**Solutions for Special Topics**

***Campbell BIOLOGY, Second Canadian Edition***

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Appendix A of the book includes answers for students for figure legend questions, Concept Check questions, Summary of Key Concepts questions, multiple-choice questions, and Draw It questions. This document for instructors includes suggested answers and teaching tips for the Scientific Skills Exercises, and suggested answers for the Interpret the Data Questions and the short-answer essay questions at the end of each chapter. The Scientific Skills Exercises can be assigned in MasteringBiology, where they are graded automatically.

**Tips for Grading Short-Answer Essays**

The ability to communicate clearly in writing is essential for almost any profession your students choose to pursue. As instructors, it is often frustrating to be faced with a large class full of students who have had inadequate preparation in writing skills, knowing that you don’t have the resources to help your students develop these skills.

The Write about a Theme questions at the end of each chapter are an attempt on the part of the authors to partner with you in this endeavour. At the end of each chapter, we ask the student to write a short essay of 100-150 words that relates the material they learned in the chapter to one of the themes introduced in Chapter 1 and featured throughout the book. The Write about a Theme exercises can be used as in-class or outside-of-class assignments.

For ease of grading, sample key points and sample top-scoring answers for the Write about a Theme questions are provided for instructors and TAs in this document. The list of key points provides a guide to the ideas that students should include in their essays. In addition, suggested answers to all of the end-of-chapter essay questions can be found in this document.

The time necessary to grade writing exercises has prohibited many instructors from assigning them. Using a grading rubric, however, can streamline the process. Some instructors have found they can train TAs or even students to grade short essays accurately. (Students can grade their own essays or those of their classmates.) A suggested grading rubric for the Write about a Theme essays is shown at the end of these tips and in the Study Area of MasteringBiology. This rubric can also be modified to use with the other end-of-chapter essay questions.

The simplest way to use the rubric is to read through each essay and determine how well the writer has accomplished the four aims listed at the top of the columns. The essay can then be graded as a 4, 3, 2, 1, or 0 based on the overall quality of the essay. Alternatively, you could assign 0 to 4 points for *each* of the aims, and then total the points out of 16 possible points.

You can also weight one of the aims more highly. For example, if you want to focus primarily on writing skills (aim #4: Quality of Writing) with the other aims weighted equally, the score for each aim can be multiplied by a “weighting factor.” Aim #4 could be assigned 40% of the total points, with aims # 1, 2, and 3 each worth 20%. The score (out of 4) obtained for aim #4 is multiplied by 40, and each of the others multiplied by 20, giving a total of 400 points (160 + 80 + 80 + 80 = 400).

To train TAs to grade essays in a large class, the instructor should first read through some of the essays, looking for a representative example of each of the five scores (4, 3, 2, 1, and 0 for the simplest grading scheme described above). Copies of the five representative essays (with scores hidden) can be passed out to TAs, asking them to grade the essays based on the rubric and a 0-4 grading scheme. Subsequent discussion with the TAs about their essay rankings should clarify the standards, after which they can be given a few “test” essays to grade to ensure consistency in grading practices. This training exercise should take no more than 30-45 minutes. Using a similar rubric and training scheme, the Montgomery County Public School System in Maryland has been able to train a team of instructors to grade thousands of short essays consistently in a relatively short time.

There is also a web-based program called Calibrated Peer Review (CPR) (developed at UCLA with funding from the National Science Foundation and the Howard Hughes Medical Institute) that trains students to evaluate their own work or that of their classmates (“peers”). The program is described at **http://cpr.molsci.ucla.edu/**.

When assigning essays, the instructor should point out the rubric to students (in the Study Area of MasteringBiology) or provide a customized rubric to students. Students can then refer to the rubric before writing to see what is expected of them. They can also check their essay before submitting it to make sure they have met all the criteria in the rubric. Instructors should also encourage students to read the Writing Tips provided under “Writing Tips and Rubric” in the Study Area of MasteringBiology, which also includes the suggested grading rubric.

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| **Suggested Grading Rubric for “Write about a Theme” Short-Answer Essays** | | | | |
|  | **Understanding of Theme and Relationship to Topic** | **Use of Supporting Examples or Details** | **Appropriate Use of Terminology** | **Quality of Writing** |
| **4** | Evidence of full and complete understanding | Examples well chosen, details accurate and applied to theme | Accurate scientific terminology enhances the essay | Excellent organization, sentence structure, and grammar |
| **3** | Evidence of good understanding | Examples or details are generally well applied to theme | Terminology is correctly used | Good sentence flow, sentence structure, and grammar |
| **2** | Evidence of a basic understanding | Supporting examples and details are adequate | Terminology used is not totally accurate or appropriate | Some organizational and grammatical problems |
| **1** | Evidence of limited understanding | Examples and details are minimal | Appropriate terminology is not present | Poorly organized; grammatical and spelling errors detract from essay |
| **0** | Essay shows no understanding of theme | Examples lacking or incorrect | Terminology lacking or incorrect | Essay is very poorly written |

**Suggested Answers and Teaching Tips**

**CHAPTER 1 EVOLUTION, THE THEMES OF BIOLOGY, AND SCIENTIFIC INQUIRY**

**Scientific Skills Exercise**

**Teaching objective:** Students build scientific skills by interpreting data in a pair of bar graphs and relating the data to the biological system it came from.

**Teaching tips:** A version of this Scientific Skills Exercise can be assigned in MasteringBiology.

If this is the first exercise the students are doing related to interpreting graphs, then you will need to spend time reviewing independent and dependent variables. If the students are confused by having two independent variables on one graph, have them cover one set of data while they look at the other (for example, cover the “full moon” portion of graph A while analyzing the “no moon” portion of it).

In these graphs, there are no statistical significance values given for comparisons between treatments. In the original paper, there was a statistical difference between predation levels of light brown versus dark brown mice in light-coloured soil enclosures with no moon and in dark-coloured soil enclosures under a full moon. The other two combinations, light-coloured soil under a full moon and dark-coloured soil with no moon, had no statistically significant difference between light and dark mice.

**Answers:**

**1.** (a) The independent variables for each graph are the coat colour of the mice (light or dark brown) and the presence or absence of moonlight (full moon or no moon). These are on the *x*-axis. Taking both graphs together, a third independent variable is the colour of soil in the enclosure. (b) The dependent variable is the amount of predation, measured as the number of mice caught. The dependent variable is on the *y*-axis of the two graphs.

**2.** (a) About 19. (b) About 12. (c) Based on the data, the mouse would be more likely to escape on dark soil. This might be because in the moonlight, a dark mouse on light soil would be more noticeable than one on dark soil.

**3.** (a) Under a full moon (12 were caught vs. 20 under no moon). (b) Under no moon (11 were caught vs. 18 under a full moon).

**4.** (a) Dark soil field with a full moon. (b) Light soil with no moon.

**5.** (a) No moon plus dark brown coat had the highest predation level in the light soil enclosure (38 mice were caught). (b) Full moon plus light brown coat had the highest predation level in the dark soil enclosure. (c) In both (a) and (b), coat colour does not match the environment, but higher predation occurs under different conditions: full moon for the light-coloured mice, and no moon for the dark-coloured mice.

**6.** Being on the contrasting soil is most deadly for both colours of mice.

**7.** The total number of mice caught on moonlit nights was about 77 and on nights with no moon was about 95, so the dark nights seem to be slightly better overall for hunting for owls.

**Interpret the Data**

**Figure 1.28** In the beach habitat, approximately 27 light models and 73 dark models were attacked. In the inland habitat, approximately 76 light models and 24 dark models were attacked.

**Suggested Answers for End-of-Chapter Essay Questions**

See the general information on grading short-answer essays and a suggested rubric at the beginning of this document.

**12. Evolution Connection**

Common ancestry explains this observation. The thousand-some-odd genes shared by humans and prokaryotes originated in early prokaryotes. They have been retained, with some modification, over the billions of years of eukaryotic evolution. These genes no doubt code for proteins and RNAs whose functions are essential for survival—for example, the genes that code for ribosomal RNA, which is important for protein synthesis in both prokaryotes and eukaryotes.

**13. Scientific Inquiry**

Many legitimate hypotheses could be proposed to extend the investigation. Here is one example. If the camouflage colour has arisen through the processes of natural selection due to visual predators, then you might wonder what would happen if a population of beach mice lived in an area where predators were absent. It might be possible to do a long-term study in an area where you excluded predators. Mice have fairly short generation times, so if predation is “naturally selecting” lighter coloured mice, then in the absence of predation you might predict the fur colour would not remain predominantly light in such an experimental population.

**14. Write about a Theme: Evolution**

**Sample key points:**

* Darwin used reasoning based on observations to develop his theory of natural selection as a mechanism for evolution.
* His observations included:
  + Heritable variations exist in each population.
  + A population has more individuals than can be supported by the environment.
  + Each species seems suited for its particular environment.
* He proposed that the best-adapted individuals in a population would outcompete others for resources and disproportionately survive and produce more offspring, leading to an increase in the adaptations seen in the population.

**Sample top-scoring answer:**

Based on many observations of different species, Darwin proposed his theory that evolution by means of natural selection accounts for both the unity and diversity of life on Earth. He noticed that variations existed among the individuals in a population and that these variations seemed to be heritable. He also saw that populations could grow larger than could be supported by the resources around them. Finally, he observed that species (like the different species of finches) seemed to suit their environment. He proposed that the best-suited individuals in a population would survive and reproduce more successfully that those less adapted to their environment, and he called this “natural selection.” In Darwin’s view, this mechanism could account for both the unity and diversity of features among species. The descent of organisms from a common ancestor explains similar features, while the force of natural selection in different environments accounts for differences between organisms.

**15. Synthesize Your Knowledge**

It’s difficult to pick out this gecko against the background of the tree trunk, because the gecko itself looks like mossy bark. This coloration likely makes the gecko unable to be seen by predators, thus enhancing its survival. This cryptic coloration pattern probably evolved over generations. The members of a gecko population that better matched their background would have been less visible to predators, thus more likely to survive, reproduce, and leave offspring. The offspring would inherit the genes necessary to generate the mossy bark coloration, and the offspring that blended in better would survive better and reproduce more successfully. Over generations, the coloration would become a closer and closer match to the tree bark. (The mossy leaf-tailed gecko is endemic to Madagascar, meaning it is found only there and nowhere else in the world. Many endemic species live in Madagascar. This is because it is an island with land features and climatic factors that have allowed evolution of many species in isolation.)