Bio 115 study questions

Limited utility of study questions:

These questions are intended as a supplement to the procedure that I have recommended in another handout regarding taking, improving, and studying your notes. There is no way to create a comprehensive list of study questions so there is a risk that a student might think, "If I can answer these then I can answer every possible question on an exam." That would be an errant conclusion. This is not an exhaustive list of topics that might serve as the basis for questions. Rather, this list is intended to help you anticipate the sorts of questions that you will encounter on exams. That said, a well-prepared student will be able to answer all of these questions before arriving for an exam. As you work to answer them, make sure your answers are precise and thorough. Check them with classmates or others.

These study questions are based on the course lectures alone. They do not include questions regarding material that is covered in the assigned readings but not during lecture, and they do not explicitly cover the material in the EvoBeaker (SimUText) simulations. You should also study and answer any questions at the end of the text chapters that pertain to assigned readings, the questions in the simulation workbooks, and try to make up your own study questions for other text material and other readings especially any major (lengthy) topics in the readings that were not covered during class.

These questions generally do not include examples but exams may ask you to describe particular examples. As you study the various questions review the applicable examples and make sure you understand those examples. Note that definition ≠ explanation ≠ example. A question may ask for a definition, an explanation, and one or more examples for any given phenomenon, such as, say, convergent evolution.

EvoBeaker (SimUText) material on exams:

Also, be able to answer any of the questions of understanding in the EvoBeaker (SimUText) simulations. If I have not returned one or more of your simulation workbooks when you are studying for the exam, remember that you have access to the workbooks and the questions, so you can study the material even if you do not have a workbook that you already completed.

Readings:

As noted above, these study questions are drawn from course lectures and discussions, not from the readings or SimUText material.

Know the main point, fundamental argument, and main evidence of every reading assignment.

Understand the major points made in any textbook readings, both those that are covered during class sessions and those that are not covered during class sessions.

(Reading assignments are chosen intentionally but are not necessarily covered during class.)

Exam format:

Exams will typically have 2-4 essay questions and about 35 multiple choice or other short answer questions.

How to work with these study questions:

Read the following questions carefully and then *write out* <u>precise</u>, <u>specific</u>, <u>articulate</u>, <u>thorough</u> answers to essay questions. Then describe particular examples. Resist the temptation to simply look at the questions and say to yourself, "I know that."

Work on answering the essay questions precisely and completely while omitting any tangential or unnecessary information. Avoid "brain dumps." In other words, avoid simply writing everything you know about a general topic. Brain dumps take too long and may not actually answer the particular question asked.

In some cases, it might be useful to supplement written answers with drawings.

After you answer the following questions, compare your answers with those of a friend and see if your friend understands your answers.

Study questions:

INTRODUCTION TO COURSE

Why do we teach evolution and ecology in the same course?

What are ecosystem services? Give some examples of ecosystem services?

What sorts of difficulties do first-year students report? Which particular difficulty do students most often report?

What must you be able to do to be confident that water is safe to drink, an electrical device will not shock you, a set of blood test results are correct, etc.

How can one distinguish science from non-science?

What are the limits of science?

What does it mean for a hypothesis to be "potentially falsifiable?"

Describe *in detail* (all the steps of) Dr. Schulze's recommended procedure for producing excellent notes.

Describe *in detail* (all the steps of) Dr. Schulze's recommended procedure for using those notes to prepare for an exam.

What good does it do to read the book if you already have good notes from class?

INTRODUCTION TO EVOLUTION & NATURAL SELECTION

What is evolution? (Define it precisely).

Define gene, gene pool, and population.

What is natural selection?

What combination of circumstances result in natural selection?

What is the relationship between natural selection and evolution?

What is artificial selection and how does it help us understand natural selection?

Describe several different examples of natural selection that have been directly observed? (Get together will classmates & see how many examples you can list & describe. Do the same for other similar study questions that ask about examples. Make sure you can describe and understand each example.)

Describe several different types of historical evidence that are consistent with the theory of evolution by natural selection. Make sure not to omit any that were discussed in class or in the assigned reading.

Describe several cases of artificial selection.

(Note regarding examples – examples provide evidence for ideas, so scholars love examples. Make sure you understand each example that is discussed in class or in an assigned reading, but realize that an example of a phenomenon is not the same as an explanation of a phenomenon. An example is often useful for illustrating an explanation, but the two are not synonymous.)

NATURAL SELECTION & OTHER PROCESSES THAT ALTER ALLELE FREQUENCIES

What four types of processes alter allele frequencies?

Explain the mechanism of each of those processes (how each process works, under what conditions it occurs, etc.). Which of the four processes are usually adaptive?

What is the definition of evolution?
(Note that alteration of allele frequencies = change in composition of a gene pool.)

Define allele.

Define dominant allele

Define recessive allele

Define homozygote

Define heterozygote

Define fitness.

Why is fitness a useful concept for studying and understanding natural selection and evolution?

What is the ultimate source of new genetic variation?

Define mutation.

What is the significance of mutations?

Why is inbreeding dangerous to individuals? (Give a detailed explanation that defines inbreeding *and does not omit any key steps* of the explanation.) (For example, the following explanation is incomplete. What is missing? "Inbreeding fosters expression of deleterious, recessive alleles because inbred individuals are often homozygous for such alleles.")

Explain the apparent conundrum that mutations are generally harmful to individuals but enable populations to adapt to new circumstances?

What are stabilizing, directional, and disruptive (= diversifying) selection? Under what general circumstances would you expect each to occur?

What examples of each of these were discussed in class? In the book? Explain each example.

Might stabilizing selection occur after directional selection? Why or why not?

What is sexual selection and what circumstances cause it to occur?

Which gender is usually the choosiest about mates? Why? (Explain in detail.)

What would be the evolutionary consequences of choosing mates badly? (What would it mean, from an evolutionary perspective, for a wild creature, to choose mates badly? In other words, how would we identify a bad choice?)

What is gene flow & how can it alter allele frequencies in a population (cause evolution)? Is gene flow adaptive?

What is genetic drift & how can it alter allele frequencies in a population (cause evolution)? Is genetic drift adaptive? How and why does genetic drift depend on population size?

Under what circumstances would genetic drift be likely to substantially alter allele frequencies?

What is a population bottleneck and why is the concept of a population bottleneck relevant to genetic drift and thus evolution?

What is the founder effect and how is the founder effect important to allele frequencies?

When is a bottleneck event also an example of the founder effect? Is it possible for a bottleneck event to occur without a founder effect? Hint: Yes. Explain.

Maintenance of Genetic Diversity in Populations

What 5 factors prevent natural selection from eliminating genetic variation?

How does each of these factors have the effect of increasing or preserving genetic variation?

Provide a real or hypothetical example of each of the processes and situations that prevent natural selection from eliminating genetic variation.

Does evolution lead to perfect organisms?

No. Why not? You should be able to offer at least 3 reasons.

Genetic Diversity in Small Populations

What are the two genetic risks to small populations?

Why is genetic drift particularly relevant to small populations?

Endler's experiments with guppies

How did Endler's study of guppies illustrate the trade-off between selection for camouflage and sexual selection?

What question(s) did Endler test?

What were the key design features of Endler's experiments?

What were the most important results of each of Endler's experiments?

How did Endler's experiments contribute to understanding of conflicting selective forces?

- End of material for 2020 mid-term exam 1 -

SPECIATION

Define "species."

Define "population."

Read your definitions and make sure they are not identical. What is the difference between them?

Which of the following statements is correct? Which is incorrect? Why? A species can have multiple populations. A population can have multiple species.

What 3 different ways do biologists use to determine whether two individuals are members of the same species? How does each work?

Define allopatric speciation.

Define sympatric speciation.

What is adaptive radiation?

Describe several cases of adaptive radiation.

What factors facilitate adaptive radiation? Why do they have that effect?

Among what kind of organisms is sympatric speciation common?

HISTORY AND FUTURE OF BIOLOGICAL DIVERSITY

According to present understanding, what are some of the most important events in the history of life on the planet, and when did they occur? (I expect you to know the events included on my PowerPoint slides.)

From the perspective of most species, what is the most important difference between the early conditions on the planet and present conditions?

What are the three domains of life? What are their fundamental characteristics?

Explain the endosymbiont hypothesis and the evidence consistent with the endosymbiont hypothesis.

How has the diversity of life varied through time?

What was the Cambrian Explosion and when did it occur? Why is it considered so significant to subsequent evolution?

What is a mass extinction and what is the evidence for mass extinctions?

What are the main proposed causes for previous mass extinctions?

When was the most recent mass extinction (not counting the present mass extinction)?

What notable species went extinct at the time of that most recent (not present) mass extinction?

What is thought to have been the cause of that mass extinction? What is the evidence for that hypothesis?

What human action is most responsible for current extinctions? What human impact on the environment is expected to be most responsible for extinctions in the near future (next few hundred years)?

What features or circumstances make species particularly susceptible to extinction? (Study the relevant PowerPoint slide so that you interpret the term "features" appropriately. In this context, "feature" does not refer merely to anatomical or physiological features.

Imagine a situation where at one time a species has only one population, then later a second population forms. Imagine the two populations are initially in separate locations but later have overlapping ranges, as might happen, for example, if their ranges expand. While separated, the two populations would evolve independently in response to the circumstances where they each occur. If such a process continues for a sufficient time, one or both populations may become a different species, but there will be a gray area between the time where the two populations are definitely members of the same species and later when there are clearly two different species. What are some of the mechanisms that could prevent interbreeding among members of the two populations during that interim when the populations have diverged somewhat but are not obviously two different species?

EVOLUTIONARY ANCESTRY OF HUMANS

What organisms constitute the primates? What are their distinguishing characteristics of primates? Which extant (not extinct) primates exist?

What group of organisms gave rise to the primates? Approximately when did this occur?

What present-day primates are most similar to the earliest primates?

What existing species comprise the anthropoids? Approximately when did the anthropoid line diverge from the other primates?

Which anthropoids are not hominoids?

Approximately when did the hominids diverge from the other hominoids?

Which living species is the closest relative of humans?

Explain the leading hypothesis to account for the rise of bipedalism in human ancestors, and the hypothesis regarding the subsequent interplay between bipedalism, tool use, and selection for intelligence. What did climate change have to do with all of this?

What genus was the ancestor to the genus *Homo*? Approximately when did that genus occur?

When did the first members of genus *Homo* arise? Where have their earliest fossils been found? Approximately when did the various *Homo* species reach other continents? What is the relationship of *Homo sapiens* to *Homo neanderthalis*?

What is the most recently discovered species of *Homo*?

Is there any biological basis for the concept of human races?

ECOLOGY: INTRODUCTION & POPULATION ECOLOGY

Draw and explain the diagram that shows the human economy as a subset of the Earth system. Include and explain the various flows of resources, energy, and wastes.

What is an ecosystem service? What are some examples of ecosystem services?

How large is the human population? What is the history of its growth?

Write Herman Daly's guidelines for sustainability and explain their logic?

Are we respecting Dr. Daly's guidelines? What is your evidence?

What is a biome? What are the major biome types? What are their basic characteristics?

How do climatic factors affect the distribution of biomes? Which factors are most important?

What are the various factors that determine the distribution of temperature and precipitation around the planet?

Why are there seasons on Earth?

What is a Hadley Cell? Explain the air and moisture movement associated with Hadley Cells.

What is a mountain rain shadow and why do they occur? What is the significance of mountain rain shadows for the distribution of biomes?

How do coastal climates compare to inland (continental) climates? How does that comparison differ between summer and winter?

Why is Europe so much warmer than Hudson's Bay, Canada, even though the two are at the same latitude?

Give some examples of types of human activities and impacts on the planet that have increased dramatically since 1950.

How have humans affected the distribution of biomes?

What is a niche and how is an understanding of niche requirements helpful to understanding a species distribution?

Give some examples of ways that organisms use behavior and other adaptations to expand the range of habitats that meet their niche requirements.

What is meant by life history?

Describe some life history adaptations that expand niche boundaries.

What are the two potential explanations for the absence of a species from a particular area?

Why is dispersal selected for? What are some of the ways that individuals disperse?

How might a small population grow?

Describe the exponential model of population growth, both as an equation and in words. What does it predict?

What does it assume?

What is competition (as the term is used by ecologists)?

What is carrying capacity?

Would you expect a population to grow according to the predictions of the exponential model? If so, for how long? If not, why not? What would be a more reasonable expectation for population growth? Why?

Define regulation?

Do you suppose populations frequently experience regulation? Why or why not?

What sorts of processes can regulate populations? Don't just list examples here. Explain the particular criterion that determines whether a process is regulatory.

What sorts of processes cannot regulate populations?

How has the human population managed to continue to expand exponentially when other species populations do not? (Think back to the questions about Herman Daly's guidelines for sustainability.)

COMMUNITY ECOLOGY

Define the different types of interspecific interactions

Define an ecological community

Explain the example of *Chthamalus* and *Semibalanus*.

Distinguish between the fundamental and the realized niche. Use the *Chthamalus* and *Semibalanus* example to illustrate your explanation.

Define "character displacement" and explain an example.

Explain how character displacement involves both interspecific competition and evolution.

Which of the following are examples of predation?
    A lion eating a gazelle
    A robin eating a worm
    A cow eating grass
    A tapeworm living in a mammal's gut

Explain some reasons why predators rarely wipe out prey populations.

Describe and explain the population dynamics of hares and lynx in the boreal forest of Canada.

Describe some of the consequences of humans acting as predators. Have humans done a good job of sustainably harvesting prey populations? Why do you draw that conclusion?

What is mutualism?

Describe some actual examples of mutualistic interactions.

What is coevolution?

Describe some examples of coevolution. Hint: See your examples of mutualism.

What circumstances, factors, or processes tend to decrease species diversity? Why do those phenomena have that effect?

How do ecologists define "disturbance?" Give some examples of disturbances and describe their effects on species diversity.

What is succession?

Why does succession occur?

ANIMAL BEHAVIOR

Why do animals behave the way they do?

Describe the typical vertical migration behavior of zooplankton.

Distinguish the proximate cue and the ultimate cause of vertical migration.

Describe some of the evidence that behaviors are genetically based.

Contrast instinct and learning.

Support or refute the following statement on the basis of evolutionary logic. Behaviors do not need to be perfect; they just need to be effective. Also, what does effective mean in this context?

Describe the curious features of nest defense by male sticklebacks.

What are some advantages of living in a group? What are some disadvantages?

Under what general circumstance would you expect an individual animal to live as a member of a group (rather than by itself)? (General circumstance – criterion – not mere examples of potential situations). Hint – why do animals behave as they do?

Under what circumstances would you expect an animal to behave in a way that helps another animal but puts itself at risk?

FLOW OF ENERGY AND CYCLES OF ELEMENTS IN ECOSYSTEMS

Describe the first and second laws of thermodynamics and explain their basic implications.

What is the source of energy for most ecosystems (except deep sea vents)?

Define primary production.

How and why do ecosystems vary in primary productivity?

How do rates of primary production constrain the abundance of herbivores and carnivores?

How does the second law of thermodynamics affect the energy available to species farther up a food web?

What are the possible fates of energy that is ingested by an individual?

What are the key features of natural cycles of elements (materials)?

How does the present use of materials by humans differ from the flow of materials in natural ecosystems? Is the difference important? Why or why not?

ECOLOGY AND ECOSYSTEM SERVICES – SYNTHESIS & REVIEW FROM ECOLOGY INTRODUCTION

Give some examples of non-sustainable impacts upon ecosystem services.

Draw my diagram of the dependence of the economy on its planetary setting.

Contrast key features of natural ecosystems and the human economy. Hint: Materials and energy.

Describe Jared Diamond's thesis regarding the causes of collapse of civilizations. Hint: You should be able to identify five key factors that may or may not interact.

What does Bill McKibben mean when he writes, "Bears are like golden retrievers now?"

Finally…

How does evolution affect ecological interactions?

How do ecological interactions affect the future course of evolution?

What does animal behavior have to do with either of the previous two questions?