Sample Final Exam Questions
BIOLOGY 121, Section 123
Ecology, Genetics, & Evolution
November 2006

**All review-sessions now booked:** all are in CHEM 124 – Thu **30 Nov** 1400-1600; Fri **1 Dec** 1400-1700; Mon **4 Dec** *(2 periods)* 1000-1200 & 1400-1600; and Tue **5 Dec** *(2 periods)* 1000-1200 & 1300-1600.

Note – CHEM 124 is in the **East wing** of Chemistry; if you look on this map, walk as indicated by arrow 2 through the breezeway and then down the stairs, watching on your left. You will reach a glass door with a sign on it that says "access to C124 and C126", the room is right inside. You can also walk to the location by following arrow 1 through Chemistry South and out into the breezeway, or from the east past Hebb Theatre and walking around the building.

Normal Biology 121 office hours will continue, as posted, ***through Wed 29 November***. After that date, the only office-hour times will be the review sessions.
Reviews are for any sort of question you want to raise: lecture material, text material or questions, my questions, whatever – feel free, but *come with some work done* (e.g. **try questions**, don't just ask for answers – if I can see what you've done, I can advise you better.)

***GENERAL INSTRUCTIONS:***
The final examination will be held 8:30-11:00AM, Wednesday 6 December, in the Student Recreation Centre, "area C" **(this is the easternmost end of the gymnasium)**. There will be ***no multiple-choice questions and no "fill-in-the-blank" questions.*** Some genetics questions may require simple calculations, so a calculator is permitted; otherwise all questions will be conceptual (requiring either explanation or application), or experimental (requiring either a full design, or a critique of a given design). Because some questions may require a graph or other diagram (even if the question doesn't *specify* a drawing, you may still wish to use one), you are advised to bring several colours of pen or pencil to make things clear. In general, "number of marks" ≠ "number of answer-points or ideas". You will be writing on the exam-paper itself, with your answer-space strictly limited, so be sure to address questions directly and clearly.
**The final exam is definitely cumulative;** probably 20-25% of the content will be pre-midterm, but for the most part pre- and post-midterm material will show up in combined forms rather than as separate questions.
For preparation, remember that in addition to the limited question-set below, you also have a posted page suggesting questions from the textbook to try.
**The final exam will not be common with the exams of the other sections of the course.**

## *Special final-exam-related rules:*

- Each student must be individually identifiable at an exam. Make absolutely sure to bring with you your UBC student ID card, and to display it on the corner of your exam-writing table so it can be checked against our attendance list. *If your UBC ID has been lost, you are required to show another form of photo ID with signature, such as a driver's license or passport.*
- ***There will be silence in the exam room at all times*** – you will have no need to talk, and every reason to listen to instructions, and you would not want others to be talking when you're trying to focus. Be considerate of your neighbours and try to minimize chair-moving or other noise-creating actions during the exam.
- You are advised to bring a watch or clock in case you are not in a good viewing position for the wall-clock. **You are not permitted to use a cell-phone or other messaging device as a clock**, nor are you permitted to have such a device with you at your writing desk.
- You can have with you at your desk only your writing materials, student ID, calculator, and timepiece. [A water-bottle is also allowed, and even candies or other foodstuffs are permitted as long as they can be consumed silently.] All your other goods (coat, backpack, laptop, *etc*., **and especially cellphone**) must be deposited at the back of the room.
- On a final exam, if you arrive 30 or more minutes late, you will not be admitted to the exam-room. No extra time is allowed for late arrivals in any case. **Thus, particularly for an 8:30AM start, make sure you allow adequate travel time!**
- You are permitted to ask me questions during the exam, to clarify any confusion you may experience. Please direct questions at me rather than at the other invigilators (who are assigned mainly as security-guards, not instructors!).
- You are not permitted to leave the exam room for any reason during *the first 30 minutes* of an exam.

- During the exam, if you desire a bathroom-break, wait to be assigned a TA escort to and from the bathroom; leave all your belongings and exam paper (face-down) at your desk.
- I will be invoking the **"15-minute" rule** to control noise and disruption at the end of the exam period. If you finish your paper *before the 2.25-hour mark*, you may hand it in and leave, but ***if you finish in the last quarter-hour you must stay in your seat and wait*** until papers are collected at the very end of the 2.5-hour exam period before leaving. No one is permitted to leave the exam room for any reason during those final 15 minutes.
- Handing-in of completed papers will be in surname-alphabetic piles, so please ensure that your paper finds the correct pile.
- Walking out of the exam-room with anything other than what you took in is ***strictly forbidden*** – no exams or pieces of exams may be removed from the exam room.

***TIMING:***
This document offers "one final-exam's-worth" of questions, so should be answerable in approximately 120-140 minutes. **The exam itself will last a maximum of 2.5 hours (150 minutes), but it will not therefore involve 10 pages at 15 minutes per page!** I plan for:

- two pages of short-answer (four-to-a-page) questions,
- four single-page questions (which may be subdivided into sections), and
- one longer integrative question (1.5 or 2 pages in length).

[The short-answer and single-page styles will be just as on the midterm; the longer style will be a larger collection of subdivisions on a common theme.] This adds up to ***a total of about 8 pages/120 minutes*** of work, assuming about 15 minutes per page – you should find you have anything up to 30 minutes "left over", or available for extra thinking-time.
[Of course the questions are jammed together here, so you have to imagine all the answer-spaces based on mark-values.]

The questions begin just a few lines below this line – ***remember***, if you scroll down and simply read the questions without taking the time to try them seriously, you will be wasting the opportunity to treat this document as a worthwhile preparation for the exam.

**Questions follow:**

---

*1. Short-answer type* (**4 on a page**, 4 marks each [16 marks per page]; there will be two pages of this type of questions)

1. *a)* You are designing a field experiment; what would be the appropriate spatial scale (size, and distance apart) of your treatment plots, and why? (*HINT* – use an example to focus the answer if you wish… but still explain)

*b)* Picture an environment in which some years have good growing conditions, and other years have poor growing conditions. Would this environment favour r-selected **or** K-selected organisms? Explain.

*c)* When describing evolutionary patterns, we often use the terms homology and analogy; explain these terms ***briefly***, and say how they differ. (*HINT* – "homology" here has nothing to do with chromosomes)

*d)* Why is a "deletion" mutation likely to have much more effect than a "substitution" mutation?

*e)* Would an environmental factor have to act in a *density-dependent* manner in order to have an *evolutionary effect* on a population? Explain your answer ***briefly***.

*f)* When a population of animals is exposed to a viral disease for the first time, most infected individuals die, those dying die quickly, and the outbreak remains local. After the population undergoes many exposures, fewer infected individuals die (and/or they die more slowly), and the disease spreads over a wider area in each outbreak. Explain how this pattern of observations can fit natural-selection theory, considering the standpoint of both disease organism and host.

*g)* Many biological molecules (*e.g.* some pigments, hormones) are highly species-specific, **but** are not made of protein, and so cannot be coded for in a DNA sequence; how is it possible, then, for these molecules to be reliably "inherited"?

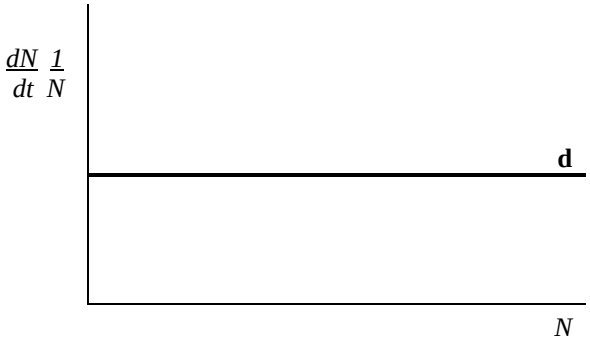
*h)* Imagine crossing two organisms with following genotypes:
DdHhTT ⊗ DdhhTt
*(Assume that the "D", "H", and "T" genes are on different chromosomes.)*
What fraction of the offspring will be (answer in the table):

| | answer |
|---|---|
| - phenotypically recessive at all loci? | |
| - of genotype DdhhTT ? | |

*2. Full-page type* (each occupies **a single page**, 12 marks each page; there will be four pages like this)

2. *a)* ***[Answer all sections i - iii.]*** *STATEMENT:* "The production of offspring is a critical part of both individual fitness, and population replacement"; *THE SECTIONS ON THIS PAGE ALL RELATE TO THIS STATEMENT*.

***[i]*** The graph below shows a population's death rate. Draw on the graph a line indicating a **density-dependent birth rate** (1 mark), and show the location of the $N_{eq}$ you would predict (1 mark). In the box beside the graph, explain ***briefly*** why the line you drew actually *shows* density-dependence (2 marks).




The line I drew *shows* density-dependence because:

***[ii]*** *CLAIM*: "A slowly-growing population always has a low *per capita* birth rate." Provide an argument against this claim. (4 marks)

***[iii]*** Parents and offspring (especially in birds and mammals) all benefit when parental care is provided, **BUT** what are the costs of parental care to a parent? (4 marks)

2. *b)* ***[Answer all sections i - iii.]*** A plant breeder crossed a true-breeding pea plant bearing green pods (fruits) with another true-breeding pea plant bearing yellow pods; when the offspring plants (F1 generation) were grown, all had green pods. F1 plants were crossed to create an F2 generation, and a total of 8 F2 plants reached fruiting age: 6 had green pods, and the other 2 had yellow pods.

***[i]*** What seems to be the basis of pod-colour determination in this series of crosses? Show phenotypes and genotypes of the plants involved (P, F1, and F2 generations), stating assumptions. (4 marks)

***[ii]*** Do the data given in the question prove the basis you suggested in section ***[i]***? Explain. (4 marks)

***[iii]*** Yellow pods, as possessed by the domestic strain described in the question, *are never observed in nature*. Why not? Provide **two possible reasons**, making the mechanism clear in each case. (4 marks, 2 per reason) (*HINT* – there could be many possible correct answers… be speculative, but use realistic assumptions)

2. *c)* ***[Answer both sections i & ii.]*** Understanding evolutionary biology involves understanding both patterns and processes.

***[i]*** One pattern which has been influential for integrating evolutionary forces with ecology and animal behaviour is morphological convergence. Explain what convergence is, and what it indicates about the organisms displaying it. (6 marks)

***[ii]*** An important evolutionary process in many taxa has been the impact of predation. Explain how predation can produce evolutionary change. (6 marks; *HINT – examples may help your explanation*)

2. *d)* A farmer (call him Mr. A) grows a variety of crops and keeps some domestic animals also, so he is very busy taking care of everything. On his land is an apple orchard, but Mr. A notices that the apple trees are growing and fruiting poorly, perhaps because there is a lot of weed- and other-underbrush-growth, so he decides to let his pigs live in the orchard. This means less pig-maintenance work (cleaning pens, carrying food) for Mr. A, because in the orchard the pigs can be left to themselves to eat small plants, fallen fruit, insects, mice, *etc.* Over a couple of years, Mr. A is pleased to observe that these pigs are really healthy-looking and well-fed, the orchard becomes less weedy, and the apple trees become healthier and more productive, a win/win situation. A neighbour-farmer (call her Ms. B) also has a weedy and unproductive apple-orchard, *but is allergic to pigs*… she hears about Mr. A's success, and wants a similar result, but cannot stand to employ pigs to get it! Ms. B reasons as follows:

- the apple trees in Mr. A's orchard may be doing better because of reduced competition from the small plants (*i.e.* pig herbivory has reduced competition for plant nutrients);
- on the other hand, the trees in Mr. A's orchard may be doing better because of enhanced fertilizing (*i.e.* pig-droppings are high in nitrogen and other significant nutrients which the trees formerly lacked).

If Ms. B could determine which of these effects were necessary, she could then decide how to manage her own orchard better.

**Design a two-factor experiment** to determine if the enhanced apple-tree growth is due to reduced competition from weedy plants, enhanced fertilizing from pig wastes, both, or neither. *State any assumptions.* [*HINT* – the outcome of your experiment should lead to a plan of action which would allow Ms. B to enhance her orchard, but not involve pigs!]

## *3. Longer-question type* (occupies **1½-2 pages**, 20 marks total; there will be one question like this)

3. ***[Answer all sections i-iv.]*** Understanding the life-cycles of organisms can tell us a lot about their ecology, evolution, and population-density-controls. All the sections of this question relate in some way to issues involving life-cycles.

***[i]*** Sexual reproduction is an integral part of many life-cycles. Explain ***briefly*** the *evolutionary/genetic advantages of sexual reproduction*; your answer should pay some attention to the role of environmental circumstances. (5 marks)

***[ii]*** For this section, consider a hypothetical species which must undergo sexual reproduction in its cycle (no asexual option). Under what *ecological conditions* might individuals of this species be *at a disadvantage* because they must reproduce sexually? *HINT* – "ecological conditions" could be abiotic, biotic, intrinsic, extrinsic, so there could be several ways to answer. (5 marks)

***[iii]*** In any life-cycle there will be at least one stage which is relatively specialized for dispersal. Imagine contrasting two imaginary species: *species W* disperses as a mature adult, while *species G* disperses as a very immature stage (spore, zygote, seed, whatever). Which of these species would you expect to be *more "r-type" or more "K-type"*? Explain and justify ***briefly***. *HINT* – this is not a question asking you merely to define the r- and K-strategies! Answer the question as it is asked. (5 marks)

***[iv]*** Organisms which reproduce asexually are often opportunists, producing a lot of offspring when conditions permit, but dying out if conditions are poor. What mode(s) of control on population-size and/or growth-rate would you expect to observe in populations of such organisms? (*i.e.* what would their birth- and death-rate graphs look like, and why?) (5 marks)