

SCIENCE

High School Student Guide

Science is both a body of knowledge that represents current understanding of natural systems and the process that continually extends, refines, and revises that body of knowledge. Progress in science cannot be made without an understanding of both. While knowing specific facts and details about the natural world is important, science is much more than merely learning content. It is the active process of investigation and the critical review of evidence related to the world around us. Science is the process of gathering and evaluating information, looking for patterns, and testing possible explanations.

Students often wonder why science is necessary for them. Science students learn to think critically and to develop reasoning skills that allow them to become independent, lifelong learners. Science methods and thought processes have applications well beyond the bounds of science, and students who understand the rules of evidence can transfer that knowledge into practical everyday life and to future employment opportunities.

A study by Arizona State University indicated that students who opt out of advanced levels of mathematics and science may now eliminate up to 75% of career opportunities from which to choose.[†] Employers want their employees to be able to make observations; gather, analyze, and critically review information; communicate information effectively; and work with other people to reach goals. It is clear that the science literacy of the twentieth century will not be sufficient for the twenty-first century.

[†]ASU Research, Fall, 1998, p. 41

ABOUT THE TEST

The science test contains 65 multiple-choice questions. Calculators are not allowed; however, the calculations required can be readily handled with pencil and paper. The questions will emphasize conceptual understanding, the inquiry process, and problem solving skills.

Hints for taking AIMS – Science

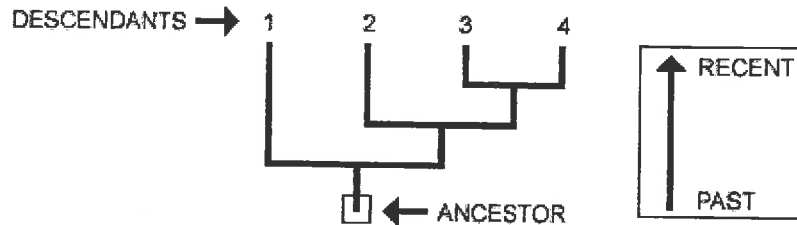
- Remember that this is **not** a timed test. Take your time and do your best work.
- **Since calculators are not allowed on this test, double-check your work!**
- Carefully read each question and all of the answer choices.

→ Please do NOT write on this!

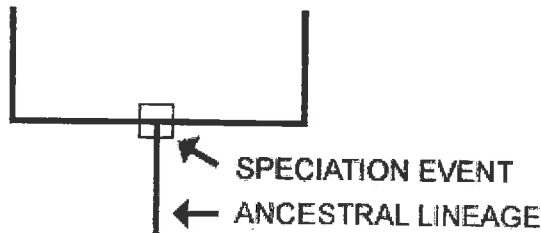


Understanding phylogenies

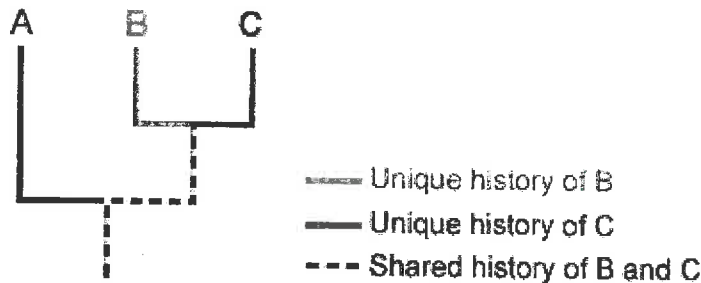
Understanding a phylogeny is a lot like reading a family tree. The root of the tree represents the ancestral lineage, and the tips of the branches represent the descendants of that ancestor. As you move from the root to the tips, you are moving forward in time.



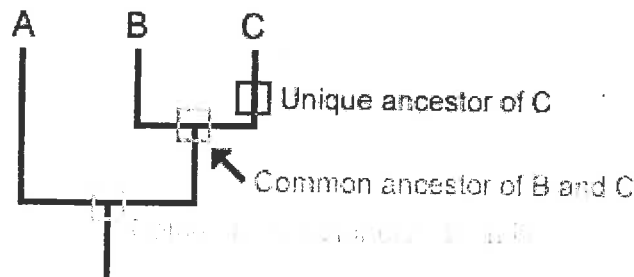
When a lineage splits (speciation), it is represented as branching on a phylogeny. When a speciation event occurs, a single ancestral lineage gives rise to two or more daughter lineages.



Phylogenies trace patterns of shared ancestry between lineages. Each lineage has a part of its history that is unique to it alone and parts that are shared with other lineages.



Similarly, each lineage has ancestors that are unique to that lineage and ancestors that are shared with other lineages — common ancestors.



[Download this series of graphics from the Image library.](#)

View this article online at:
http://evolution.berkeley.edu/evolibrary/article/evo_05

21.1 Fossil evidence indicates that evolution has occurred.

At its core, the case for evolution is built upon two pillars: first, evidence that natural selection can produce evolutionary change and, second, evidence from the fossil record that evolution has occurred. In addition, information from many different areas of biology—including fields as different as embryology, anatomy, molecular biology, and biogeography (the study of the geographic distribution of species)—can only be interpreted sensibly as the outcome of evolution.

The Fossil Record

The most direct evidence that evolution has occurred is found in the fossil record. Today we have a far more complete understanding of this record than was available in Darwin's time. Fossils are the preserved remains of once-living organisms. Fossils are created when three events occur. First, the organism must become buried in sediment; then, the calcium in bone or other hard tissue must mineralize; and, finally, the surrounding sediment must eventually harden to form rock. The process of fossilization probably occurs rarely. Usually, animal or plant remains will decay or be scavenged before the process can begin. In addition, many fossils occur in rocks that are inaccessible to scientists. When they do become available, they are often destroyed by erosion and other natural processes before they can be collected. As a result, only a fraction of the species that have ever existed (estimated by some to be as many as 500 million) are known from fossils. Nonetheless, the fossils that have been discovered are sufficient to provide detailed information on the course of evolution through time.

Dating Fossils

By dating the rocks in which fossils occur, we can get an accurate idea of how old the fossils are. In Darwin's day, rocks were dated by their position with respect to one another (*relative dating*); rocks in deeper strata are generally older. Knowing the relative positions of sedimentary rocks and the rates of erosion of different kinds of sedimentary rocks in different environments, geologists of the nineteenth century derived a fairly accurate idea of the relative ages of rocks.

Today, rocks are dated by measuring the degree of decay of certain radioisotopes contained in the rock (*absolute dating*); the older the rock, the more its isotopes have decayed. Because radioactive isotopes decay at a constant rate unaltered by temperature or pressure, the isotopes in a rock act as an internal clock, measuring the time since the rock was formed. This is a more accurate way of dating rocks and provides dates stated in millions of years, rather than relative dates.

A History of Evolutionary Change

When fossils are arrayed according to their age, from oldest to youngest, they often provide evidence of successive evolutionary change. At the largest scale, the fossil record documents the progression of life through time, from the origin of eukaryotic organisms, through the evolution of fishes, the rise of land-living organisms, the reign of the dinosaurs, and on to the origin of humans (figure 21.2).

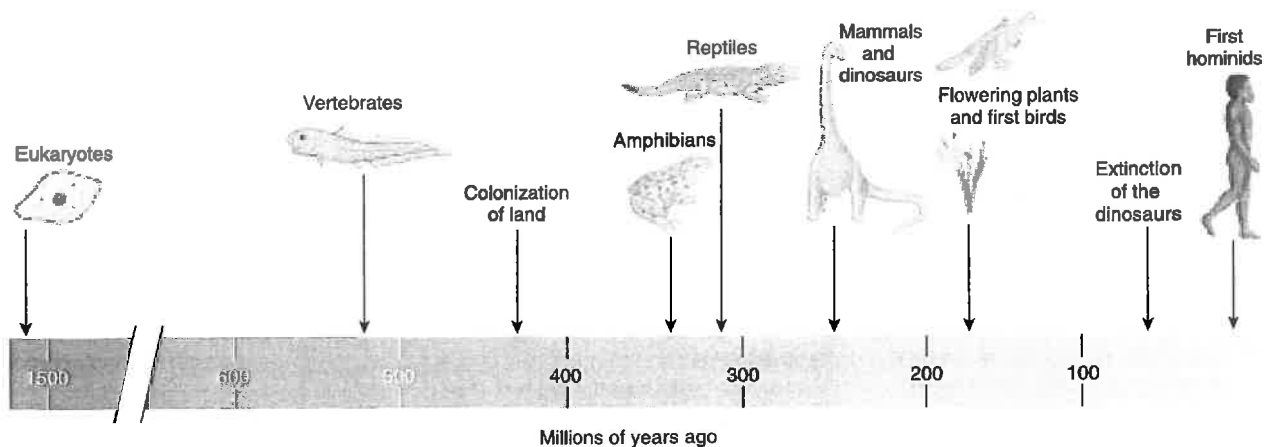


FIGURE 21.2
Timeline of the history of life as revealed by the fossil record.

Gaps in the Fossil Record

This is not to say that the fossil record is complete. Given the low likelihood of fossil preservation and recovery, it is not surprising that there are gaps in the fossil record. Nonetheless, paleontologists (the scientists who study fossils) continue to fill in the gaps in the fossil record. While many gaps interrupted the fossil record in Darwin's era, even then, scientists knew of the *Archaeopteryx* fossil transitional between dinosaurs and birds. Today, the fossil record is far more complete, particularly among the vertebrates; fossils have been found linking all the major groups. Recent years have seen spectacular discoveries closing some of the major remaining gaps in our understanding of vertebrate evolution. For example, recently a four-legged aquatic mammal was discovered that provides important insights concerning the evolution of whales and dolphins from land-living, hoofed ancestors (figure 21.3). Similarly, a fossil snake with legs has shed light on the evolution of snakes, which are descended from lizards that gradually became more and more elongated with simultaneous reduction and eventual disappearance of the limbs.

On a finer scale, evolutionary change within some types of animals is known in exceptional detail. For example, about 200 million years ago, oysters underwent a change from small curved shells to larger, flatter ones, with progressively flatter fossils being seen in the fossil record over a period of 12 million years (figure 21.4). A host of other examples all illustrate a record of successive change. The demonstration of this successive change is one of the strongest lines of evidence that evolution has occurred.

The fossil record provides a clear record of the major evolutionary transitions that have occurred through time.

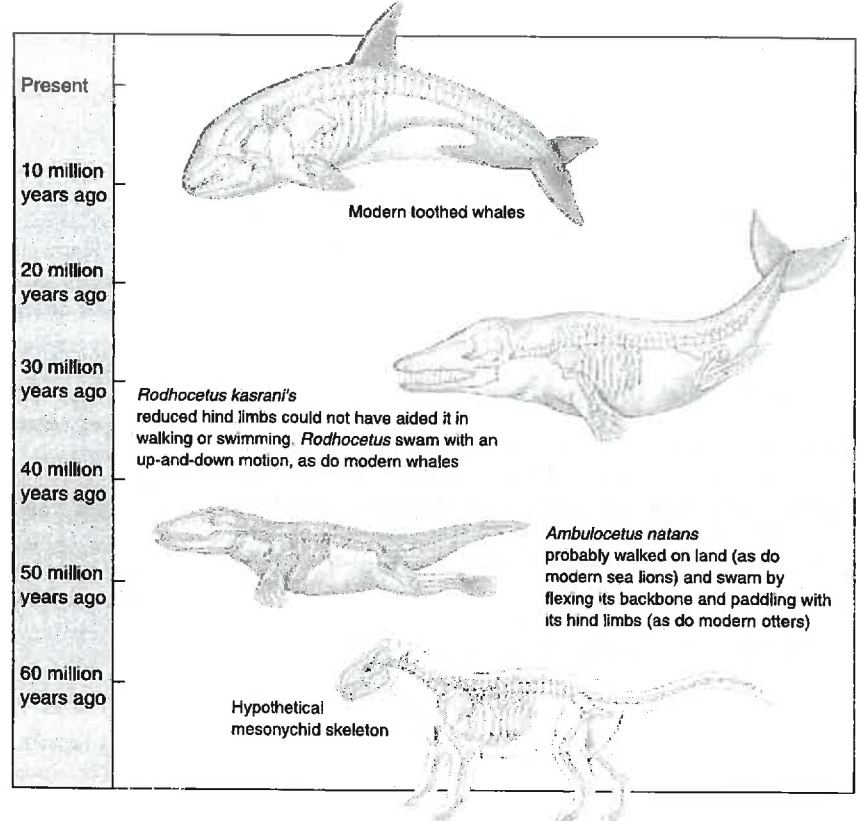


FIGURE 21.3

Whale “missing links.” The recent discoveries of *Ambulocetus* and *Rodhocetus* have filled in the gaps between the mesonychids, the hypothetical ancestral link between the whales and the hoofed mammals, and present-day whales.

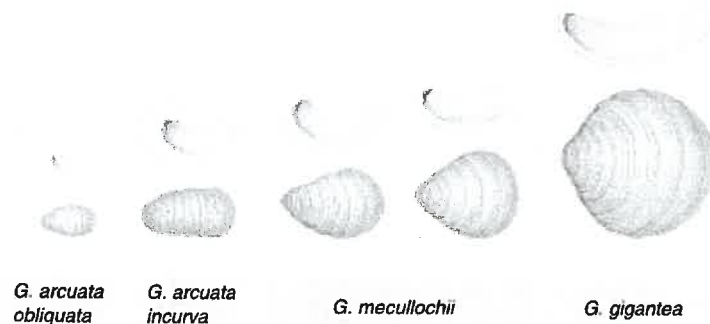


FIGURE 21.4

Evolution of shell shape in oysters. Over 12 million years of the Early Jurassic Period, the shells of this group of coiled oysters became larger, thinner, and flatter. These animals rested on the ocean floor in a special position called the “life position,” and it may be that the larger, flatter shells were more stable in disruptive water movements.

Sample Questions for Science

What To Expect From This Section

This AIMS Student Guide for Science provides examples of the format and types of questions that will appear on AIMS Science. An attempt has been made to provide a sampling of the types of questions that might be asked; however, not every concept in each strand has a corresponding sample question in this Guide. An answer key for all Science sample questions is provided in the appendices.

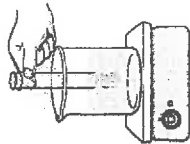
Strand 1: Inquiry Process

General concepts you should know:

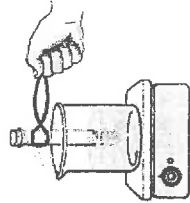
- Formulate predictions, questions, or hypotheses based on observations. Evaluate appropriate resources.
- Design and conduct controlled investigations.
- Evaluate experimental design; analyze data to explain results and propose further investigations.
- Communicate results of investigations.

1.

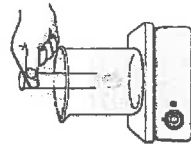
A student must heat the contents of a test tube. Which of the following shows the correct technique the student should use to heat and hold the test tube while it is in the hot water bath?



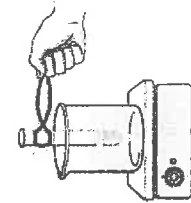
A



C



B



D

2.

The table below shows the number of unprovoked shark attacks on humans in 5 states.

Number of Unprovoked Shark Attacks (1670–2004)

State	Total Attacks
California	85
Florida	500
Hawaii	100
North Carolina	28
South Carolina	47

What is the mean number of unprovoked shark attacks in the 5 states?

- A 47
- B 85
- C 127
- D 152

3.

A student completed an experiment that compared the amount of nitrogen given to a tomato plant to how many tomatoes the plant produced. Which of the following is the best axis label and placement for the independent variable?

- A Amount of Nitrogen Given (in kilograms), x-axis
- B Amount of Nitrogen Given (in meters), y-axis
- C Amount of Tomatoes Produced (in kilograms), x-axis
- D Amount of Tomatoes Produced (in meters), y-axis

Strand 2: History and Nature of Science

General concepts you should know:

- Identify individual, cultural, and technological contributions to scientific knowledge.
- Understand how science is a process for generating knowledge.

6. The discovery of which of the following has most directly led to advances in the identification of suspects in criminal investigations and in the identification of genetic diseases?

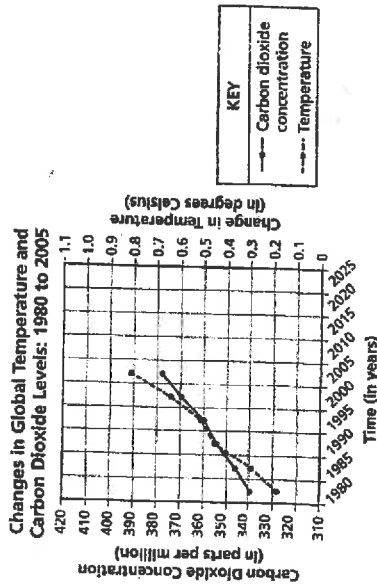
- A antibiotics
- B cell structure
- C DNA structure
- D sterile procedures

7. Darwin's theory states that evolutionary changes occur gradually over a long period of time. However, scientists have recently discovered that some mutations lead to rapid and dramatic changes in a short period of time. What does this discovery suggest about Darwin's theory?

- A It may need to be modified.
- B It should be discarded as incorrect.
- C It is supported by modern and historical species.
- D It is correct in its original form about all species.

Directions: Use the information below to answer Numbers 4 and 5.

Scientists have collected data that indicate Earth's temperature is in a warming trend. Many scientists believe this temperature increase may be caused by an increase in the amount of carbon dioxide in the atmosphere. The graph below shows the changes in global temperature and carbon dioxide levels from 1980 to 2005.



4. Based on the data in the graph, which of the following is the best prediction of what the carbon dioxide level will be in the year 2020?

- A 375 parts per million
- B 385 parts per million
- C 395 parts per million
- D 405 parts per million

5. Which hypothesis is best supported by the overall data trends in the graph?

- A As the carbon dioxide level rises, temperature rises.
- B As the carbon dioxide level rises, temperature falls.
- C As the carbon dioxide level rises, the ocean level rises.
- D As the carbon dioxide level rises, the ocean level falls.

Strand 3: Science in Personal and Social Perspectives

General concepts you should know:

- Describe the interactions between human populations, natural hazards, and the environment.
- Develop viable solutions to a need or problem.
- Analyze factors that affect human populations.

8.

In recent years, cattle producers have used growth hormones to increase the rate of growth in their cattle. Which statement does **not** support the use of growth hormones in cattle?

- A Using these hormones might cause an increase in reproduction in cattle.
- B Using these hormones might increase creation of lean muscle on the cattle.
- C Using these hormones might cause meat products from the cattle to be unsafe to eat.
- D Using these hormones might increase beef production and lower prices of beef products.

9.

The percentage of severely overweight children in the United States has been steadily increasing since 1970. Being severely overweight has been linked to an increase in the probability that a person will develop diabetes and heart disease. If the percentage of severely overweight children continues to rise, which of the following is the most likely outcome?

- A More people will have heart disease and diabetes.
- B Fewer people will be overweight and have heart disease.
- C Fewer people will be overweight, and fewer people will have diabetes.
- D More people will have diabetes, and fewer people will have heart disease.

Strand 3 is also addressed in Item 18.

Strand 4: Life Science

General concepts you should know:

- Understand the role of the cell and cellular processes.
- Understand the molecular basis of heredity and resulting genetic diversity.
- Analyze the relationships among various organisms and their environment.
- Understand the scientific principles and processes involved in biological evolution.
- Understand the organization of living systems and the role of energy within those systems.

10.

Which structure is outside the nucleus of a cell and contains DNA?

- A chromosome
- B gene
- C mitochondrion
- D vacuole

- genes are found on chromosomes.
- chromosomes are found in the nucleus and contain DNA.
- mitochondria contain circular DNA instead of chromosomes.

11.

The genome of a goldfish contains 96 chromosomes. How many chromosomes will each daughter cell have after mitosis of a goldfish cell is complete?

- A 24
- B 48
- C 96
- D 192

look @ page 218
in the textbook.

12. Which of the following is the template for the production of RNA within a cell?

- A DNA
- B ATP
- C protein
- D carbohydrate

100K at page 214-217
in the textbook.

- 13.

Which sequence of DNA bases would pair with the ones shown in the partial strand below?

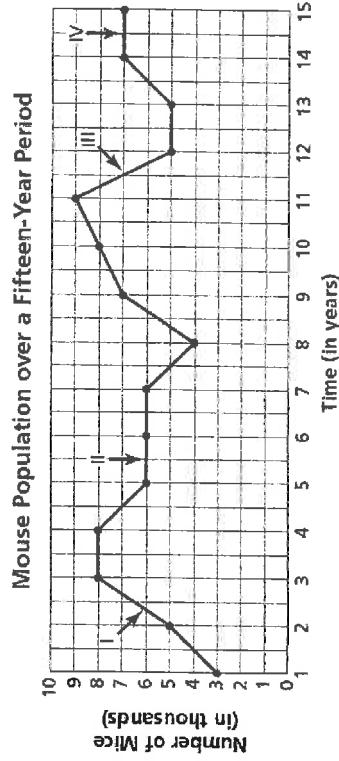
¹ ATG ² TGA ³ CAG

- A ¹ ATG ² TGA ³ CAG
- B ¹ TAC ² ACT ³ GTC
- C ¹ GTA ² AGT ³ GAC
- D ¹ CAT ² TCA ³ CTG

100K at page
42-43 in the
textbook.

- 14.

The graph below shows the population of mice living in a certain area over a fifteen-year period.



Which numeral on the graph points to a time when the birth rate exceeded the death rate of the mice?

- A I
- B II
- C III
- D IV

100K e page 255
in the textbook.

15.

A termite population was sprayed with a certain brand of insecticide. After being sprayed, the number of surviving termites within the population were counted and recorded as a percentage of the total. This process was repeated until a total of six generations of termites had been sprayed. The results are shown in the table below.

Termite Generation	Percentage of Surviving Termites After Spraying
1	5%
2	10%
3	25%
4	40%
5	60%
6	80%

Read:

- paragraph 1 on page 238
- Reproduction paragraph on 239
- Natural selection paragraph on 239

Which statement best explains why later generations had higher percentages of termites that survived?

- A Earlier generations had several members that were old and weak.
- B Earlier generations had smaller numbers of termites than later generations.
- C Later generations were able to live through the spraying because they were used to it.
- D Later generations were the offspring of termites that were more resistant to the spraying.

16. → Read attached pages 440-441.

Which statement about fossils could be used as evidence that evolution by natural selection has been in effect for millions of years?

- A Fossils found in higher layers of rock are older than those found in lower layers.
- B Fossils found in lower layers of rock are more complex than those found in higher layers.
- C Fossils of current species have been found throughout rock layers that are billions of years old.
- D Fossils of species that no longer exist but are ancestors of current species have been found in rock layers.

17.

Which molecule supplies the energy for cellular functions?

- A ATP
- B oxygen
- C DNA
- D water

Cells get energy from the process called respiration, which breaks down glucose using oxygen and produces CO₂, water and energy.

Strand 4 is also addressed in Items 19 and 20.

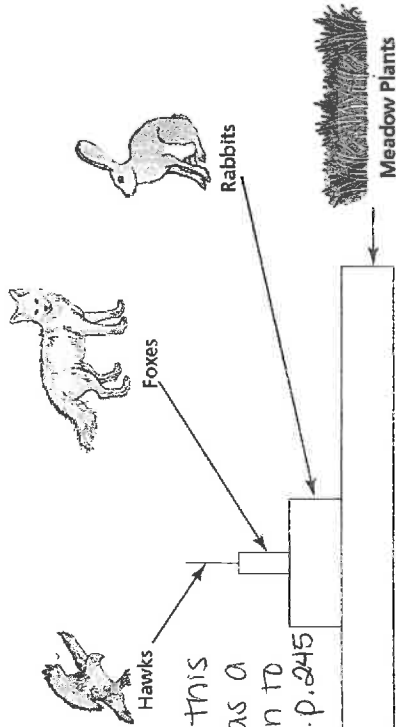
Another name for this is one of the choices above.

The following item set addresses Strand 3 (Science in Personal and Social Perspectives) and Strand 4 (Life Science):

Directions: Use the information below to answer Numbers 18 through 20.

The picture below shows the energy flow through a meadow community.

Energy Transfer in a Meadow Community



Think of this diagram as a food chain to help you. p. 245

Read page 241 in the textbook.

18. Which of the following would most likely occur to the populations within the community of organisms immediately after a wildfire burns the environment?
- A Hawks would increase and foxes would increase.
 - B Hawks would decrease and foxes would increase.
 - C Meadow plants would increase and rabbits would decrease.
 - D Meadow plants would decrease and rabbits would decrease.

19.

Which statement best describes what will happen if the population of herbivores in the community decreases?

- A The population of foxes will increase.
- B The population of hawks will increase.
- C The population of rabbits will increase.
- D The population of meadow plants will increase.

Read 'consumers' on textbook page 241

20.

Which statement best describes the flow of energy as it passes through the organisms in the pyramid?

- A Energy flows through the organisms from bottom to top and increases at each level.
- B Energy flows through the organisms from bottom to top and decreases at each level.
- C Energy flows through the organisms from top to bottom and increases at each level.
- D Energy flows through the organisms from top to bottom and decreases at each level.

Read 'Energy losses' on textbook pages 240-241