

AP[®] BIOLOGY

2008 SCORING GUIDELINES

Question 3

3. Regulation is an important aspect of all biological processes.

For FOUR of the following processes, **describe** the specific role of the regulator and **discuss** how the process will be altered if the regulation is disrupted.

SCORING RUBRIC FOR EACH PROCESS (**1 point per bullet; 3 points maximum per process**)

Role of regulator (**2 points**)

- Cause and effect
- Effecting mechanism

How process is disrupted (**2 points**)

- Increase in regulator
- Decrease in regulator

Cell Cycle/Cyclin

Role of regulator

- Allows cell cycle to proceed OR get past checkpoint from one phase to next: G₁, S, G₂
- Works/combines with Cdk, S-phase, MPF, APC; OR how concentration fluctuates

How process is disrupted

- Decrease in cyclin: no mitosis/not past checkpoints/G₁, cell in G₀; examples: nerve and muscle cells
- Increase in cyclin: cancer/uncontrolled growth/cell division

Metabolic Rate/Thyroxine

Role of regulator

- Stimulates/increases metabolic rate
- Discuss negative feedback, TSH OR hypothalamus-releasing hormone—anterior pituitary—TSH OR metamorphosis in frog OR conversion T₄ → T₃ discussion

How process is disrupted

- Decrease in thyroxine: weight gain, lethargy, no negative feedback (altered), hypothyroidism, osteoporosis OR decrease in iodine: decrease in thyroxine—goiter
- Increase in thyroxine: weight loss, increase in heart rate, increase in blood pressure, hyperthyroidism, Grave's disease

Ovarian Cycle/FSH

Role of regulator

- Stimulates maturation/development of follicle/egg OR stimulates estrogen production OR leads to (not causes or triggers) ovulation
- Continuation of meiosis OR completion of meiosis 1 OR discuss negative feedback, FSH/estrogen

How process is disrupted

- Decrease in FSH: sterile, no possibility of fertilization/pregnancy—no ovulation
- Increase in FSH: multiple eggs develop, multiple births

AP[®] BIOLOGY
2008 SCORING GUIDELINES

Question 3 (continued)

Prey Population Dynamics/Predators

Role of regulator

- Predator decreases (consumes, eats, etc.) prey population in size/number
- Negative feedback discussion: graph/lag elaboration, cyclic fluctuation or equilibrium leads to stabilizing size or carrying capacity

How process is disrupted

- Decrease in predators: prey population increases, exceeds carrying capacity, increased competition for resources—decrease in prey
- Increase in predators: prey population decreases, boom/bust as result of more prey being captured/eaten causing decrease in prey population; may cause predator decrease due to lack of food

Ecological Succession/Fire

Role of regulator

- Triggers/sets stage for succession; OR maintains a stable community
- Returns/releases nutrients into soil; OR triggers germination in some plant species;
OR changes community makeup, allows for pioneer species, eliminates some species

How process is disrupted

- Decrease in fire: leads to invasive species opportunity, lack of nutrient recycling, leads to detritus build-up (may lead to catastrophic fire)
- Increase in fire: never achieves stable/climax community, succession is suspended, increase/decrease in biodiversity (with explanation)

3. Regulation is an important aspect of all biological processes.

3A1

For FOUR of the following processes, **describe** the specific role of the regulator and **discuss** how the process will be altered if the regulation is disrupted.

Process	Regulator
Cell cycle	Cyclin
Metabolic rate	Thyroxine
Ovarian cycle	Follicle-stimulating hormone (FSH)
Prey population dynamics	Predators
Ecological succession	Fire

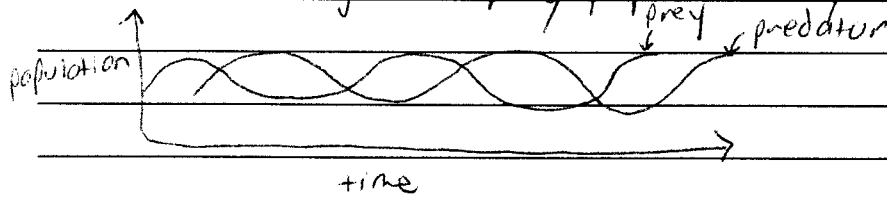
Thyroxine, a hormone secreted by the thyroid gland, regulates the metabolic rate of organisms. Thyroxine stimulates metabolic pathways. It causes organisms to break down food in order to obtain energy necessary to fuel endergonic cell reactions. Secretion of thyroxine levels too high or too low result in either hyperthyroidism or hypothyroidism. In hyperthyroidism, an overabundance of thyroxine causes breakdown of food to occur too quickly. Thus, an individual with hyperthyroidism will have high levels of energy and have a high metabolic rate, which may cause them to lose excessive weight. In hypothyroidism, not enough thyroxine is produced. Consequently, the individual's metabolic rate will be too slow. This results in a deficiency of energy, feelings of sluggishness, and weight gain.

Follicle-stimulating hormone, a hormone produced by the anterior pituitary gland, regulates the ovarian cycle. It stimulates follicle growth in the ovaries. Many follicles will grow until one follicle grows more than others. This follicle will continue to grow as the ovum matures as long as FSH is released. Finally, a luteal surge of luteinizing hormone will cause the follicle to rupture and release the mature ovum in the fallopian tube in order to be fertilized. If FSH is not secreted, a woman may not be fertile, or able to produce offspring. This occurs because the follicles containing the oovms will not

GO ON TO THE NEXT PAGE.

mature properly. In addition, the follicle will not form ~~an~~ corpus luteum, which will prepare the endometrium for implantation of the fertilized ovum within the uterus. Therefore, disruption of the regulator FSH will cause a woman to not undergo menstruation as well since ovums won't be released, and progesterone, which prepares the uterine lining, will not be secreted by the follicle.

Predators regulate prey population dynamics.



As the predator-prey graph illustrates, the populations of the predator and prey interact, yet changes in the prey population will mirror changes in the predator population that cycles behind the prey population. On one hand, predators keep the population of the prey in check. Predators will increase in population after an increase in the prey population because more food is now available to the predators. Thus, the prey population will not grow ~~to~~ exponentially for an extended time period. However, the ~~prey~~ predator population will decrease following a drop in the prey population since the predator's food source is decreasing. However, without predators to interact with the prey, the prey population dynamics may become out of control. For example, without predators to curb exponential growth of the prey, the prey population will continue to grow exponentially the prey may take over a habitat and reduce biodiversity. On the contrary, too many predators may cause extinction of a prey population if overpredation occurs.

Fires may destroy and kill certain species of an

GO ON TO THE NEXT PAGE.

ecosystem, thus, the ecosystem may then undergo secondary succession after the fire. The secondary succession will occur faster than the primary ecological succession because the soil is already there, seeds may still remain, and colonizers should already be close to the area. In addition, decomposition of dead plants and animals after a fire may enrich the soil further with ~~the~~ important vitamins and minerals. Without fires, a few select species may become so dominant in an ecosystem that they utilize too many of the resources. Consequently, there are not enough resources for other species to survive there as well. The dominance of these few select species would reduce biodiversity, therefore, fires prevent this from happening, so they promote biodiversity in an ecosystem. Finally, the few organisms that may survive after a fire would have a different gene pool ~~than~~ than all the organisms in the prior population. This group of survivors would display the founder effect, which is a type of genetic drift that could affect natural selection and evolution.

GO ON TO THE NEXT PAGE.

3. Regulation is an important aspect of all biological processes.

331

For FOUR of the following processes, **describe** the specific role of the regulator and **discuss** how the process will be altered if the regulation is disrupted.

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Cell cycle	Cyclin
Metabolic rate	Thyroxine
Ovarian cycle	Follicle-stimulating hormone (FSH)
Prey population dynamics	Predators
Ecological succession	Fire

The role of thyroxine is to increase metabolic rate. If thyroxine levels increase, this will result in an overactive thyroid.

An individual with an overactive thyroid may develop a disease called Grave's disease. Symptoms include being underweight, excess sweating, and shaking. If thyroxine levels decrease, this will lead to an underactive thyroid. Individuals with underactive thyroids often experience weight gain.

Predators control prey populations. If the predator is a secondary consumer, the population of primary consumer is affected. If the number of secondary consumer predators increase, the

primary consumers will decrease thus increasing the population of the primary producers. ~~If the number of~~ If the number of

secondary consumers predators decrease, the population of primary consumers would increase thus decreasing the population of primary producers. Forest fires cause secondary

succession to occur. Many living organisms are killed in the process, but the soil remains intact. The fire

controls plant and animal populations. The FSH hormone

regulates the ovarian cycle. Without this hormone, ~~the~~ a

woman will have trouble ovulating. If a woman does not ovulate, she has no chance of getting pregnant.

GO ON TO THE NEXT PAGE.

3. Regulation is an important aspect of all biological processes.

3C1

For FOUR of the following processes, **describe** the specific role of the regulator and **discuss** how the process will be altered if the regulation is disrupted.

Process	Regulator
Cell cycle	Cyclin
Metabolic rate	Thyroxine
Ovarian cycle	Follicle-stimulating hormone (FSH)
Prey population dynamics	Predators
Ecological succession	Fire

The cell cycle regulator, cyclin, ensures that each cell undergoes proper reproduction and programmed cell death. If cyclin were to be altered or its access to the cells disrupted, cells may be malformed or may not undergo mitosis or meiosis at all.

The ovarian cycle is in part regulated by follicle-stimulating hormone or FSH. FSH stimulates the production of the cells that line the uterine wall as well as the maturation of egg cells in the ovaries. If this hormone were somehow disrupted, menstruation would be impacted and infertility could result.

Predators play a key role in prey population dynamics. Predators keep the balance of an ecosystem in check by ensuring that no consumer becomes too populous. If predatory animals were removed from an environment, the results would be disastrous for the environment. Eaters of the producers would multiply in numbers faster than the producers and with nothing to ~~slow~~ thin their numbers, it would end in the starvation of primary consumers from the depletion of primary producers.

Ecological succession is aided by fire in that it helps to return nutrients to the soil so that new things may grow. If fires were prevented, a climax ecological community would become overgrown and the nutrients in the soil depleted.

GO ON TO THE NEXT PAGE.

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2008 SCORING COMMENTARY

Question 3

Overview

The goal of this question was to have students address mechanisms of regulation or control in various biological processes. In addition, the question applied the concept of regulation (a unifying theme) to processes from key content areas in biology—cells, endocrine system, reproduction, and ecology. The students were first asked to describe a specific process (cell cycle, metabolic rate, ovarian cycle, prey population dynamics, ecological succession) and then discuss how that process would be altered if the regulation was disrupted. Students were required to address four of these five processes.

Sample: 3A

Score: 10

The student earned a cause-and-effect point for stating: “Thyroxine stimulates metabolic pathways.” The student then earned 2 more points for a discussion of the effects resulting from hyperthyroidism and hypothyroidism leading to “excessive” weight loss or weight gain. The student again earned a cause-and-effect point for stating that FSH “stimulates follicle growth in the ovaries” and drives this point home by adding: “This follicle will continue to grow as the ovum matures.” A disruption point was earned for the decrease in FSH by stating that “a woman may not be fertile, or able to produce offspring.” For prey population dynamics, the student earned an effecting mechanism point by referring to a diagram depicting the cyclic fluctuations in a predator–prey relationship. The student continues elaborating on the cyclic fluctuations and earned the disruption point by finally stating that “without predators to curb exponential growth of the prey, the prey population will continue to grow exponentially.” A cause-and-effect point was earned for the role of fire causing secondary succession. The student earned an effecting mechanism point for a description of soil being enriched after a fire. The tenth and final point was awarded for the discussion of the reduction in biodiversity as a result of no fires.

Sample: 3B

Score: 7

The student earned a clear cause-and-effect point for stating: “The role of thyroxine is to increase metabolic rate.” The student earned a second point for describing how an overactive thyroid can lead to Grave’s disease, which causes symptoms such as “being underweight, excess sweating, and shaking.” A third point was earned for describing a decrease in thyroxine levels where individuals “experience weight gain.” Thus the student earned the maximum points for the process of metabolic rate without ever addressing the effecting mechanism. The student earned 2 points for discussing what occurs when the predator population increases or decreases and its resulting effect on the prey population. The student earned a cause-and-effect point for stating that “fires cause secondary succession to occur.” A final point was earned for a discussion of the disruption of FSH as a regulator of the ovarian cycle. (“Without this hormone, a woman will have trouble ovulating. If a woman does not ovulate, she has no chance of getting pregnant.”) While this was a short response, the student still earned a total of 7 points.

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2008 SCORING COMMENTARY

Question 3 (continued)

Sample: 3C

Score: 3

The student begins with the cell cycle but earned no points. A point was earned for the cause and effect of FSH (“stimulates . . . the maturation of egg cells in the ovaries”). The student writes about the removal of predators from the environment but never addresses what that does to the prey population. For ecological succession, the student earned 2 points: 1 point for stating that fire “helps to return nutrients to the soil” and a second point for stating: “If fires were prevented, a climax ecological community would become overgrown and the nutrients in the soil depleted.”