Tennessee Comprehensive Assessment Program

TCAP

Biology
Test Practice

TN Department of Education

Metadata—Science

Items

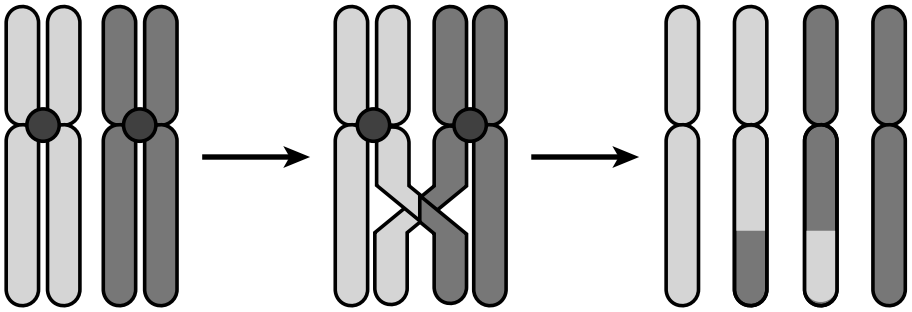
Page Number	Cluster (N/A for standalone items)	Grade	Item Type	Key	TN Standards	SEP	CCC
1	N/A	Biology	MC	D	BIO1.LS3.4	CEDS	-
2	N/A	Biology	MS	B, C	BIO1.LS4.1	CEDS	SC
3	N/A	Biology	MC	D	BIO1.LS2.1	MATH	PAT
4	N/A	Biology	MS	A, E	BIO1.LS3.2	ARGS	-
5	N/A	Biology	MC	D	BIO1.LS3.3	CEDS	CE
9	Liver Regeneration	Biology	MC	A	BIO1.LS1.3	MOD	SF
10	Liver Regeneration	Biology	MC	C	BIO1.LS3.1	INFO	-
11	Liver Regeneration	Biology	MC	D	BIO1.LS3.1	ARGS	SYS
12	Liver Regeneration	Biology	MC	C	BIO1.LS1.3	MOD	SC
13	Liver Regeneration	Biology	MC	D	BIO1.LS3.1	CEDS	CE
14	N/A	Biology	MC	C	BIO1.LS1.4	MATH	SC
15	N/A	Biology	MS	B, D, E	BIO1.LS3.2	-	SYS
16	N/A	Biology	MC	C	BIO1.LS4.2	CEDS	CE
17	N/A	Biology	MS	B, D, E	BIO1.LS2.1	DATA	CE
18	N/A	Biology	MC	A	BIO1.LS1.1	CEDS	SF

Metadata Definitions:

Grade	Grade level or Course.
Item Type	Indicates the type of item. MC= Multiple Choice; MS= Multiple Select
Key	Correct answer. This may be blank for constructed response items where students write or type their responses.
TN Standards	Primary educational standard assessed.
SEP	SEP Science and Engineering Practices: These are the essential practices of scientists and engineers which help students figure out explanations for phenomena or solutions for design problems.
CCC	CCC Cross Cutting Concepts: These are concepts that permeate all science disciplines and provide a lens through which students can apply their science ideas to phenomena or design problems.

00. The figure shows an event involving chromosomes that occurs during meiosis.

Meiosis Event



How does this event affect the genetic variation of a population?

A. It reduces genetic variation in a population by creating new chromosomes that contain less DNA.

B. It reduces genetic variation in a population by creating genetically identical daughter cells from a parent cell.

C. It increases genetic variation in a population by creating DNA mutations that can be passed on to offspring.

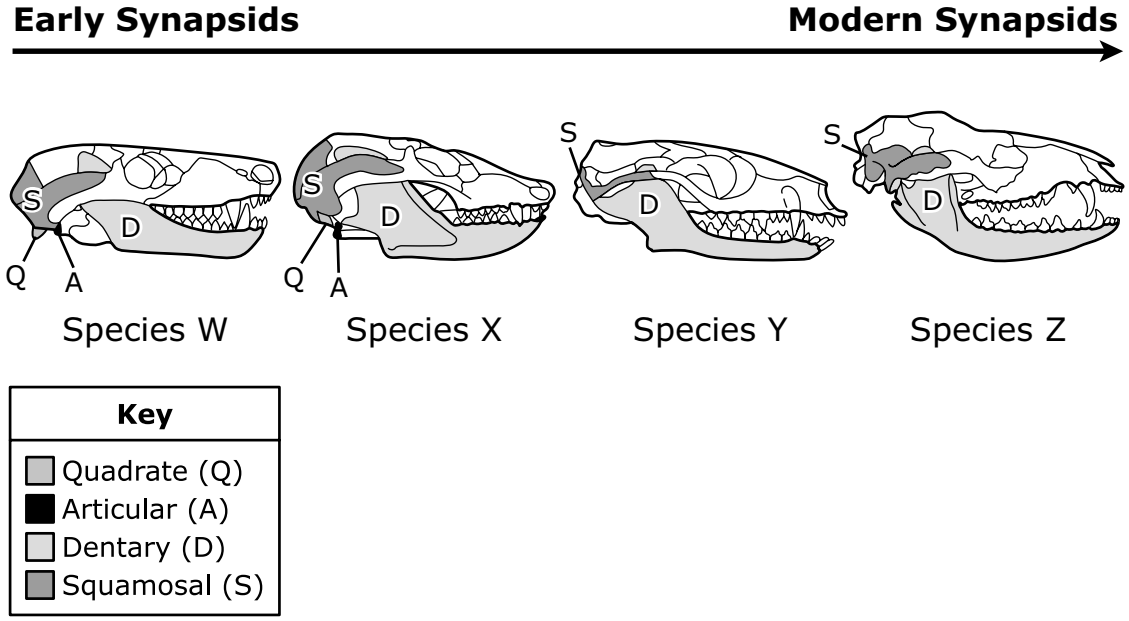
D. It increases genetic variation in a population by creating gametes that contain new combinations of alleles.

00. Synapsids are a group of animals with a connected upper and lower jaw that allows movement of the jaw.

- The earliest synapsids had two bones called the quadrate (Q) and the articular (A) that made this connection.
- The most recent synapsids have two different bones, the dentary (D) and the squamosal (S), that make this connection.

The figure shows changes in the jaw bones of synapsids over time.

Changes in the Jaw Bones of Synapsids



Which **two** statements about changes in synapsids over time are **best** supported by the information in the figure?

A. The quadrate and articular bones disappeared before the dentary and squamosal bones appeared.

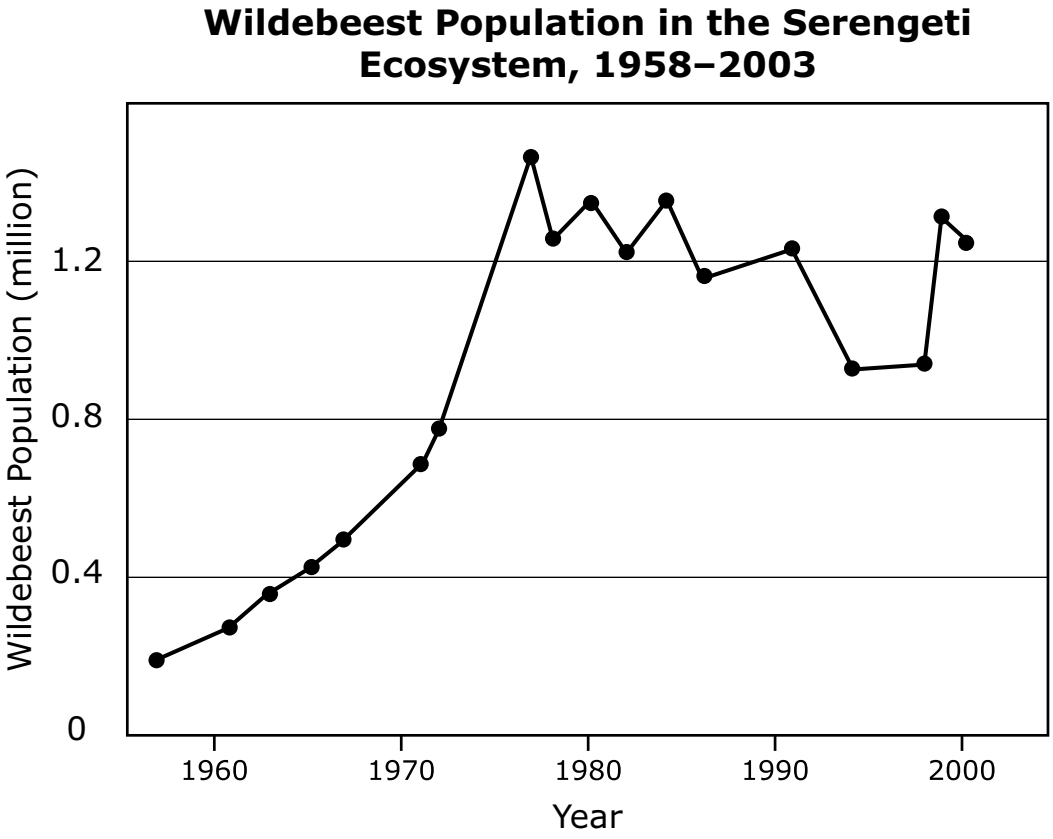
B. Species Y is more closely related to Species X than to Species W.

C. The dentary and squamosal bones were present in the common ancestor for all four species.

D. The common ancestor of Species Y and Species W had both the quadrate-articular and dentary-squamosal connections in all locations.

E. Species X is a common ancestor of the other three species.

00. The graph shows the estimated numbers of wildebeest over a period of time in an African ecosystem.



Which claim is **best** supported using the data shown in the graph?

A. Between 1978–1995 the birth rate was equal to the death rate.

B. Between 1970–1978 the predator population increased.

C. Around 1980 a contagious pathogen was introduced into the population.

D. Around 1978 the population reached its carrying capacity.

00. The reproductive cycle of the species *Apis mellifera* is known for producing offspring that have many gene sequences not found in the parent cells. Based on this information, a student claims that *A. mellifera* **most likely** reproduces sexually rather than asexually.

Which **two** pieces of evidence would **best** support the student's claim?

A. *A. mellifera* combines chromosomes from two gametes whenever it reproduces.

B. The body cells of *A. mellifera* have the same number of chromosomes as their gametes.

C. Homologous chromosomes in *A. mellifera* exchange genetic information within body cells.

D. *A. mellifera* produces specialized sex cells that contain the same genetic information as the parent cells.

E. Homologous chromosomes in *A. mellifera* exchange genetic information during the production of specialized sex cells.

00. The time of year during which a rose plant blooms, or flowers, is a trait called blooming seasonality. The blooming seasonality trait is controlled by the *RoKSN* gene. The *RoKSN* gene is a repressor gene that, when expressed, prohibits rose plants from blooming. The data table shows the blooming time associated with two alleles of the *RoKSN* gene.

Alleles for the Blooming Seasonality Trait

Rose Type	RoKSNAllele	Blooming Time
Type 1	*X*	Only in the spring
Type 2	*Y*	Can flower all the time as long as appropriate growing conditions are available

Source: Soufflet-Freslon, V., et al., *Horticulture Research*, 2021

How do differences between the *RoKSN* alleles **most likely** account for the differences in the blooming seasonality trait in the two types of roses?

A. Type 1 roses have an allele of the *RoKSN* gene that is expressed, so the rose plant blooms continuously.

B. Type 1 roses have an allele of the *RoKSN* gene that is not expressed, so the rose plant blooms continuously.

C. Type 2 roses have an allele of the *RoKSN* gene that is expressed, so the rose plant blooms continuously.

D. Type 2 roses have an allele of the *RoKSN* gene that is not expressed, so the rose plant blooms continuously.

Questions XX–XX refer to the passage(s) and image(s) shown.

Liver Regeneration – Part 1

The human liver is capable of regenerating large amounts of its tissue mass after disease, injury, or surgery. The regeneration process replaces all the specialized cell types necessary for the liver to carry out vital functions.

Scientists studied the process that produces the specialized cells of the liver during development to help them understand how the liver regenerates. Figure 1 shows part of the development process of specialized liver cells from pluripotent stem cells. Pluripotent stem cells have the capacity to develop into all of the body cell types. Multipotent stem cells can develop into a limited number of cell types.

Figure 1. Development of Specialized Liver Cells

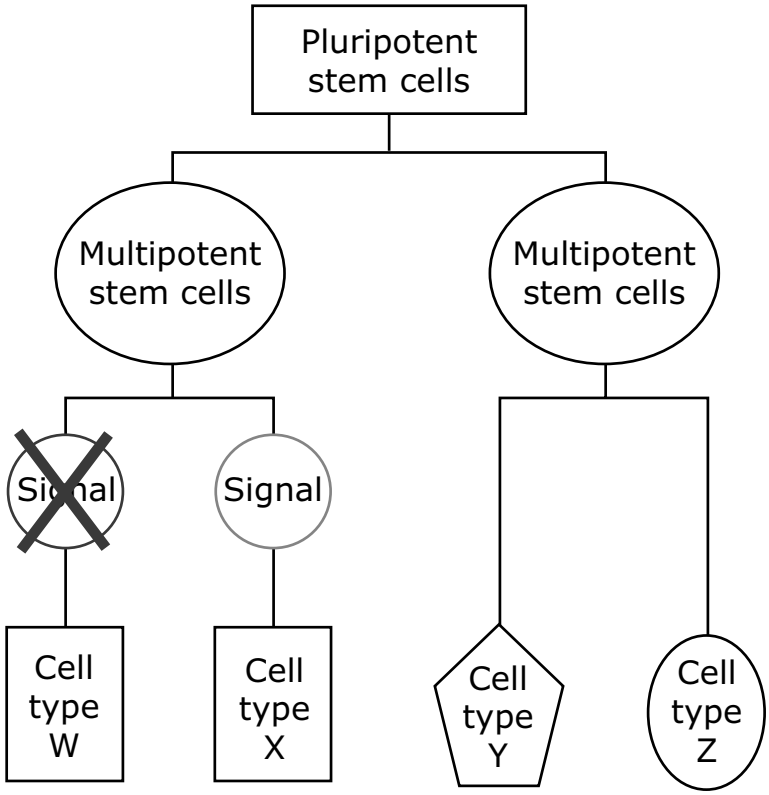


Table 1 describes the functions of four of the specialized cell types of the liver.

Table 1. Cell Types of the Liver

Cell Type	Function
W	• Processes nutrients • Produces bile • Metabolizes drugs and toxins
X	• Modifies and transforms bile • Regulates bile flow through bile ducts • Regulates immune response and repair of bile ducts
Y	• Stores vitamins • Transforms to myofibroblast-like cell following injury
Z	• Exchanges substances between blood and Cell type W • Plays a role in regulating blood flow through vessels

Liver Regeneration – Part 2

Studies provide evidence that three regeneration mechanisms are used by the liver to replace lost or damaged tissue. Table 2 compares the regeneration mechanisms. Oval cells are found in the liver but appear to be active only during liver regeneration and repair.

Table 2. Liver Tissue Regeneration Mechanisms

Mechanism	Description
J	Existing cells replicate and form daughter cells of the same type.
K	One cell type divides to produce another cell type.
L	Oval cells in the liver divide and differentiate into different cell types.

Table 3 describes different stages of a liver cell's life cycle.

Table 3. Liver Cell Life Cycle

Stage	Primary Activity
1	• The cell performs a specialized function. • The cell performs maintenance.
2	• The cell performs a specialized function. • The cell grows. • Cell contents and structures increase.
3	• Chromosomes in the cell replicate.
4	• The cell grows. • The cell prepares for division.
5	• Genetic materials are divided between two sides of the cell. • Cell contents are divided into two daughter cells.

00. Based on the information in Figure 1 (Part 1), what will happen during the development of specialized liver cells when the signal is present?

A. Cell type X will express different genes than Cell type W.

B. Protein production will be greater in Cell type Y than in Cell type W.

C. Chromosomes that are used in Cell type W will be inactivated in Cell type X.

D. Genes in the multipotent stem cells that are not needed in Cell type X will be deleted.

00. CYP3A5 is a protein that is important in metabolizing drugs in the liver. A student claims that some multipotent stem cells contain the gene for CYP3A5 production but others do not.

Based on the information in Figure 1 and Table 1 (Part 1), is the claim supported?

A. Yes. All multipotent stem cells have the gene for CYP3A5 production, but it is only active in differentiated Cell type W.

B. Yes. Only multipotent stem cells that differentiate into Cell type Y have the gene for CYP3A5 production.

C. No. All multipotent stem cells have the gene for CYP3A5 production, but it is only active in differentiated Cell type W.

D. No. Only multipotent stem cells that differentiate into Cell type Y have the gene for CYP3A5 production.

00. Studies have shown that some of Cell type W in the liver may contain more than two sets of chromosomes. Scientists think that this enhances the ability of Cell type W to regenerate.

What change to the process described in Table 3 (Part 2) could **best** explain the additional chromosomes in some of Cell type W?

A. Stage 3 occurs after Stage 4.

B. Stage 4 occurs after Stage 5.

C. Chromosomes are not properly separated in stage 3.

D. Chromosomes are not properly separated in stage 5.

00. How could Figure 1 (Part 1) be revised to include the process of Mechanism K described in Table 2 (Part 2)?

A. Remove the signal before Cell type X.

B. Add the signal before Cell type Y.

C. Add an arrow between Cell type W and Cell type X.

D. Remove the line between the multipotent stem cell and Cell type Y.

00. Scientists surgically removed part of the liver in a group of mice. Ten days later, the scientists observed a low rate of DNA synthesis in the remaining liver cells.

Based on the information in Part 2, which explanation is **best** supported by this observation?

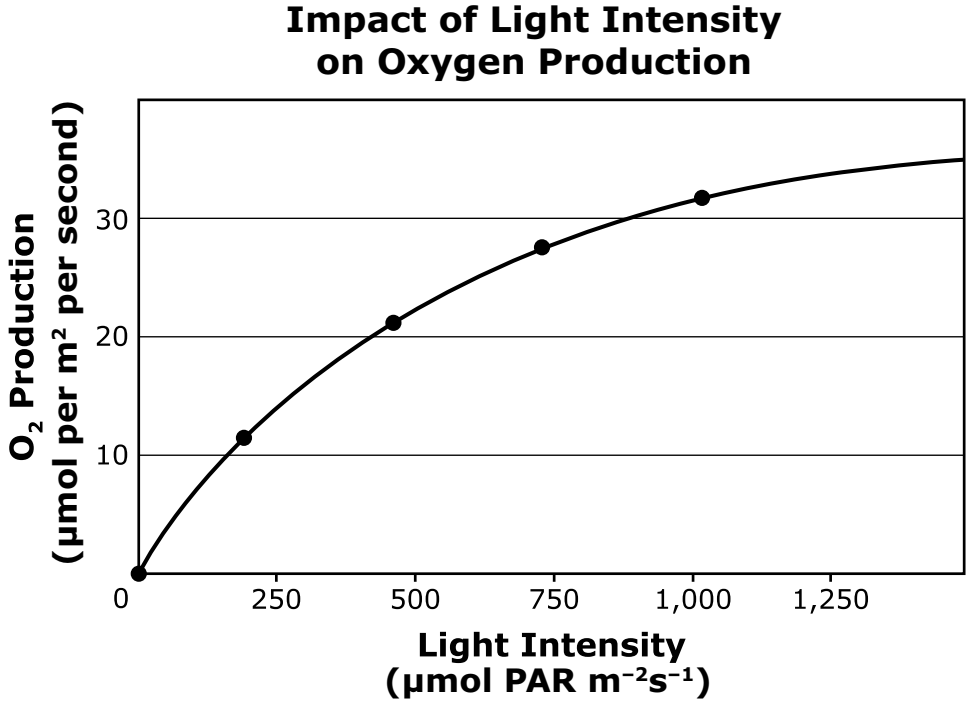
A. The liver is actively regenerating, and chromosomes are replicated as the cells prepare to divide.

B. Liver regeneration is switching from Mechanism K to Mechanism J, which does not require DNA synthesis.

C. The liver is increasing the rate of regeneration because more genes are expressed for specialized cell functions before cell division.

D. Liver regeneration is slowing or is complete because few liver cells are actively preparing for cell division by replicating DNA.

00. While studying photosynthesis, a group of scientists measured the rate of oxygen production of bean plant leaves exposed to different light intensities, as shown in the graph.



The scientists observe that the rate of photosynthesis does not increase at a constant rate as light intensity increases.

Based on the trend shown in the graph, what will likely happen to the rate of oxygen production if the scientists increase the light intensity on the bean plants to 1,400 µmol PAR $m^{-2}s^{-1}$?

A. The rate of oxygen production will decline rapidly.

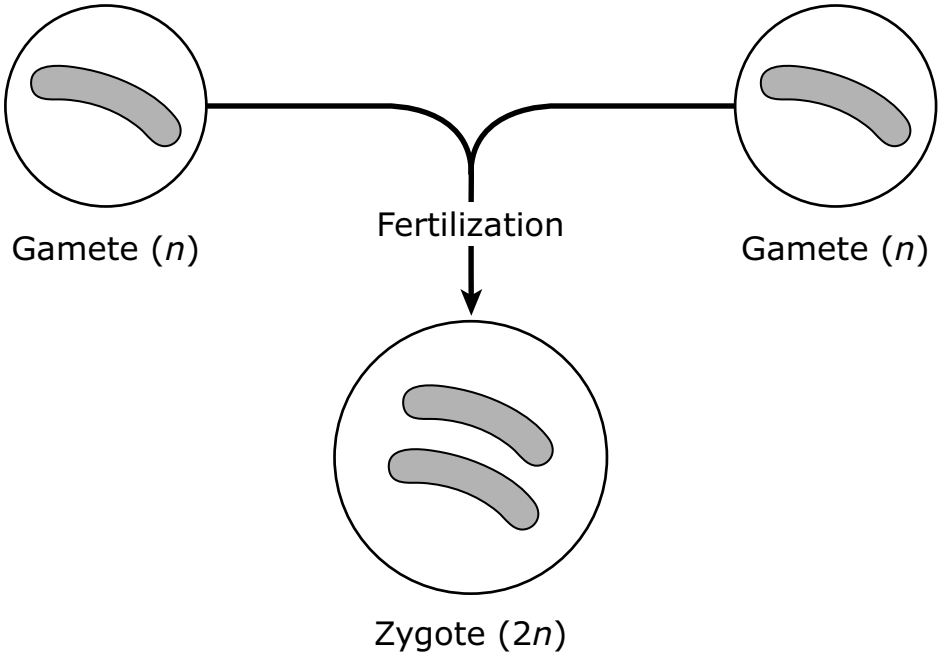
B. The rate of oxygen production will be reduced by half.

C. The rate of oxygen production will remain fairly constant.

D. The rate of oxygen production will nearly double.

00. A student draws a simplified model to represent meiosis and fertilization.

Meiosis and Fertilization Model



Which **three** changes should the student make to the model to better represent how meiosis and fertilization promote genetic diversity?

A. Double the number of chromosomes in the 2*n* zygote.

B. Use different shades for the chromosomes from each gamete to show that fertilization combines genes from both parents.

C. Remove one of the gametes to show that some organisms can reproduce without fertilization.

D. Add a step at the beginning to show the diploid parent cell for each gamete.

E. Add steps at the beginning to show that information is exchanged before the gametes are formed.

00. Information about the peppered moth is shown in the table.

Changes in Peppered Moth Color by Era

Era	Moth Habitat	Moth Color
Pre–Industrial Revolution (18th century)	Trees with light-colored bark with black spots	Light-colored with black spots
Industrial Revolution (early 19th century)	Trees covered with black soot	Black
Post–Industrial Revolution (20th century)	Trees with light-colored bark with black spots	Light-colored with black spots

Which statement **best** explains the color variations in the population of peppered moths?

A. The air pollution prevented gas exchange in the light-colored moths, resulting in low survival rates.

B. The light-colored moths had better mechanisms for flight and migrated to a less-polluted environment.

C. Moths that had the same coloration as the trees were provided with protection from predators.

D. Developing moths chose their color based on the background color of trees in the environment.

00. A research group collected data on populations of coral, shellfish, and sea grass in a small geographic area of the Pacific Ocean that experienced changes in ocean acidity level. The acidity of the ocean increases as the pH decreases. The data are shown in the table.

Populations of Ocean Organisms in Study Area

Year	pH	Sea Grass Population	Coral Population	Shellfish Population
1950	8.17	51,007	124,890	63,452
1980	8.12	62,504	115,673	52,004
2010	8.08	76,410	98,801	47,659

Based on the data, which **three** changes will **most likely** occur if the pH continues to decrease in the study area?

A. The carrying capacity of animals that consume sea grass will decrease.

B. The carrying capacity of animals that consume sea grass will increase.

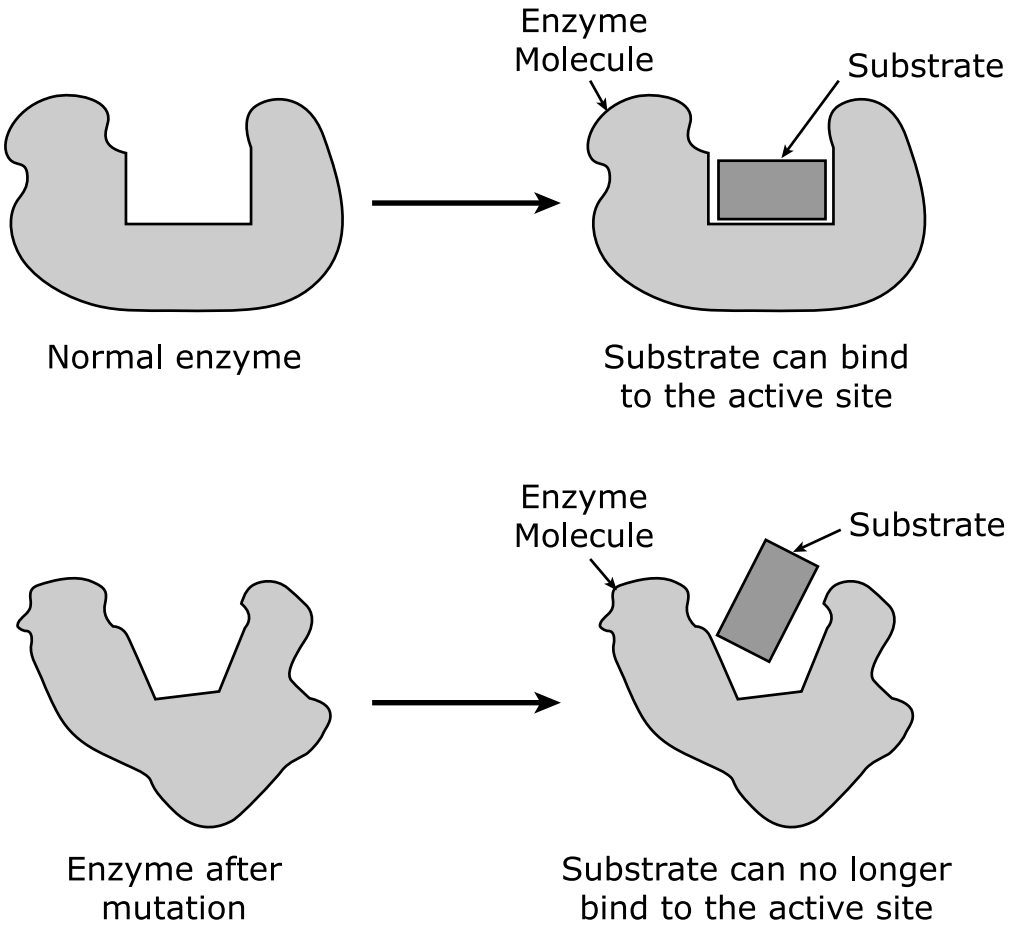
C. The populations of organisms that prey upon shellfish will increase as the population of shellfish decreases because of acidity.

D. The populations of herbivores that are better adapted to more acidic waters will increase.

E. The populations of organisms living on and around coral will decrease because of a decline in resources and habitat.

00. Mutations in the gene encoding an enzyme can change the way an enzyme interacts with a substrate. The figure shows the enzyme-substrate interactions between a normal enzyme and an enzyme after mutation.

Enzyme-Substrate Interactions



How is the difference in the enzyme-substrate interaction because of the mutation **best** explained?

A. The mutation changed the amino acid sequence of the protein, which resulted in a structural change in the active site.

B. The mutation changed the active site on the substrate, preventing collisions between the enzyme and the substrate.

C. The mutation created a new type of enzyme with a different active site that does not recognize the substrate.

D. The mutation affected the speed of the enzyme colliding with the substrate which affected the shape of the enzyme.

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