ctenophores scatter light produced by beating the eight rows of locomotory cilia. The cilia appear as a rainbow of colors running down the comb rows. The effect is due to light diffraction or scattering of light by the moving cilia.
Do ctenophores have stinging cells? _____. Do they have tentacles? _____.
What is your explanation for the common name? _____.

Phylum Platyhelminthes
What are polyclads? _____.
What does the name mean? _____.
Where do you find polyclads in the marine environment? _____.

Phylum Annelida
What class of worms are common in Monterey, California? _____.
Describe the Feather Duster Worm (*Eudistylia polymorpha*).
_____.
What are the tentacles used for? _____.
How *E. polymorpha* differ from the Northern Feather Duster? _____
_____.

Phylum Mollusca
The class Polyplacophora contains the _____ (common name).
Describe the morphology of the lined chiton. _____
_____.
What do chitons feed on? _____.
What preys upon chitons? _____.

Describe the differences between the Whitecap Limpet and the Blue-Ring Top Snail.

What class are these two species assigned to? _____.

What is *Hermissenda*? Common name #1-_____. Common name #2-_____. What is the typical size and color of *H. crassicornis*?

What is the name of the octopus class? _____
What are two differences between the Giant Pacific Octopus and the Red Octopus?

Phylum Arthropoda
Does *Panulirus interruptus* occur in Monterey? _____. What is its range and habitat?

What are two morphological differences between *Pagurus hemphilli* and *P. armatus*?

Where do you find the Kelp Crab, *Pugettia producta*? _____.
Is *P. producta* a decapod? _____. What color is its carapace? _____.

Phylum Bryozoa
Describe *Bugula californica*. _____.
What are moss animals? _____.
_____.

Phylum Echinodermata
Is *Cucumaria miniata* a suspension feeder? _____. What preys upon it? _____.
Describe the California Sea Cucumber. _____.
What does it feed on? _____.

What is the difference between the spines on *Eucidaris thouarsii* and *Strongylocentrotus franciscanus*? _____.

How many of the sea stars in this book have 5 arms (rays)? _____.
What is the scientific name of the Ochre Star? _____ _____.
Describe the Ochre Star.

Phylum Chordata
What is the subphylum for tunicates and sea squirts? _____.
How do tunicates feed? _____.
Are tunicates pelagic or benthic organisms? _____.
The generalized body form of a tunicate includes two siphons. Does *Ascidia paratropa* have two siphons? _____. How about *Didemnum carnulentum*? _____. How about *Cnemidocarpa finmarkiensis*? _____. How about *Styela montereyensis*? _____.

Hemichordata and Chordata- Chapters 7 and 8

Phylum Hemichordata- acorn worms

•Missing link?
  –Larvae are similar to _____ larvae.
  –Dorsal, hollow nerve _____ and _____ slits.
•_____ _____.
•Reproduction- _____.
•Habitats- _____, hydrothermal vents.
•85 species.
•Example- _____.

Phylum Chordata

- _____, hollow nerve cord
- _____ or pharyngeal slits
- _____
- _____ tail
- _____
-

Subphylum _____chordata- tunicates

- _____ a backbone.
- _____current and _____current _____ for filter feeding.
- _____- leathery or gelatinous outer covering.
- _____.
- _____ larva.

•3,000 species.
•Examples- Styela and _____.

Tunicates

Tunicates

Subphylum _____chordata- _____

- _____ a backbone.

•Muscles are _____.
- _____. They use gill slits.

•Reproduction- _____.
•Habitats- soft bottoms.
•23 species.
•Example- _____.

Subphylum Vertebrata

Class _____- jawless fishes
•_____ jaws.
•_____ skeletons.
•Scavengers, invertebrates, and blood _____.
•Reproduction- marine and freshwater.
•Habitats- _____ and _____ bottoms.
•_____ species.
•Examples- _____ and Petromyzon.

Class _____- cartilaginous fishes
•_____ jaws.
•Cartilaginous endoskeleton.
•_____ scales.
•_____ located mouth.
•_____ lateral fins.
•Scavengers, filter feeders, invertebrates, and fish.
•_____ _____ intestine.
•Reproduction- _____ fertilization, sexes _____.
•Habitats- all.
•~850 species.
•Examples- Myliobatis and Carcharodon.

Shark Size and Habitat

Classification
•_____- _____.
•_____- _____.

Fish Scales

Diffusion
•Diffusion- the spontaneous tendency of a substance (solute or solvent) to move from a _____ concentrated to a _____ concentrated area.
–T or F. Diffusion results in the uniform distribution of a substance.

Buccal Ventilation

Myliobatis- bat rays

Spiracles

Gas Exchange

Blood

- _____ - the study of blood.
- Blood consists of 2 components.
  - _____
  - _____ _____
- _____ (99+%)- red blood cells.
- _____ (<1%)- white blood cells.

Hemoglobin

- Hemoglobin- _____ carrying protein/pigment.
  - _____ protein that consists of 4 polypeptide chains.
  - _____ molecules are attached to each polypeptide chain.
- Each heme contains an iron ion (_____) that binds to oxygen.
- Transports oxygen from the gills to tissues and transports the carbon dioxide to the gills.
- _____ - percentage of blood occupied by cells.

Cardiovascular System of Fishes

Ampullae of Lorenzini

Lateral Line

Olfaction

Shark Teeth

Spiral Valve Intestine

Claspers and Eggs

Osteichthyes- Chapter 8

Osteichthyes

- _____ endoskeleton.
- Ctenoid, cycloid, and ganoid _____.
- _____.
- _____cercal tail.
- _____ _____.
- Fins supported by _____ _____ and highly maneuverable.
- Scavengers, filter feeders, invertebrates, and fish.
- Reproduction- internal and external fertilization, sexes separate.
- Habitats- _____.
- ~_____ species.
- Examples- Hypsypops and _____.

Bone Functions

- _____
- _____
- Assistance in _____
- Mineral _____and _____
- _____ storage

_____ **and** _____**Bone**

Fin Rays

***Latimeria*- the coelocanth.**

Protandry- _____.

Protogyny- _____.

Swim Bladder

Catadromous- _____.

Anadromous- _____.

Fish Locomotion

- _____-like swimming
- _____-like swimming

- _____ _____ swimming
- _____ _____ _____ swimming

_____-predator

_____-predator

_____-oriented fishes

_____ fishes

_____-_____ fishes

_____-_____ fishes

Ctenoid Fish Scale

Scale Removal Locations

Take measurements of what?

Age and Growth

Fish Otoliths

Biology 30- Marine Biology
Hartnell College

Laboratory #9- Pacific Coast Fishes

The last several weeks in lecture we focused on the jawless fishes, sharks, skates, rays, and bony fishes. Today in the laboratory you will learn to how to use "A Field Guide to Pacific Coast Fishes of North America" by Eschmeyer, Herald, and Hammann (1983). You will also learn the biology of some of the more common marine fishes from Monterey.

Eschmeyer and Herald organized the book taxonomically. To help the you, the user, they included maps, illustrations within the text, plates with illustrations in black and white as well as color, detailed descriptions of species, a glossary, and an index.

Inside the inner front cover, what five illustrations are presented?

How about the inner back cover, what is illustrated?

How many plates are included in this guide? _____. Where are the plates located?

Is there a glossary in this book? _____. On what page does the glossary begin? _____

How does your book define denticles?

What is the definition of fusiform?

What is an example of a fusiform shaped fish?

What is ovoviviparous?

Where is the index of this book?

Using the index, on what page do you find the description of the albacore? _____ What is the scientific name for albacore? _____ _____ What distinguishes the albacore from the Yellowfin and Bigeye tunas? _____ _____ What other fishes are in the same family as the tuna? _____

Using your index, to what family are trouts and salmon classified? _____
How large do King salmon (Chinook) grow? _____ How do you distinguish a King salmon from other salmons? _____
What is the geographical range of the King Salmon? _____
What is anadromous? _____
How long does the average King Salmon remain at sea? _____

Chapter 1- About this Book
What geographical area is covered in this treatise? From _____ to _____

Describe how the authors recommend you use this book:

Based on information given under the heading "Size", do fishes continue to grow throughout their life? _____ Is this growth faster or slower? _____

Approximately how many centimeters are in 1 inch? _____

Does color vary between individuals of the same fish species? _____

T or F. Usually the male grows to a larger size than the female fish of the same species.

T or F. Most fish species have a restricted geographic range.

Are fishes known to inhabit specific habitats? _____

T or F. Fishes are typically nocturnal.

Chapter 2- Collecting and Observing Fishes
How do you preserve fish?

Chapter 3- Jawless Fishes
What two types of jawless fishes are found on our coast? _____ and _____ Based on the figures and information provided on Plate 1, how do you differentiate these two fishes?

Chapter 4- Cartilaginous Fishes: Class Chondrichthyes
Read page 15 "Typical Sharks." What is the most interesting piece of information you learned from this reading?

Rays are _____ (see pg. 45), with gill slits on the _____, and they lack a _____ fin.

What is the key morphological (shape) feature of the common Thresher shark? _____
What do you think is the function of the caudal fin of this species? _____

What is the key morphological feature of the leopard shark? _____ Is the Leopard shark considered dangerous to humans? _____ Is it 'good eatin'? _____

Describe the bat ray (*Myliobatis californica*):

How does *Myliobatis* feed? _____
How does *Myliobatis* differ from mantas and stingrays? _____
_____

Chapter 5- Bony Fishes: Class Osteichthyes
Describe the California Moray: _____
_____

What do morays eat? _____

Does the California Moray bite divers? _____

How long does the California Moray live? _____

Describe the Northern Anchovy: _____
_____

Is this anchovy common in our area? _____

What are these anchovies processed for? _____

What eats the Northern Anchovy? _____

The Pacific Cod has _____ dorsal fins, a _____ barbel, and _____ anal fins. Illustrate (draw) the Pacific Cod below:

How is the Pacific Cod of significance to humans? _____
_____

What size does *Gadus macrocephalus* grow to? _____

What other fishes are similar to the Pacific Cod? _____

What are sculpins? _____

What is distinctive about sculpins? _____

What is a "Home Pool"? (see pg. 160)

What is *Sebastes*? _____

Which *Sebastes* is your favorite? _____
Where does it live (habitat)? _____

List 6 interesting traits or pieces of information about the California Sheephead (*Semicossyphus pulcher*):
1) _____
2) _____
3) _____
4) _____
5) _____
6) _____

What is the main difference between species illustrated on plate 43, versus those illustrated on plates 44 and 45? _____

What is the common name for these fishes (pg. 283)? _____

Describe what one of the eyes does as the fish grows:

Have you ever eaten *Paralichthyes californicus*? _____ Is it a left or right eyed flounder? _____

What is the bottom side (typically white in color) of a flounder referred to as? _____ side

What type of habitat is the California Halibut found in? _____

What does *Paralichthyes californicus* eat? _____

Select 1 species in this book that you would like to learn more about. Read about it, then summarize its characteristics, habitat, feeding habits, behavior, reproduction, or anything of interest in the space provided below. Then describe your fish to one of your lab partners.

Class Aves and Reptilia- Chapter 9

Class Aves

- _____ endoskeleton
- _____
- _____
- _____thermic
- _____ bones
- _____ for maneuverability
- Eat- scavengers, filter feeders, invertebrates, and fish.
- Reproduction- _____ egg.
- Habitats- all.
- ~_____ species.
- Examples- Phalacrocorax, _____, and _____.

Hollow Bones with Struts

Feathers

Beak Shape

a) Petrel-
b) Razorbills and Penguins-
c) Terns and Boobies-
d) Skimmers-

Feeding Strategies

____ Pelicans	a. pattering
____ Boobies	b. aerial pursuit
____ Jaegers	c. dipping
____ Frigate birds	d. pursuit diving with wings
____ Gulls	e. pursuit diving with feet
____ Storm Petrels	f. surface plunging
____ Diving Petrels	g. pursuit plunging
____ Penguins	
____ Cormorants	
____ Shearwaters	

Emperor Penguins

Archaeopteryx

Class Reptilia

•Bony endoskeleton
•_____ skin
•_____thermic
•Well developed _____
•Limbs for support on land
•Eat- algae, invertebrates, and fish.
•Reproduction- _____ fertilization; egg with shell, _____ egg.
•Habitats- pelagic and near shore.
•~_____ species.
•Examples- Dermochelys and _____.

Reptile Skin

Reptile Eggs

Iguanas and Snakes

Turtle Necks

Turtle Skeleton

Life Cycle of the Sea Turtle

Natal Homing Hypothesis- Meylan et al. 1990 (*Science* 248:724).

Philopatry of Male Turtles- FitzSimmons et al. 1997 (*Proc. Natl. Acad. Sci. USA* 94:8912-8917).

Class Mammalia- Chapter 9

Class Mammalia

- _____
- _____thermic
- _____ glands
- Complex _____ nervous systems
- Eat- filter feeders, predators on invertebrates, fish, birds, and mammals.
- Reproduction- mostly _____.
- Habitats- all.
- ~4,600 species in the ocean
- Examples- Phoca, _____, and _____.

Brains

Nervous System

- _____- (neur- *gr. nerve*) the scientific study of the nervous system.
- Nervous Tissue
  - _____ (nerve cells)
  - _____

Neurons

- Neuron- the functional unit of the nervous system.
- Numbers
  - >_____ billion in the brain.
  - ~_____ billion in the spinal cord.
- Neurons consist of _____, _____ _____, & _____.

Order Pinnipedia- _____, _____ _____, and _____

- Paddle-shaped flippers
- Predators
  - Eat _____ **and** _____,
- _____
- Breed on _____

Anatomy of Pinnipeds

Leptospirosis

Order Carnivora- _____ _____ and _____ _____

- _____
- Teeth adapted for _____ flesh
- _____

Sea Otters

- Enhydra lutris
- _____ marine mammal
- _____ lbs.
- Dense fur
- Eat _____-_____% of body weight/day
  - Urchins, abalone, mussels, crabs, fishes.

Order Sirenia- _____ and the _____

Order Cetacea- _____, _____, and _____

- _____ of marine mammals
- Spend entire lives in _____
- _____ bodies
- _____ present in front, but lack rear limbs
- Most have a _____ fin
- _____
- _____
- ~_____ species

Order Cetacea

- Suborder_____
  - Baleen whales
  - 2 external blowholes
  - Symmetrical skull
  - Echolocation doubtful
  - Usually 4 digits in flipper
  - Large tongue
  - Rigid thorax

•Suborder _____
- _____ whales
- _____ external blowhole
- _____ skull
- Echolocation _____
- Usually _____ digits in manus
- _____ tongue
- _____ thorax

Porpoise-

Dolphin-

Streamlined Morphology

Dolphin Fetus- 2 pairs of limbs

Fluke Morphology

Mysticeti Morphology

Baleen

Migration Routes

Mating Behavior

Swimming and Diving

Echolocation- sonar

•Emit bursts of _____ _____ (clicks) through air passages and sacs.

•_____ directs the clicks.

•Sound waves are _____ and _____ by the _____ to the inner ear, then to the brain.

Stranding (_____)

•Whales and dolphins

– _____ and _____ whales

•Herd mentality

•Recent strandings result of high-intensity naval sonar.

– _____ _____

Reproduction

•_____- collection of many females guarded by a single _____ male.

– Sea lions, fur seals, elephant seals.

•_____ groups- males that _____ _____ hold harems.

Gestation

•Gestation- _____.

_____

International Whaling Commission (IWC)

•Established in _____

•Regulate hunting and _____ _____

•Nearly all great whales are listed as endangered

•_____, _____, _____ still hunt.

Great Whale Population Estimates

Drift Nets

•Marine mammals get entangled in the nets.

•Net size- as large as _____ miles long and _____ ft deep.

•Trap _____ _____ as well.

•_____ practice in _____.

***Science of Whales* Notes**

Marine Ecology- Chapter 10

What does Environmental science focus on?

Ecological Definitions

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

What are transects and quadrats?

Deep Water Invertebrate Sampling

- _____ _____- used to collect a known area (usually 0.1 m^2) of sediment.
  - Most common technique for determining the number of _____ _____.

Sieve out animals, preserve them, sort by species and count.

Ecology Deals with 3 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.

Physical Communities

Marine Communities

- _____ outer coast
  - Rocky shores
  - Sandy beaches
- Open (_____) coast
  - _____ shores
  - _____ beaches
- _____
- _____

Abiotic and Biotic Factors

•Abiotic- characterized by the absence of life; _____.

- –_____
- –_____
- –_____
- –_____of shoreline
- –_____
- –Light _____ and _____
- –_____
- –_____
- –_____
- –_____

•Biotic- of or relating to life; _____.

- –_____- space, substrate, light, nutrients, prey.
- –_____

Algal-Herbivore Interactions

Succession

•Succession- the _____ process of _____ after disturbance.

- –_____succession- the initial colonization of available rock by pioneer species (algae).
- –_____succession- the changes in the algae and animals that live in a community after the initial colonization.

Opportunistic vs. Late Successional Species

•r-selected

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

•K-selected

- –Invade _____ communities on predicatable basis.
- –Life History- complex, _____, _____ reproduction.
- –Size- _____.
- –Growth- _____.
- –Reproduction- _____ output, _____ offspring, high cost/unit.
- –Energy storage- _____ distributed.

Population Explosions

Carrying Capacity

Competitive Exclusion

Species form relationships

- _____- a close relationship between 2 species.
  - _____
  - _____
- 3 Main types of Symbiosis
  - _____
  - _____
  - _____
    - Facultative Symbiosis
    - Obligate Symbiosis

Commensalism

Parasitism

Mutualism

Tides, Evolution, Between the Tides- Chapters 3, 4, 11

Tidal Ranges and Tidal Bulges

Types of Tides

Abiotic and Biotic Factors

Abiotic- characterized by the absence of life; physical.
- –Temperature
- –Salinity
- –Dessication
- –Topography of shoreline
- –Nutrients
- –Light quantity and quality
- –Substrate
- –Currents
- –Wave exposure
- –Depth (Pressure)
- –Anthropogenic
- –pH

Biotic- of or relating to life; biological.
- –Competition- space, substrate, light, nutrients, prey.
- –Herbivory

Origin of Species

- _____- each of the different kinds of organisms were created in their present form.
- Inheritance of acquired characteristics- the _____ an organism acquires during its _____ can be passed along to its _____.

Charles Darwin- 1831 HMS Beagle

Observations by Darwin in the Galápagos

•Two Important Observations
1) Plants and animals on the island were _____ to those on the nearby _____.
2) _____ variation occured between organisms from _____ to _____.

Darwin repeatedly emphasized two points in his book.

•Species evolve from other species. He termed this "descent with modification" = _____

•The mechanism or driving force of evolution is = _____

Darwin cited the following in support of Natural Selection:

•_____ _____ in every group of plants and animals.
•_____ _____ have the potential to _____-_____.
•_____.
•Only the _____ _____ to the local environment _____ and _____ along _____ to the next generation.

Darwin's own sketches of Galápagos finches.

(1) Large ground finch *Geospiza magnirostris*
(2) Medium ground finch *Geospiza fortis*
(3) Small tree finch *Camarhynchus parvulus*
(4) Warbler finch *Certhidea olivacea*

Plant Seeds- _____.

Exposure at Low Tide Leads to Dessication- drying out.

Why do chitons and snails congregate in tide pools at low tide?

How do mussels retain moisture

How do algae retain moisture?

How do snails stay cool?

•**Salinity Regulation**
- –Rain
- –Evaporation
- –Rivers
- –Runoff

How do these snails retain moisture and escape salinity fluctuations?

How do these mussels retain moisture and escape salinity fluctuations?

Exposure to Wave Shock

Adaptations to Wave Shock

Rocky Shore Food Web

Competition for Space

Intertidal Zonation

Intertidal Zonation and Distribution

<u>Keystone Predators</u>- predators whose _____ on their communities are proportionately much _____ _____ their _____.

Ecological Succession

Intermediate Disturbance Hypothesis
- **_____ is highest when disturbance is neither too rare nor too frequent.**

Soft Bottom Intertidal Communities

Sand types and sorting types affect the amount of detritus, draining capabilities, and oxygen content.

Soft Bottom Food Web

Resources from the Sea- Chapter 17

Human Population Growth

Types of Resources from the Sea

- Living Resources
  - _____
  - _____ and recreation
- Non-Living Resources
  - Oil and gas
  - Mining
  - Drinking water
  - Minerals
  - Energy

Fish Catch

- Processed for:
  - Human _____
  - _____ _____
  - _____
  - _____ _____

Total Catches by Major Fishing Nations

Northeast Pacific

World Commercial Catches

Fishing Methods

Optimal Yields and Overfishing

- Renewable resources- organisms that can _____ _____.
- Nonrenewable resources- organisms that are _____ _____ _____.

Overfishing and Stock

- Reproductive rate partly depends on the _____ of the population, _____.
- _____- a method of harvesting or using a resource so that the resource is not depleted or permanently damaged.
  - Sustainable yield- amount that can be caught, but will still maintain a _____ population size.

_____ **Sustainable Yield**

- The highest catch that can be continued _____ _____ _____ without threatening the stock.

Sardine Population

Threats Caused by Fishing

- Exhausting the fisheries
  - _____% of big fishes in the world are gone
  - _____% of all marine commerical fishes are exploited or depleted
  - _____% reduction in shark populations on the eastern coast of the US
  - _____% swordfish reduction
- _____ - _____
  - 25% of the world catch
- Effects on marine mammals, birds, and other fish

Mariculture

- The culture of marine organisms (marine _____).
- Open mariculture
  - Organisms are cultured in _____ _____
- Closed mariculture
  - Organisms are cultured in a _____ _____

Nori Mariculture

Oil and Gas

- The _____ _____ is rich in oil and natural gas.
  - Gulf of Mexico

- _____
- Oil _____

Ocean Mining

- Sand and Gravel for construction purposes
- Phosphates
- _____ _____
  - Manganese, nickel, copper, cobalt
- Hydrothermal vents

_____

Minerals

- _____
- Magnesium
- Bromine
- Uranium?

Energy

- Tidal Energy
  - _____
  - _____
  - _____
- Ocean Thermal Energy Conversion (_____)

Study Guide for Lab and Lecture Examination 1

1-22. Multiple Choice. Select the single best possible answer for each question.

1. In the correct order, the steps to the scientific method are _____.
    a. observation, hypothesis, experiment, conclusions
    b. observation, experiment, hypothesis, conclusions
    c. hypothesis, observation, experiment, conclusions
    d. observation, hypothesis, conclusions, experiment
    e. none of the above
2. Which of the following is not a building block (macromolecule) found in living things?
    a. hormones
    b. carbohydrates
    c. proteins
    d. nucleic acids
    e. lipids
3. Prokaryotic cells _____.
    a. include the Bacteria and Archaea
    b. are small (1-10 μm)
    c. lack organelles
    d. have circular DNA
    e. all of the above
4. Which of the following is not true of the Cell Theory?
    a. all living things are composed of cells
    b. new cells arise only from preexisting cells
    c. cells are similar in structure but dissimilar in chemical composition
    d. cells contain hereditary information which is passed from cell to cell during cell division
    e. the cell is the basic unit of life
5. Which of the following is not classified in the Domain Eukarya?
    a. Plantae
    b. Fungi
    c. Animalia
    d. Protista
    e. Cyanophyta
6. The pelagic zone of the marine environment _____.
    a. includes the neritic and the oceanic provinces
    b. is defined as the region between the high tide mark and the low tide mark
    c. is divided into the subtidal, bathyal, and the deep sea floor
    d. is the part of the ocean that extends from the intertidal to the edge of the continental shelf
    e. none of the above
7. Cyanophyta _____.
    a. contain chlorophyll A
    b. are bacteria
    c. includes members of the genus Oscillatoria
    d. are photosynthetic
    e. all of the above
8. A group of similar cells that perform a common function are _____.
    a. cells
    b. atoms
    c. organs
    d. tissues
    e. systems
9. Two or more different tissues that perform a common function is _____.
    a. an organ
    b. tissue
    c. an organ system

d. an individual
e. ludicrous and does not occur in marine animals

10. Cyanophyta _____.
    a. produce about 20% of the world's oxygen
    b. produce about 80% of the world's oxygen
    c. are heterotrophic
    d. are eukaryotic
    e. are red in color due to phycobilisomes present on the thylakoids
11. The dinoflagellates are known for _____.
    a. causing red tides
    b. depositing silica (glass) in their cell walls
    c. their golden-brown color
    d. having prokaryotic nuclei
    e. living in the armpits of dinosaurs during the Cretaceous period
12. The diatoms _____.
    a. are eukaryotic Protista
    b. contain fucoxanthin which gives them a brown color
    c. includes the genera Bacillaria, Chaetoceros, and Navicula
    d. are the most abundant eukaryotic phytoplankton in the ocean
    e. all of the above
13. Foraminiferans _____.
    a. are made of silica
    b. are all extinct
    c. include the genera Strombilidium and Tintinnopsis
    d. have spirally arranged chambers made of calcium carbonate (CaCO3)
    e. none of the above
14. Foraminiferans and radiolarians capture food particles using _____.
    a. enzymes
    b. spines
    c. pseudopodia
    d. ooze
    e. trichocysts
15. Which of the following is not true of the Fungi?
    a. they are eukaryotic
    b. most are multicellular
    c. most are composed of hyphae
    d. they are autotrophic
    e. they are ubiquitous
16. The green algae _____.
    a. are photosynthetic
    b. contain chlorophylls A and B, as well as carotenoids
    c. are typically grass green in color
    d. include genera such as Ulva and Codium
    e. all of the above
17. The red algae _____.
    a. are generally yellow brown in color due to the pigment fucoxanthin
    b. contain 2 flagella, 1 tinsel and the other whiplash
    c. have alginate in their cell walls
    d. contain phycobilins and chlorophylls A and D
    e. include genera such as Laminaria and Fucus
18. Photosynthesis _____.
    a. occurs in the mitochondria of the cell
    b. produces carbon dioxide that fishes and invertebrates need to respire (breathe)
    c. produces carbohydrates from carbon dioxide and water
    d. was first proposed by Albert Einstein in 1905
    e. all of the above

19. The light reaction in photosynthesis _____.
    a. is also called the z-scheme
    b. is the site of light energy absorption
    c. creates molecules (ATP and NADPH) that are used in the Calvin cycle
    d. contains reaction centers that contain plant pigments
    e. all of the above
20. Scyphozoans _____.
    a. do not have tissues or organs
    b. are composed of pinacocytes and porocytes
    c. are large jellies with a sizeable layer of mesoglea
    d. contain calcareous spicules
    e. are suspension feeders
21. Cnidarians _____.
    a. show system level organization
    b. have stinging cells called cnidocytes which contain nematocysts
    c. are filter feeders
    d. occur in 3 forms: polyps, medusae, and fusiforma
    e. include the genera Haliotis, Mytilus, and Loligo
22. Heterokont algae _____.
    a. contain 2 flagella that are similar in structure
    b. contain 1 flagellum that is the whiplash type
    c. contain 1 flagellum that is the tinsel type
    d. contain 2 flagella, 1 is whiplash and 1 is tinsellated
    e. none of the above

23-44. True or False. Mark A for true, mark B for false. If false, correct the statement so that it is true.

23. The scientific method is a procedure that is used to solve problems and answer questions.
24. The scientific method is a technique that can only be applied to scientific problems.
25. A scientific theory is a broad-ranging explanation for some aspect of the universe that has been repeatedly confirmed through hypothesis testing.
26. Genetic evidence indicates that aborigines were the first to measurably sail the ocean 70,000 years ago.
27. The first large scale European civilization, the Minoan, was based on maritime trade.
28. An example of a scientific theory is the cell theory.
29. A scientific theory is a hypothesis that is being tested for the first time.
30. Elements are substances composed of two types of atoms.
31. Carbon, nitrogen, and magnesium account for 90% of the elements in living things.
32. The English scientist Edouard van Beneden described and named the first cells in 1665.
33. The very first microscope was made in Holland around 1895.
34. Diffusion is the spontaneous tendency of a substance to move from a less concentrated to a more concentrated area.
35. Osmosis is the diffusion of water through a selectively permeable membrane.
36. Plankton are classified according to their size.
37. The smallest plankton are termed picoplankton.
38. Archaea live in extreme environments such as hydrothermal vents.
39. Anthophyta contain roots, stems, and leaves.
40. Sugars from photosynthesis are produced in the Calvin Cycle.
41. Invertebrates are animals with backbones.
42. Sponges are able to asexually reproduce by fragmentation.
43. Cephalopods include squids, cuttlefishes, nautiluses, and octopuses.
44. Clams, mussels, and oysters are gastropods.

45-56. Matching. Match the level of organization on the left to its definition on the left.

45. Molecule	a. all the species in an ecosystem that can interact
46. Cell	b. a single organism
47. Organ	c. a community and its physical environment
48. Organ System	d. group of related organs that have a common function

49. Individual	e. all individuals of the same species that occupy a given area
50. Population	ab. two or more different tissues that perform a common function
51. Community	ac. the basic unit of life
52. Ecosystem	ad. the part of the earth that supports life
53. Biosphere	ae. group of similar cells that perform a common function
54. Tissue	bc. combinations of atoms that are bonded together
55. Atom	bd. the fundamental unit of all matter
56. Organelle	be. a subcellular membrane-bound compartment

57-60. Match the description on the right to the microscope type on the left.

57. Compound	a. 50,000X; electrons are passed through a specimen
58. Dissecting	b. 1,000X; light is passed through a specimen
59. Transmission Electron	c. 4X-50X; light is passed through or reflected on a specimen
60. Scanning Electron	d. 10,000X; electrons are run over the surface of a specimen coated with metal

61-63. Match the description on the right to the solution type on the left.

61. Isotonic	a. have lower solute concentrations than the cell
62. Hypotonic	b. have higher solute concentrations than the cell
63. Hypertonic	c. have the same concentration of solute as the cell

64-66. Match the protozoan names on the right to the taxonomic name on the left.

64. Granuloreticulosa	a. ciliates
65. Polycystina	b. radiolarians
66. Ciliophora	c. foraminiferans

67-74. Match the algae on the right to the taxonomic name on the left.

67. Dinophyta	a. golden-brown algae
68. Cryptophyta	b. diatoms
69. Haptophyta	c. haptophytes
70. Phaeophyceae	d. brown algae
71. Chrysophyceae	e. green algae
72. Bacillariophyceae	ab. red algae
73. Chlorophyta	ac. cryptomonads
74. Rhodophyta	ad. dinoflagellates

75-78. Match the animals on the right to the taxonomic group on the left.

75. Porifera	a. squid, snails, octopus, limpets, bivalves
76. Cnidaria	b. hydroids, jellies, anemones, and corals
77. Mollusca	c. sponges
78. Ctenophora	d. comb jellies

79-88. Match the taxonomic group on the right to the structures on the left.

79. Medusae	a. Porifera
80. Nematocysts	b. Cnidaria
81. Collar cells (choanocytes)	c. Mollusca
82. Mantle	d. Ctenophora
83. Nerve net	
84. Foot	
85. Radula	
86. Most primitive animals	
87. Epidermis and gastrodermis	
88. Rows of cilia	

Additional Questions

-What are the characteristics of a good marine biologist?

-Provide an example of an everyday use of the scientific method.

-Provide an example of the scientific method used in science.

-At some intertidal sites mussels are the dominant organism and at others we see a more diverse assemblage of organisms including sea stars, mussels, barnacles, and rockweeds. Provide an explanation for the differences observed at these two sites and describe how you would test your explanation (hypothesis).

-Place the following in order from largest level of classification to smallest: genus, family, domain, species, order, phylum, kingdom, class.

-Draw the life cycle of Ulva and Aurelia. Label the structures shown in lecture or in your lab handout.

-How do marine animals use seaweeds? List 5 uses.

-How do killer whales effect the growth of kelp forests?

Laboratory portion of the examination

-Be able to make an observation, ask a question, come up with a hypothesis, experiment (list the variables, control-dependent-independent), and predict your conclusions, as we practiced in the lab.

-Be able to distinguish between the dissecting and compound microscopes.

-Be able to determine the total magnification on an object or specimen using the dissecting and compound microscopes.

-Be able to identify the 12 microscope structures illustrated in the lab handout as well as know their functions.

-Using the illustrations in your lab manual, be able to distinguish zooplankton from phytoplankton.

-Be able to identify a plankton net if you saw one.

-Based on an anatomical section of a seaweed thallus, be able to determine if a blade belongs in the Chlorophyta, Rhodophyta, or the Phaeophyceae.

-Using a dichotomous key or by picture keying, be able to identify seaweeds to species.

-Using herbarium specimens, be able to identify seaweeds to species.

-Be able to identify an Aurelia medusa.

-Using Aurelia as a model, be able to identify the following: oral arms, tentacles, exumbrella, subumbrella, mouth, rhopalium, gonads, gastric filaments, gastric pouches, bell, and radial canals. Be able to describe the function of each structure.

-Using Figure 8.7 of the lab handout and your notes of the anemone dissection, study and know the following: mouth, oral disc, tentacles, pharynx, retractor muscle, acontia, pedal disc, gonads, gastrovascular cavity, retractor muscles. Be able to describe the function of each structure.

-Know all of the anatomical structures for the octopus listed on page 135, Fig. 7.24. Also know their functions.

-Be able to identify all of the structures illustrated on pages 16-4 and 16-5 of the lab handout (pages 248 and 249), as well as describe the function of each structure.

Study Guide for Lab and Lecture Examination 2

1-43. Multiple Choice. Select the single best possible answer for each question.

1. Crustacean maxillipeds are useful for _____.
    a. feeding
    b. filtering
    c. sorting through food material
    d. locomotion
    e. all of the above
2. Barnacles are _____.
    a. part photosynthetic, part decomposers
    b. deposit feeders
    c. suspension feeders
    d. echinodermata
    e. none of the above
3. Which of the following is not true of decapods?
    a. they are crustaceans
    b. they have 10 legs
    c. they typically have pincer-like 1st legs
    d. they lack an anus
    e. they have a protective cephalothorax and abdomen
4. Marine crustaceans _____.
    a. have radial symmetry
    b. include genera such as Bugula and Watersipora
    c. spend part of their life in the plankton as larvae after they hatch
    d. compared to other animals in the ocean, account for the least number of species
    e. are crusty, like 2 day old bread, which is where the name 'crusta' came from
5. Marine food webs _____.
    a. begin and end with primary producers (algae)
    b. begin with primary producers and are followed by crustaceans
    c. begin with the zooplankton
    d. do not have a beginning, that is why they are called 'webs'
    e. none of the above
6. Echinoderm tube feet _____.
    a. are driven by a blood vascular system
    b. are always located on the aboral surface
    c. are used for feeding, sensing, and locomotion
    d. lack muscles
    e. all of the above
7. Which of the following is not true of Asteroidea?
    a. the madreporite and anus are aborally located
    b. pedicellariae are present
    c. the tube feet have suckers at the tips
    d. the tube feet are used for locomotion
    e. they have a well defined central disc but lack arms (rays)
8. Echinoids _____.
    a. have a globular to disc shape calcium carbonate test
    b. lack spines
    c. lack pedicellariae
    d. contain a madreporite, but lack an anus
    e. all of the above
9. Which of the following is not a characteristic of chordates?
    a. dorsal, hollow nerve cord
    b. pinacocytes
    c. gill or pharyngeal slits

d. post-anal tail
e. endostyle

10. Acorn worms _____.
    a. are classified in the phylum Chordata
    b. live and swim in the pelagic zone
    c. are deposit feeders
    d. have larvae that are similar to fish
    e. all of the above
11. Urochordata _____.
    a. includes about 3,000 species
    b. contains the genera *Styela* and *Ciona*
    c. have tadpole larvae
    d. have incurrent and excurrent siphons for filter feeding
    e. all of the above
12. The common name 'Tunicate' comes from _____.
    a. the word 'Tunisiphonia', which means to siphon
    b. the word 'Tunicata', which means to swim like a tuna
    c. the behavior of the larva, which is said to 'Tunicate' when it feeds
    d. the leathery or gelatinous outer covering that is termed 'Tunic'
    e. its two ('tu') Greek discoverers, which were coincidentally both named 'Nikos'
13. Salps are _____.
    a. the mussel stock used by biologists for culturing
    b. sessile and typically occupy the benthic zone of the low intertidal
    c. the component of plankton that consists of 0.2-2 μm sized individuals
    d. terrestrial snails that eat algae
    e. pelagic tunicates with transparent bodies that sometimes form long colonies
14. Lancelets _____.
    a. are monoecious
    b. lack myomeric (muscle) segmentation
    c. are fish-like filter feeding animals that lack a backbone
    d. are best exemplified by the genera Saccoglossus and Schizenocystia
    e. inhabitants of the pelagic
15. Cephalochordates _____.
    a. live partially buried on soft bottoms where they filter feed using tentacles
    b. have a totally sessile and a free-swimming stage
    c. lack an anus
    d. are typically found near hydrothermal vents
    e. none of the above
16. *Myxine* and *Petromyzon* are examples of _____.
    a. jawed fishes
    b. an extinct assemblage of fish
    c. jawless fishes
    d. bony fishes
    e. fishes ground up and used for 'Petro' or fuel in Scandinavia
17. Some agnathans _____.
    a. parasitize the gills of fish
    b. are scavengers
    c. can live in freshwater
    d. live on muddy bottoms
    e. all of the above
18. Hagfish tie themselves into knots _____.
    a. to accelerate gas diffusion across their gills
    b. to mimic a pretzel, which attracts snappers and other prey
    c. when they are spawning
    d. because its fun, haven't you ever played the game twister
    e. to remove slime and tear apart decomposing marine animals

19. Which of the following is not a characteristic of the class Chondrichthyes?
    a. movable jaws
    b. cartilaginous endoskeleton
    c. ventrally located mouth
    d. ctenoid scales
    e. spiral valve intestine
20. *Myliobatis* is the genus for _____.
    a. bat ray
    b. surf perch
    c. great white shark
    d. ratfish
    e. garibaldi
21. Which of the following is not one of the scale types found in fishes?
    a. placoid
    b. ctenoid
    c. cycloid
    d. hexoid
    e. ganoid
22. Spiracles _____.
    a. are larger in size in fast swimming sharks
    b. are specialized gas valves that regulates the swim bladder
    c. are respiratory openings located behind the eyes
    d. are modified pelvic fins that act as reproductive structures
    e. is a good name for a poodle that likes to run in circles
23. The operculum _____.
    a. encloses the gills of cartilaginous fishes
    b. helps the muscles of the caudal (tail) fin to contract
    c. is a hard, flat structure that protects the gills of bony fishes
    d. is a bone used to detect sensitive sounds in the water column
    e. none of the above
24. Gas exchange in fishes occurs in the gills using _____.
    a. a concurrent system of exchange
    b. a countercurrent system of exchange
    c. a negative feedback loop of exchange
    d. a positive feedback loop of exchange
    e. an antagonistic feedback loop of exchange
25. Which of the following is not true of fish blood?
    a. it contains plasma
    b. it contains erythrocytes
    c. it contains leucocytes
    d. it lacks thrombocytes (blood clotting cells)
    e. active fish contain more red blood cells than inactive fish
26. The ampullae of Lorenzini _____.
    a. detect chemicals in the water
    b. detect water temperature
    c. detect electrical fields in the water
    d. detect tastants (tastes) in the water
    e. are found in the face region of bony fishes
27. The fish lateral line _____.
    a. detects movement in the water
    b. consists of a linear series of mechanoreceptors
    c. contains neuromast cells
    d. contains canals with openings
    e. all of the above
28. Shark teeth _____.
    a. are rarely regenerated

b. shed once in the lifetime of an individual
c. are sharp, triangular, and replaced throughout the lifetime of an individual
d. are made predominantly of keratin
e. are indistinguishable between species

29. Skates and rays _____.
    a. are catadromous
    b. are anadromous
    c. are oviparous and ovoviviparous
    d. are members of Osteichthyes
    e. none of the above
30. Which of the following is <u>not</u> a characteristic of the class Osteichthyes?
    a. they have bony endoskeletons
    b. they have operculums
    c. they have heterocercal tails
    d. they have swim bladders
    e. their fins are supported by fin rays
31. *Hypsypops* and *Thunnus* are examples of _____.
    a. elasmobranchs
    b. echinoderms
    c. holocephalli
    d. bony fishes
    e. cephalopods
32. Which of the following is <u>not</u> a function of bone?
    a. support
    b. protection
    c. assistance in movement
    d. mineral storage and release
    e. hormone synthesis
33. The order in which prey is digested in a bony fish is as follows:
    a. mouth, throat, esophagus, stomach, intestine, anus
    b. mouth, esophagus, throat, stomach, intestine, anus
    c. mouth, throat, esophagus, intestine, stomach, anus
    d. mouth, esophagus, throat, intestine, stomach, anus
    e. mouth, throat, esophagus, stomach, anus, intestine
34. Which of the following is <u>not</u> a type of swimming seen in marine fishes?
    a. eel-like
    b. tuna-like
    c. shark-like
    d. fins only
    e. caudal fin only
35. Fish scales _____.
    a. are composed of keratin, a fibrous protein
    b. contain annuli
    c. contain circuli
    d. can be used to estimate the age and growth of a fish
    e. all of the above
36. *Phalacrocorax*, *Larus*, and *Pelecanus* are examples of _____.
    a. bird genera
    b. reptile genera
    c. bony fish genera
    d. shark genera
    e. mammal genera
37. Which of the following is <u>not</u> a characteristic of the class Aves?
    a. bony endoskeleton and beak
    b. solid bones
    c. feathers

d. endothermic
e. amniotic egg

38. The shape of a bird's beak _____.
    a. is related to the kind of food it eats
    b. is related to its feeding style
    c. is heavy (robust) in penguins that eat crustaceans
    d. is straight and narrow in plunge divers such as terns
    e. all of the above
39. Which of the following does <u>not</u> support a dinosaur ancestry for birds?
    a. a fused collar bone (furcula)
    b. *Archaeopteryx*
    c. astragalus (anklebone) fused to tibia (shinbone)
    d. saurischian pelvis in dinosaurs and birds
    e. flight feathers on some saurischian dinosaurs
40. Which of the following is <u>not</u> a characteristic of the class Reptilia?
    a. they are endothermic
    b. they have scaly skin
    c. they have well developed lungs
    d. they eat algae, invertebrates, and fish
    e. there are about 7,000 species of them
41. Which of the following is <u>not</u> true of turtles?
    a. their shell has two parts: a plastron and carapace
    b. their sex can be determined by examining the plastron and the location of the anus
    c. their shells consists of scutes (plates)
    d. they use gills for breathing
    e. they migrate from feeding to mating grounds
42. Which of the following is <u>not</u> represented in the ocean?
    a. turtles
    b. snakes
    c. iguanas
    d. lizards
    e. crocodiles
43. According to mitochondrial DNA data _____.
    a. male turtles return to the area where they were hatched when they feed
    b. female and male turtles return to the area where they were hatched to mate
    c. male turtles randomly select areas to mate regardless of where they were hatched
    d. female turtles randomly select areas to mate regardless of where they were hatched
    e. none of the above

<u>44-76. True or False. Mark A for true, mark B for false. If false, correct the statement so that it is true.</u>

44. Copepod antennae contain mechanoreceptors and chemoreceptors.
45. Copepods are benthic organisms that crawl around on the mud.
46. The exoskeleton of amphipods and isopods is made of keratin.
47. Female fiddler crabs use an enlarged pincer to attract males during courtship.
48. Echinoderms are unable to asexually reproduce.
49. Pedicellariae occur in sponges where they function as cleaners of the epidermis.
50. Ophiuroideans lack an anus and their ambulacral groove is closed.
51. Holothuroideans lack arms and are cucumber shaped.
52. The smallest extant shark is the spined pygmy shark.
53. The largest living sharks in the world are filter feeders.
54. Shark scales reduce drag and offer protection.
55. Diffusion is the spontaneous tendency of a substance to move from a more concentrated to a less concentrated area.
56. Blood entering the gills of a fish is poorly oxygenated.
57. Hematology is the study of blood.

58. Hemoglobin transports oxygen from the gills to tissues and carbon dioxide to the gills.
59. Olfaction is a sense used only by reptiles and mammals.
60. Shark cartilage has been shown to weaken the immune system of humans.
61. Spongy bone is very dense.
62. Fin rays in bony fishes can be sharp or soft.
63. The swim bladder regulates buoyancy in sharks.
64. Bony fishes drink a lot of seawater because they lose it through osmosis.
65. Sharks retain urea in their blood to maintain about 35 $^{o}/_{oo}$ or higher blood tonicity.
66. Body shape of bony fishes varies with habitat.
67. An example of a lie-in-wait predator is a tuna.
68. Surface oriented fishes are laterally flat like the starry flounder.
69. Surf perch are characteristic of deep-bodied fish.
70. Hollow bird bones are supported by struts.
71. Contour feathers are used primarily for insulation.
72. *Archaeopteryx* is an extinct reptile with bird like features.
73. *Dermochelys* is the genus for the leatherback sea turtle.
74. Lift in cartilaginous fishes is accomplished with the fatty liver and shape of the body.
75. California's state marine fish is the ratfish.
76. Male bony fishes have claspers that are used for copulation.

77-79. Match the animals on the right to the taxonomic group on the left.

77. Echinodermata	a. bryozoans
78. Arthropoda	b. crabs, shrimp, barnacles, copepods, amphipods
79. Ectoprocta	c. sea stars, urchins, brittle stars, sea cucumbers

80-88. Match the taxonomic group on the right to the structures on the left.

80. Compound eyes	a. Arthropoda
81. Pentamerous	b. Ectoprocta
82. Exoskeleton is molted	c. Echinodermata
83. Lophophore	
84. 2 pairs of antennae	
85. Water vascular system	
86. Zooids	
87. Jointed appendages	
88. Segmented	

89-98. Match the feeding strategy on the right to the type of bird on the left.

89. Pelicans	a. pattering
90. Boobies	b. aerial pursuit
91. Jaegers	c. dipping
92. Frigate birds	d. pursuit diving with wings
93. Gulls	e. pursuit diving with feet
94. Storm Petrels	f. surface plunging
95. Diving Petrels	g. pursuit plunging
96. Penguins	
97. Cormorants	
98. Shearwaters	

-Be able to illustrate and label the gills of a fish. Label the following: gill raker, gill arch, gill lamellae, gill filaments, capillaries.
-Draw the generalized life cycle of a sea turtle.

Laboratory portion of the examination

General comment- read and understand the laboratory handouts.

-Common Marine Invertebrates of Monterey. "Guide to Marine Invertebrates: Alaska to Baja California" by Gotshall (2005) to the exam. You should know how to use this book. For instance if I give you a specimen and ask you which species or invertebrate group it belongs in, you should be able to answer. Be able to define terms and look up specimens via scientific and common names.

-Sea star dissection. Be able to identify as well as know the functions of the following structures: mouth; cardiac stomach; pyloric stomach; intestine; anus; pyloric ceca (plural- cecae); pyloric duct; gonads; madreporite plate; stone canal; ring canal; radial canal; ampulla (plural- ampullae); tube feet; eyespot; ambulacral ridge; dermal ossicles; epidermis, aboral and oral surfaces.

-Sea urchin dissection. Be able to identify as well as know the functions of the following structures: test, spines, tubed feet, pedicellariae, ambulacral plates and interambulacral plates, madreporite, aboral and oral surfaces, 5 teeth, mouth, pharynx, esophagus, intestines, anus, aristotle's lantern, ring canal, radial canal, ampullae, gonads, and gills.

-Shark dissection. Be able to identify as well as know the functions of the following shark structures: head; gill slits; caudal fins; pectoral fins; pelvic fins; dorsal fins; mouth; teeth; nostrils; snout; spiracles; lateral line; cloacal opening; and claspers. Figure 19-6 (atrium; ventricle; sinus venosus; conus arteriosus; liver; gallbladder; stomach; spiral valve intestine; rectum; duodenum; spleen; kidney; colon; rectal gland; Wolffian duct; testes; pancreas). Know the general functions of the digestive, urogenital, circulatory, and respiratory systems.

-Pacific Coast Fishes. Using "A Field Guide to Pacific Coast Fishes of North America" by Eschmeyer, Herald, and Hammann." You should know how to use this book. For instance if I provide you with a fish specimen, and ask you what species you are looking at, you should be able to answer using your book. Be able to define terms and look up the scientific and common names of specimens.

Study Guide for Lab and Lecture Examination 3

General comment- study your lecture notes as well as the following multiple choice, true and false, and matching questions.

1-40. Multiple Choice. Select the single best possible answer for each question.

1. 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
2. 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
3. To analyze populations ecologists set up _____ and use _____ to gather data.
    a. reefs, tools
    b. patches, clearings
    c. conservational sites, management teams
    d. habitats, dredges
    e. transects, quadrats
4. The most common practice for sampling deep water invertebrates is the _____.
    a. box core
    b. purse seine
    c. gill net
    d. longline
    e. grenade launching technique
5. Which of the following levels is not typically dealt with by ecologists?
    a. individual
    b. population
    c. community
    d. system
    e. none of the above
6. Which of the following is not considered one of the marine communities found here in California?
    a. bays
    b. exposed outer coast
    c. protected outer coast
    d. rivers
    e. estuaries
7. Biotic factors _____.
    a. are biological
    b. include competition for space
    c. include competition for light
    d. include herbivory
    e. all of the above
8. 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
9. Spring tides _____.

a. occur when the moon is in first quarter
b. occur when the moon is in third quarter
c. produce the least gravitational pull on the tidal bulges
d. generate greater tidal ranges than neap tides
e. occur only in the spring

10. The intertidal zone is also referred to as the _____ zone.
    a. nutrient
    b. littoral
    c. dispersal
    d. attachment
    e. recruitment
11. Inheritance of acquired characteristics suggests that new species _____.
    a. were created in their present form
    b. arise from the modifications an organism acquires during its lifetime
    c. evolve from other species
    d. are brought about by natural selection
    e. none of the above
12. Which of the following was not cited by Darwin in support of natural selection?
    a. variation occurs in every group of plants and animals
    b. all organisms have the potential to over-reproduce
    c. natural resources are limited
    d. organisms travel great distances over time
    e. only the most adapted to the local environment survive and pass along traits to the next generation
13. How do mussels retain moisture?
    a. by growing closely together and closing their valves
    b. by colonizing the upper intertidal
    c. by rooting themselves in moisture rich rocks
    d. by climbing daily down from the midtidal zone to the subtidal zone
    e. none of the above
14. Snails stay cool by _____.
    a. living in the spray zone
    b. having ridges on their shells
    c. having a white or other light colored shell
    d. by taking refuge in crevices
    e. all of the above
15. The upper intertidal is dominated with _____.
    a. barnacles
    b. mussels, barnacles, and seaweeds
    c. seaweeds and surf grass
    d. sun stars and kelp
    e. periwinkles, limpets, lichens, and encrusting algae
16. The intermediate disturbance hypothesis says that _____.
    a. a little amount of disturbance leads to a greater number of species
    b. biodiversity is highest when disturbance is neither too rare nor too frequent
    c. greater amounts of disturbance leads to greater number of species
    d. little amounts of disturbance leads to the extinction of species
    e. none of the above
17. Mud is defined as a combination of the two sediments _____.
    a. gravel and sand
    b. gravel and silt
    c. gravel and clay
    d. sand and clay
    e. none of the above
18. Which of the following is a type of resource humans take from the sea?
    a. food
    b. oil and gas

c. mining
d. drinking water
e. all of the above

19. Which of the following is not one of the products fish catch is used for?
    a. human consumption
    b. therapy
    c. pet food
    d. fertilizers
    e. chicken feed
20. Which nation has the largest total fish catch?
    a. china
    b. peru
    c. united states
    d. japan
    e. chile
21. In the northeast Pacific, which of the following is not one of the major fisheries?
    a. salmon
    b. halibut
    c. herring
    d. hake
    e. mackerel
22. Which of the following fishes accounts for the largest global commercial catch?
    a. clupeoids
    b. cods
    c. tunas
    d. salmon
    e. flounders
23. Maximum sustainable yield _____.
    a. indicates underutilization
    b. leads to overfishing
    c. is the highest catch that can be continued year after year without threatening the stock
    d. is the catch that can be continued for a maximum of 10 years
    e. none of the above
24. Overfishing effects _____.
    a. marine mammals
    b. human populations
    c. birds
    d. other fish
    e. all of the above
25. Energy in the future may come from _____.
    a. tides
    b. waves
    c. currents
    d. OTEC
    e. all of the above
26. Which of the following is not a characteristic of the class Mammalia?
    a. hair
    b. endothermy
    c. their reproduction is mostly ovoviviparous
    d. complex central nervous systems
    e. mammary glands
27. Neurons _____.
    a. transmit, receive, and interpret nerve impulses
    b. are supported by neuroglia
    c. are the functional unit of the nervous system
    d. consist of dendrites, cell bodies, and axons

e. all of the above

28. Which of the following is not true of blubber?
    a. it is composed of collagen and lipids
    b. it functions in insulation
    c. it functions in buoyancy and energy storage
    d. it is positioned below the skin
    e. it is especially thick in members of Carnivora
29. Which of the following is not true of sea otters?
    a. they are the smallest marine mammal
    b. they weigh about 60-80 lbs.
    c. they eat about 5-10% of body weight per day
    d. they eat urchins, abalone, mussels, crabs, fishes
    e. they have about 394,000 hairs per cm^2
30. Cetaceans _____.
    a. are the largest group of marine mammals
    b. have streamlined bodies
    c. have flukes
    d. include about 90 species
    e. all of the above
31. Which of the following is not considered one of the great whales?
    a. sperm
    b. fin
    c. bowhead
    d. killer
    e. gray
32. Whales can be identified to species based on _____.
    a. the manner in which they surface and blow
    b. fluke morphology just after returning to the surface from a dive
    c. dorsal morphology just prior to diving
    d. the shape and size of their anterior (front) flippers
    e. all of the above
33. Which of the following is not true of baleen?
    a. it is made of keratin
    b. historically it was used to make corset stays, buggy whips, and in billiard tables
    c. it is used by whales for filter-feeding
    d. it is found in toothed whales when they are young, but replaced as adults
    e. it traps plankton
34. Gray and humpback whales _____.
    a. migrate from artic and Antarctic waters to warmer winter waters for mating and calving
    b. do not migrate
    c. migrate from warmer waters to artic and Antarctic winter waters for mating and calving
    d. migrate from the arctic to Antarctic waters without stopping in the tropics
    e. none of the above
35. In _____ whales, courtship involves a pair surfacing vertically face to face.
    a. gray
    b. humpback
    c. sperm
    d. minke
    e. northern right
36. The Weddell seal _____.
    a. eats other seals
    b. has been recorded diving for more than 1 hour
    c. is capable of diving 3,000 feet deep
    d. has the ability to extract about 50% of the oxygen contained in the lungs
    e. all of the above
37. Which of the following is not true of echolocation?

a. it results in the emiting of bursts of sound waves (clicks)
b. it uses high frequency sounds to detect information about the topography
c. clicks are produced by air passages and sacs
d. the melon directs the clicks
e. sound waves are received and transmitted by the jaw

38. Pilot and sperm whales are known for _____.
    a. breaching
    b. following the wakes of boats
    c. beaching themselves
    d. attacking humans
    e. containing spermaceti organs
39. The International Whaling Commission (IWC) _____.
    a. was established in 1946 to regulate hunting and stop the extermination of whales
    b. is primarily concerned with vocalization research in toothed whales
    c. currently lists all whales as endangered
    d. publishes data on the health benefits of eating whale meat
    e. none of the above
40. Sea lions, fur seals, elephant seals _____.
    a. are polygamous and form harems on land
    b. are monogamous and form harems on land
    c. are polygamous and form harems in the pelagic zone
    d. are monogamous and form harems in the pelagic zone
    e. none of the above

41-80. True or False. Mark A for true, mark B for false.

41. Some brown algae contain chemicals that deter herbivory.
42. Secondary succession is the initial colonization of available rock by pioneer species.
43. Carrying capacity is the least number of cells that a habitat can support.
44. Dinoflagellate populations do not undergo blooms.
45. Competitive exclusion occurs when 1 species eliminates another by out competing it.
46. The California coast experiences semidiurnal tides.
47. Darwin observed that phenotypic variation did not occur between organisms from island to island.
48. The mechanism or driving force of evolution is natural selection.
49. Exposure at high tide leads to desiccation.
50. Algae retain moisture by growing in clumps and in crevices.
51. Snails can retain moisture and protect themselves from salinity fluctuations by retracting into their shells.
52. Exposure to wave shock does not alter the morphology of animals or algae.
53. Seaweeds handle wave shock by growing flexible thalli and holdfasts.
54. Detritus consists of particles of living organic matter.
55. Barnacle distribution in the intertidal is determined by desiccation only.
56. Keystone predators effect their communities much less than other species.
57. Sand type affects the amount of detritus, drainage, and oxygen content.
58. Cod, pollock, and hake are usually caught with a purse seine.
59. Renewable resources are organisms that can replace themselves.
60. The sustainable yield is the amount that can be caught but will still have a drastic effect on population size.
61. Closed mariculture is a technique where organisms are cultured in natural environments.
62. The nervous system of mammals is divided into central and peripheral systems.
63. The brain of a sperm whale is about 6 times larger in mass than that of a human.
64. Pinnipeds need to breed on land.
65. The diet of pinnipeds is largely fish and squid.
66. The teeth of sea otters are adapted for herbivory.
67. The continued existence of manatees is threatened by recreational boating.
68. Whales spend half of their lives on land.
69. Convergent evolution is the result of species developing similar structures because they have similar lifestyles.
70. The fetus of cetaceans lacks any evidence of having rear limbs.

71. Breaching is thought to remove external parasites from whales.
72. Cetaceans swim with strong side to side movements of the flukes.
73. Blue and killer whales can swim up to speeds of 30 mph.
74. Drift net practice was suspended in 1993.
75. Gestation is the length of time it takes an embryo to develop.
76. Gestation lasts for 11-12 years in most cetaceans.
77. Ambergris, used in fine perfumes, is the undigested sticky glob of food in sperm whales guts.
78. The mammalian diving reflex speeds the heart rate of marine mammals from 12 bpm to about 85 bpm.
79. SURTASS LFA Sonar may affect marine mammal migration routes.
80. The scientific research program (SRP) studied feeding, migration, and breeding patterns to determine if LFA sonar had an adverse affect on marine mammals.

81-85. Match the species type on the right to its characteristics on the left.

80. Colonizers of newly-cleared surfaces	a. r-selected
81. Ephemerals and annuals	b. K-selected
82. Large in size	
83. Growth is slow	
84. Many offspring	
85. Energy is stored throughout	

86-91. Match the type of symbiosis on the right to the animals on the left.

86. Tape worm and whale	a. commensalism
87. Isopod and fish	b. parasitism
88. Grey whale and barnacles	c. facultative symbiosis
89. Cleaning wrasse and Moray eel	d. obligate symbiosis
90. Dinoflagellates and anemones	
91. Dinoflagellates and corals	

92-101. Match the orders on the right to the animals on the left.

92. Walruses	a. Pinnipedia
93. Dolphins	b. Carnivora
94. Sea lions	c. Cetacea
95. Whales	d. Sirenia
96. Seals	
97. Polar bears	
98. Porpoises	
99. Sea otters	
100. Manatees	
101. Dugong	

102-108. Match the whale group on the right to its characteristics on the left.

102. 1 external blowhole	a. baleen whales
103. 2 external blowholes	b. toothed whales
104. Asymmetrical skull	
105. Echolocation present	
106. Large tongue	
107. Mobile thorax	
108. Usually 5 digits in manus (front flipper)	

List 8 abiotic factors.

List 3 marine organisms that are cultured for human consumption.

-Describe 5 differences between a sea lion and a seal.
-Describe 5 differences between a Humpback and a Gray Whale.
-Be able to construct a food web using the knowledge you learned from the laboratory exercise.
-Be able to use the bird book we used in the field to identify any bird to species.