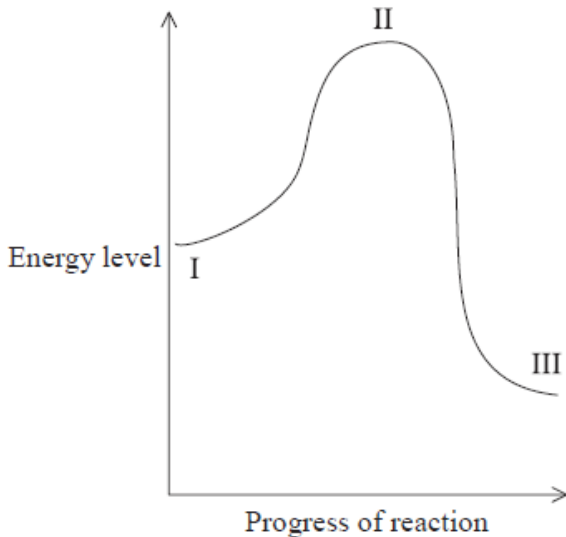

HL Paper 1

The graph below shows energy changes during a chemical reaction that occurs without a catalyst. What would change if the reaction was catalysed by an enzyme?



- A. The initial energy level (I) would be higher, speeding up the reaction.
- B. The maximum energy level (II) would be higher, speeding up the reaction.
- C. The maximum energy level (II) would be lower, speeding up the reaction.
- D. The final energy level (III) would be lower, speeding up the reaction.

How does a competitive inhibitor interact with an enzyme?

- A. It binds to the active site, denaturing the enzyme.
- B. It binds to the active site, preventing substrate binding.
- C. It binds to an allosteric site, causing conformational change of the enzyme.
- D. It binds to the allosteric site, causing competition with the substrate.

Which technological advance enabled Calvin to perform his lollipop experiment on the light-independent reactions of photosynthesis in 1949?

- A. Methods for tracing radioactive carbon incorporated in molecules produced by the alga *Chlorella*
 - B. Development of electron microscopes enabling the molecules produced by the alga *Scenedesmus* to be viewed
 - C. Methods for changing the wavelength of light shining on the alga *Scenedesmus* contained in the lollipop
 - D. Development of X-ray diffraction techniques enabling the molecules produced by the alga *Chlorella* to be identified
-

Which of the following factors influence(s) the rate of oxygen production in photosynthesis?

- I. Temperature
- II. Wavelength of light
- III. Number of mitochondria

- A. I only
 - B. I and II only
 - C. II and III only
 - D. I, II and III
-

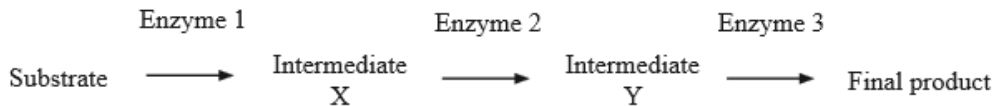
Where precisely in the cell do the reactions of the Krebs cycle take place?

- A. In the cytoplasm
 - B. In the space between the inner and outer membrane of the mitochondria
 - C. On the surface of cristae in the mitochondria
 - D. In the fluid matrix of the mitochondria
-

What reaction, involving glycerate 3-phosphate, is part of the light-independent reactions of photosynthesis?

- A. Glycerate 3-phosphate is carboxylated using carbon dioxide.
 - B. Two glycerate 3-phosphates are linked together to form one hexose phosphate.
 - C. Glycerate 3-phosphate is reduced to triose phosphate.
 - D. Five glycerate 3-phosphates are converted to three ribulose 5-phosphates.
-

A substrate undergoes a series of enzyme-catalysed reactions to form intermediate substances X, Y and then the final product.



What would be the effect on the reaction of adding a competitive inhibitor to enzyme 2?

- A. The substrate would not react to form intermediate X.
 - B. The concentration of intermediate X would increase.
 - C. The activity of enzyme 3 would increase to compensate.
 - D. No final product would be formed.
-

Which reaction does **not** cause a net release of energy?

- A. ADP combines with inorganic phosphate to form ATP
- B. ATP releases inorganic phosphate to form ADP

C. Loss of hydrogen from reduced NAD

D. Oxidation of reduced FAD

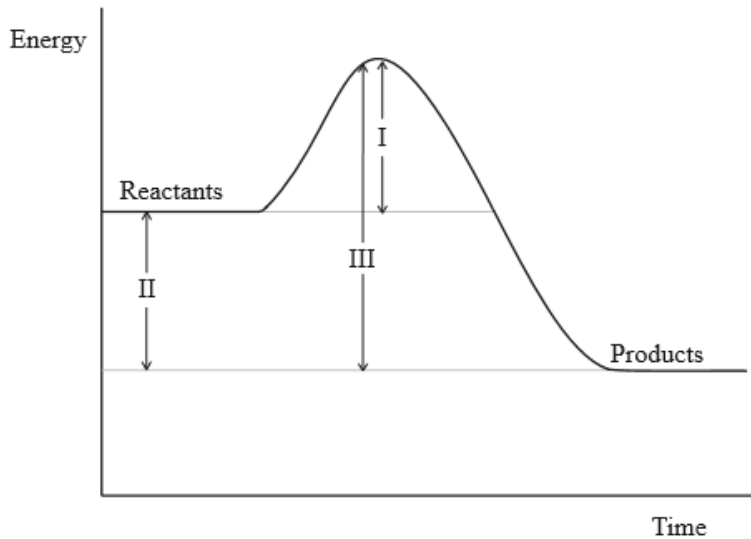
In the light-dependent reactions of photosynthesis what supplies low energy electrons to photosystem II?

- A. Photolysis of water
 - B. Reduction of NADP⁺
 - C. Chemiosmosis
 - D. Photosystem I
-

Which describes the role of amino acids in the channels of membrane proteins used for facilitated diffusion?

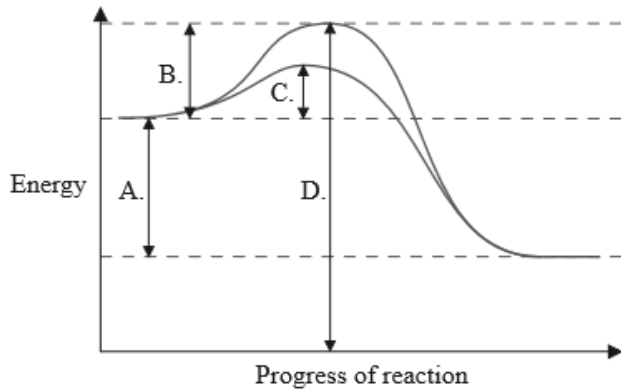
- A. Polar amino acids create a channel through which hydrophilic molecules can pass.
 - B. Polar amino acids create a channel through which hydrophobic molecules can pass.
 - C. Non-polar amino acids create a channel through which hydrophilic molecules can pass.
 - D. Non-polar amino acids create a channel through which hydrophobic molecules can pass.
-

What effect would adding an enzyme have on energy changes during the reaction?



- A. Reduce energy change I
 - B. Reduce energy change II
 - C. Increase energy change II
 - D. Increase energy change III
-

The following graph shows energy changes with and without enzymes during a chemical reaction. Which letter represents the activation energy required to carry out this reaction without an enzyme catalyst?



What process occurs during the light-independent reactions of photosynthesis?

- A. Oxygen is released into the atmosphere.
- B. Protons are pumped from the thylakoid space to the stroma.
- C. RuBP is carboxylated then regenerated in the Calvin cycle.
- D. Triose phosphate is converted to glycerate 3-phosphate.

Which of the following is a role of ATP in photosynthesis?

- A. It provides the energy to make carbohydrate molecules.
- B. It splits water molecules to form oxygen and hydrogen.
- C. It breaks down pyruvate into carbon dioxide.
- D. It converts light energy into chemical energy.

What occurs during the light-independent reactions of photosynthesis?

- A. ATP is produced.
- B. Ribose reacts with carbon dioxide to form glucose.
- C. Energy for the cycle is provided by the light-dependent reaction.
- D. Darkness stimulates the conversion of glucose to starch.

What is the role of NADH + H⁺ in aerobic cell respiration?

- A. To transfer hydrogen to the electron transport chain
 - B. To reduce intermediates in the Krebs cycle
 - C. To accept electrons from the electron transport chain
 - D. To combine with oxygen to produce water
-

What is an allosteric site?

- A. The area on an enzyme that binds the end-product of a metabolic pathway
 - B. The area on a competitor molecule that inhibits an enzyme reaction
 - C. The site on an enzyme where the substrate binds
 - D. The active part of a non-competitive inhibitor of an enzyme reaction
-

How has the transmission of HIV been reduced?

- A. Delaying the progression of HIV to AIDS
 - B. Single use of disposable needles
 - C. Treatment with antibiotics
 - D. Vaccination
-

What is the total number of ATP molecules used and produced during glycolysis?

	ATP used during glycolysis	ATP produced during glycolysis
A.	2	2
B.	0	2
C.	2	4
D.	4	4

On sites polluted with heavy metals, some grasses show tolerance to concentrations of those metals that are normally toxic. What explains this tolerance?

- A. Grasses continually exposed to high doses of heavy metals mutate.

- B. Rapid reproduction rate of grasses produces little genetic variation.
 - C. Grasses not killed by the heavy metals reproduce and pass on their genes.
 - D. Heavy metals become less toxic over time.
-

In the mitochondrial electron transport chain, what is the last electron acceptor?

- A. CO₂
 - B. H₂O
 - C. O₂
 - D. NAD
-

What products of the light-dependent reactions are used in the light-independent reactions?

- A. ATP and NADPH
 - B. NADPH and ribulose biphosphate (RuBP)
 - C. CO₂ and ATP
 - D. ATP and O₂
-

What causes cyclic photophosphorylation to occur in photosynthesis?

- A. Reduced NADP is accumulating in the stroma.
 - B. Photoactivation of photosystem II is inhibited.
 - C. Light-dependent reactions are slower than light-independent reactions.
 - D. ATP is not required for the Calvin cycle.
-

Which is correct for the non-competitive inhibition of enzymes?

	Inhibitor resembles substrate	Inhibitor binds to active site
A.	+	+
B.	+	-
C.	-	+
D.	-	-

When is energy released in a cell?

- A. ADP combines with inorganic phosphate.
 - B. ATP releases inorganic phosphate.
 - C. NAD^+ combines with hydrogen.
 - D. NAD^+ releases hydrogen.
-

From which substrate is the first carbon dioxide molecule released during cellular respiration?

- A. Glucose
 - B. Pyruvate
 - C. Acetyl CoA
 - D. Citrate (a C_6 intermediate compound in the Krebs cycle)
-

Where are complex carbohydrates made in the chloroplast?

- A. In the intermembrane space
 - B. In the stroma
 - C. On the inner membrane
 - D. In the thylakoid space
-

What describes non-competitive inhibition?

- A. Inhibiting molecule does not resemble substrate and binds to an area other than active site
 - B. Inhibiting molecule resembles substrate and binds to active site
 - C. Inhibiting molecule does not resemble substrate and binds to active site
 - D. Inhibiting molecule resembles substrate and binds to an area other than active site
-

What is chemiosmosis?

- A. Coupling of ATP synthesis to the electron transport and proton movement
- B. Phosphorylation of glucose in the mitochondrial matrix
- C. H^+ ions moving down a concentration gradient into the mitochondrial matrix
- D. Activation of ATPase in order to synthesize ATP

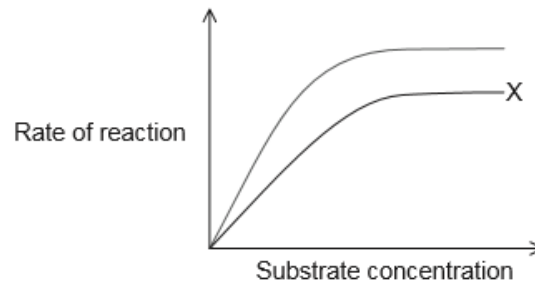
What is the difference between movement of the knee joint and hip joint?

- A. The knee only allows flexion whereas the hip allows flexion and extension.
- B. The knee allows more rotation than the hip.
- C. The knee is used to walk forwards whereas the hip is used for running around corners.
- D. The knee allows movement in one plane whereas the hip allows movement in three planes.

What is produced by the light-dependent reactions of photosynthesis and used in the Calvin cycle?

- A. Hydrogen and oxygen
- B. ATP and NADPH
- C. NADPH and oxygen
- D. ATP and CO₂

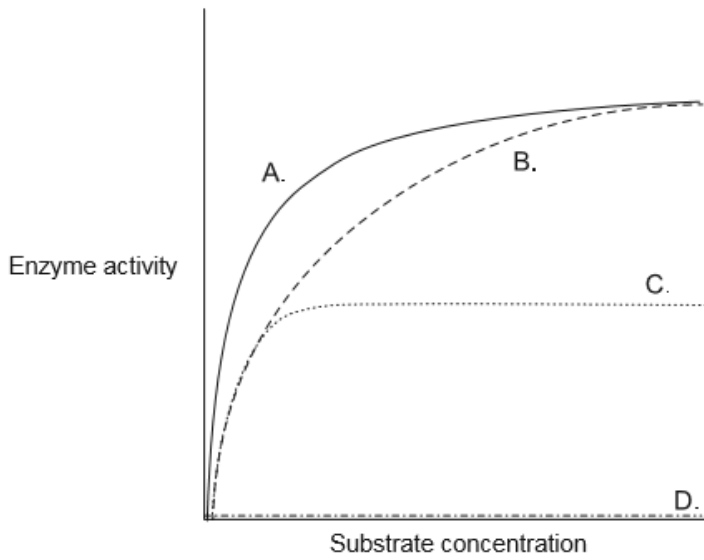
The graph shows an example of an enzyme-catalysed reaction.



What does the curve labelled X represent?

- A. No inhibition
- B. Competitive inhibition
- C. Non-competitive inhibition
- D. Reversible inhibition

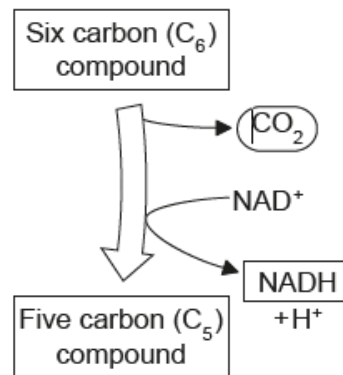
In one of the curves in the graph, the rate of an enzyme-catalysed reaction has been plotted against the substrate concentration in presence of a small quantity of a competitive inhibitor. Which curve represents competitive inhibition?



Where is chlorophyll found in a plant cell?

- A. Thylakoid membranes
- B. Stroma
- C. Matrix
- D. Cristae

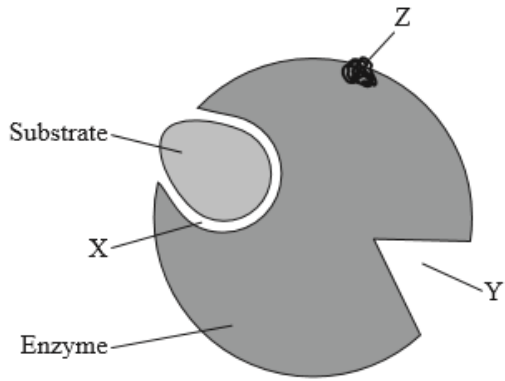
This reaction occurs in mitochondria.



What explains that this reaction enables energy to be converted into a usable form?

- A. The oxidized NAD^+ will transfer the energy from the C_6 compound to ATP.
- B. The chemical energy stored in the C_6 compound is used to reduce NAD^+ allowing ATP production.
- C. Energy stored in the CO_2 molecule will generate an electron gradient.
- D. The C_6 compound is reduced and the energy resulting from the removal of one carbon is used to oxidize NAD^+ .

The diagram represents an allosteric enzyme.

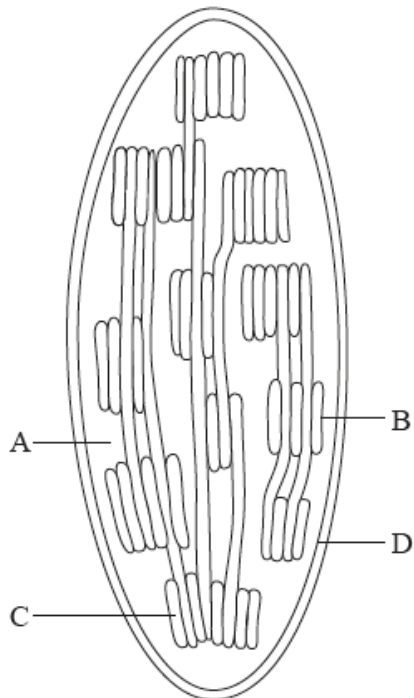


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Where would the following inhibitors be most likely to bind?

	End-product inhibitor	Competitive inhibitor	Non-competitive inhibitor
A.	X	Y	Z
B.	Y	Z	X
C.	X	Z	Y
D.	Y	X	Z

Where is ATP synthase located?

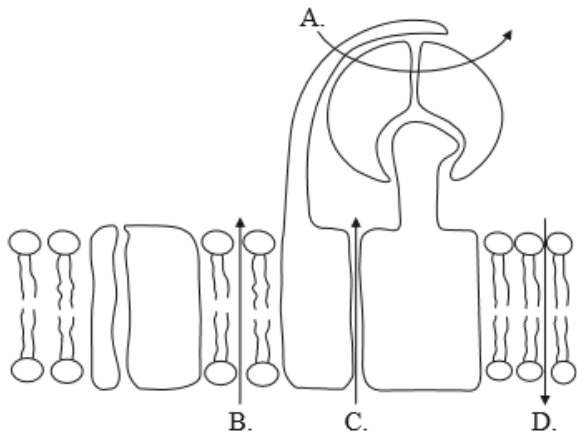


[Source: © International Baccalaureate Organization 2014]

In a chloroplast where are the enzymes of the Calvin cycle located?

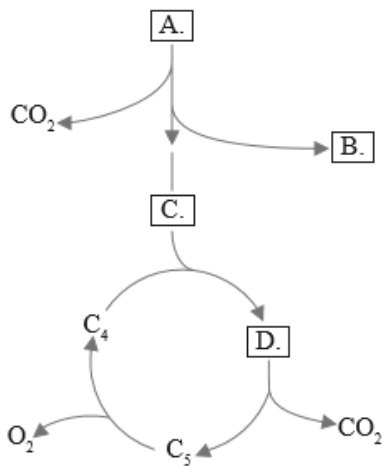
- A. Thylakoid membranes
- B. Stroma
- C. Grana
- D. Outer membrane of chloroplast

The diagram represents components of the cristae in mitochondria. Which arrow indicates how protons (H^+) move to generate ATP directly?



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In the following diagram of a metabolic pathway, which letter represents acetyl CoA?



What happens for each glucose during glycolysis?

- A. Four ATP are used.
 - B. Two three-carbon compounds are formed.
 - C. Two NADPH + H⁺ are formed.
 - D. Two pyruvates are decarboxylated
-

Which molecule would first contain ¹⁴C if the alga *Chlorella* was grown in the presence of light and radioactive CO₂?

- A. Glycerate 3-phosphate
 - B. Glucose
 - C. Rubisco
 - D. Ribulose biphosphate (RuBP)
-

During glycolysis a hexose sugar is broken down to two pyruvate molecules. What is the correct sequence of stages?

- A. Phosphorylation → oxidation → lysis
 - B. Oxidation → phosphorylation → lysis
 - C. Phosphorylation → lysis → oxidation
 - D. Lysis → oxidation → phosphorylation
-

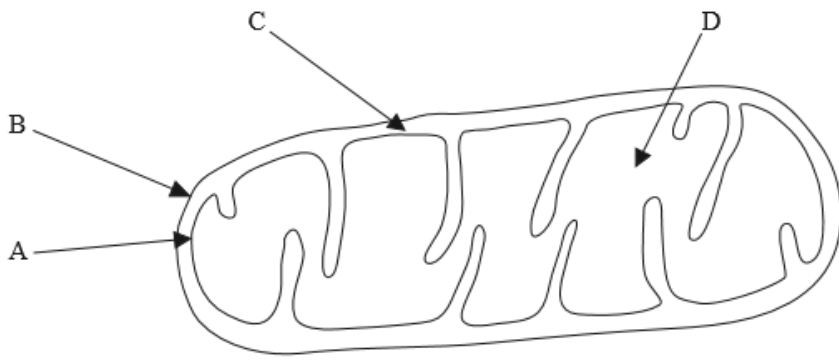
What is the link reaction in aerobic respiration?

- A. Pyruvate is carboxylated, acetyl reacts with coenzyme A, reducing NADH + H⁺
 - B. Pyruvate is decarboxylated, acetyl reacts with coenzyme A, forming NADH + H⁺
 - C. Pyruvate reacts with coenzyme A, forming NADH + H⁺
 - D. Pyruvate is decarboxylated, reacting with coenzyme A, reducing NADH + H⁺
-

Which process requires oxygen in aerobic cell respiration?

- A. Oxidation of triose phosphate
 - B. Reduction of hydrogen carriers
 - C. Maintaining an oxygen concentration gradient in mitochondria
 - D. Accepting electrons at the end of the electron transport chain
-

Where is carbon dioxide produced in the mitochondrion?



Where in the cell does the Calvin cycle take place?

- A. Stroma of chloroplast
- B. Mitochondrial matrix
- C. Cytoplasm
- D. Inside thylakoid

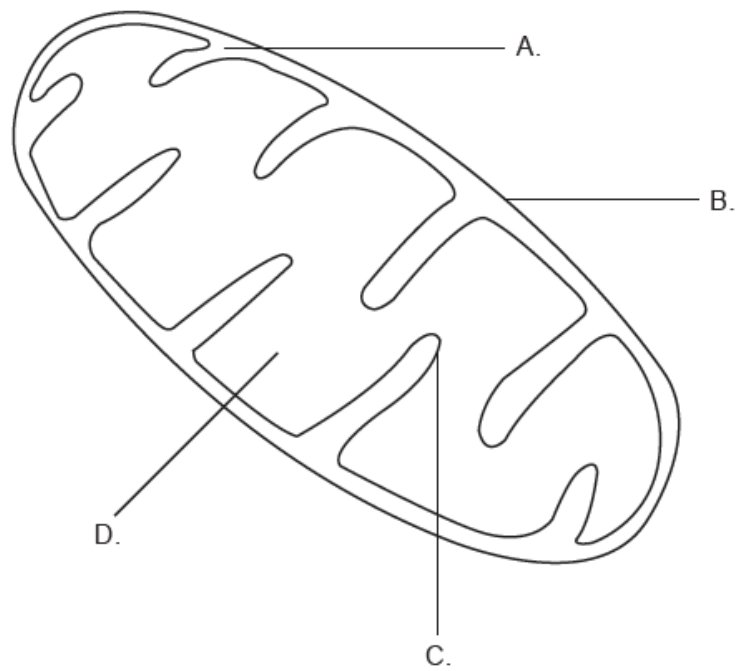
What is used to reduce NADP in the light-dependent reactions of photosynthesis?

- A. Conversion of ATP into ADP+P_i
- B. Electrons from Photosystem I
- C. Protons from the thylakoid space
- D. Oxygen released by photolysis of water

What happens to triose phosphate (TP) in the light-independent reactions of photosynthesis?

- A. TP is reduced to glycerate-3-phosphate (GP).
- B. TP is linked to CO₂ by ribulose biphosphate carboxylase (Rubisco).
- C. TP is oxidized by NADPH + H⁺.
- D. TP is regenerated into ribulose biphosphate (RuBP).

The diagram shows a mitochondrion. Which letter indicates the structure where ATP synthase is located?



Which process occurs during the light-dependent reaction of photosynthesis?

- A. ATP, CO₂ and H₂O are produced.
- B. CO₂ is used to produce carbohydrates.
- C. ATP and O₂ are produced.
- D. RuBP is phosphorylated.

What occurs during oxidative phosphorylation?

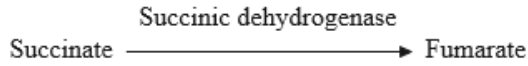
- A. ATP production using electrons from NADP
- B. Coupling of ATP synthesis to electron transport
- C. Chemiosmosis in the matrix of the mitochondrion
- D. Release of energy as ATP reacts with oxygen

What is the advantage of having a small volume inside the thylakoids of the chloroplast?

- A. High proton concentrations are rapidly developed.
- B. High electron concentrations are rapidly developed.

- C. Photosynthetic pigments are highly concentrated.
 - D. Enzymes of the Calvin cycle are highly concentrated.
-

The enzyme succinic dehydrogenase catalyses the conversion of succinate to fumarate.



The addition of malonate to the reaction mixture decreases the rate of the reaction. If more succinate is added, the reaction rate will increase. What is the role of malonate in this reaction?

- A. End-product inhibitor
 - B. Non-competitive inhibitor
 - C. Catalyst
 - D. Competitive inhibitor
-

What happens during oxidative decarboxylation of pyruvate?

- A. Reduction of NAD^+ and oxidation of CO_2
 - B. Oxidation of NADH and production of CO_2
 - C. Reduction of NAD^+ and production of CO_2
 - D. Oxidation of NADH and reduction of CO_2
-

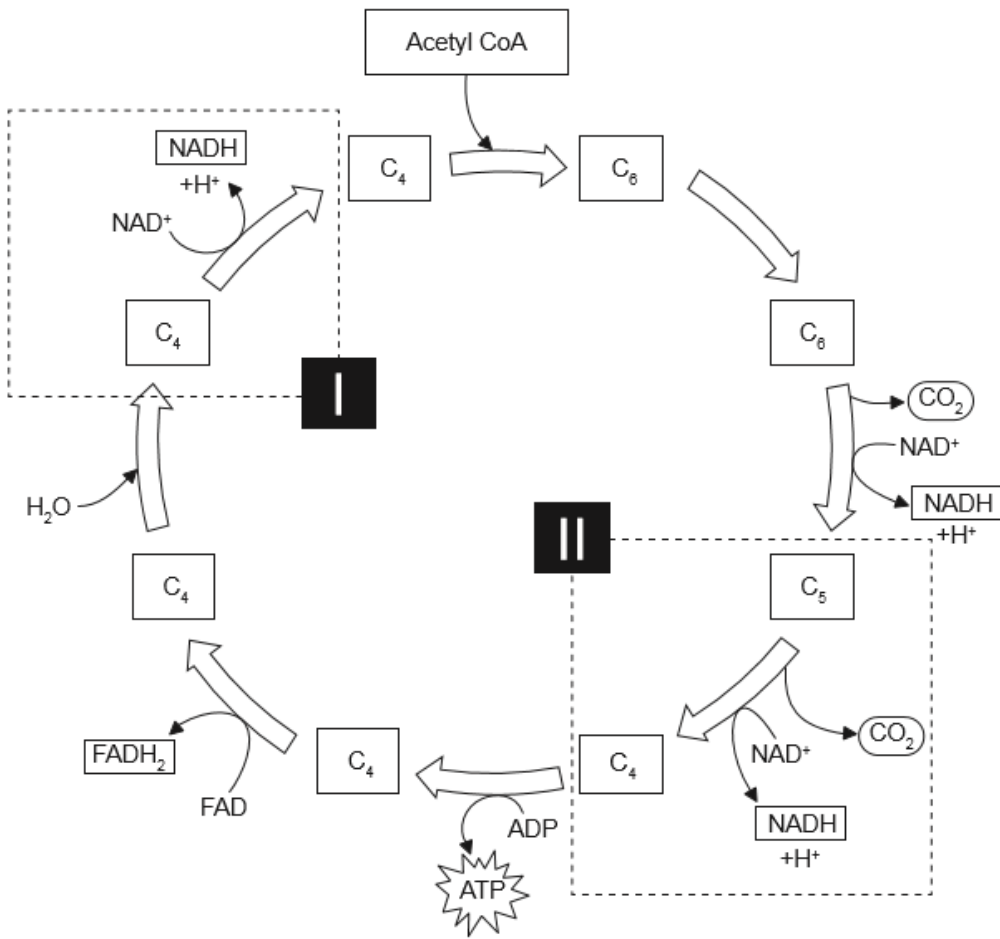
If both parents are heterozygous for sickle-cell anemia ($\text{Hb}^A \text{Hb}^S$), what percentage of their offspring will have a homozygous genotype?

- A. 25
 - B. 50
 - C. 75
 - D. 0
-

Where in a eukaryotic cell does the Krebs cycle take place?

- A. In the cytoplasm
- B. Between the inner and outer membranes of the mitochondria
- C. In the matrix of the mitochondria
- D. On the surface of the cristae

The diagram represents the Krebs cycle.

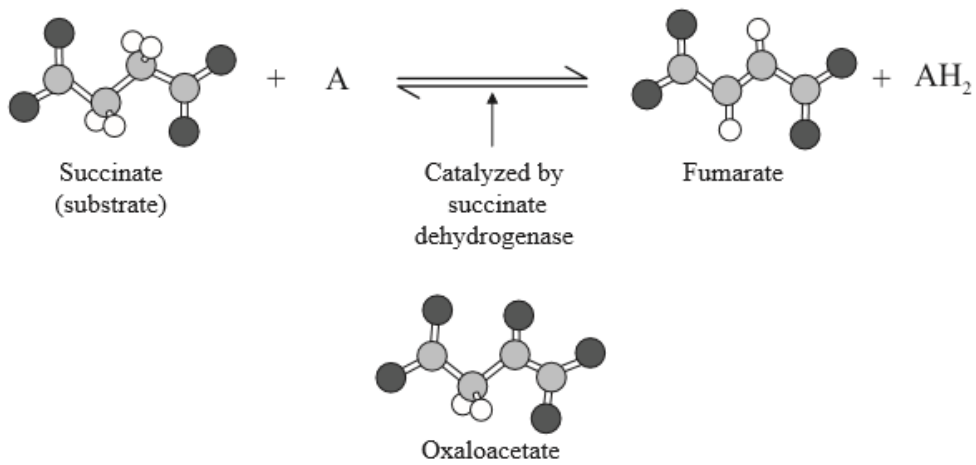


[Source: CAMPBELL, NEILA.; REECE, JANE B., *BIOLOGY*, 7th, ©2005, p.68. Reprinted by permission of Pearson Education, Inc., New York, New York.]

What processes are occurring at I and II?

	Process I	Process II
A.	C ₄ is being reduced	NAD ⁺ is being oxidized
B.	NAD ⁺ is being decarboxylated	C ₅ is being oxidized
C.	NADH is being reduced	C ₅ is being decarboxylated
D.	NAD ⁺ is being reduced	C ₅ is being decarboxylated

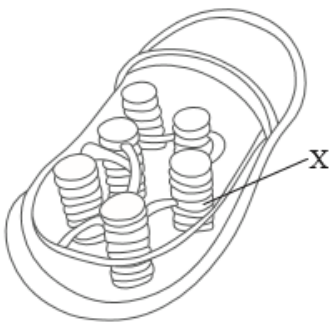
Why is oxaloacetate a competitive inhibitor?



[Source: image from WK Purves, *et al.*, (2003) *Life: The Science of Biology*, 4, Sinauer Associates (www.sinauer.com) and WH Freeman (www.whfreeman.com)]

- A. It causes a conformational change to the active site.
- B. It binds to the enzyme away from the active site.
- C. It is structurally similar to succinate.
- D. It is structurally similar to succinate dehydrogenase.

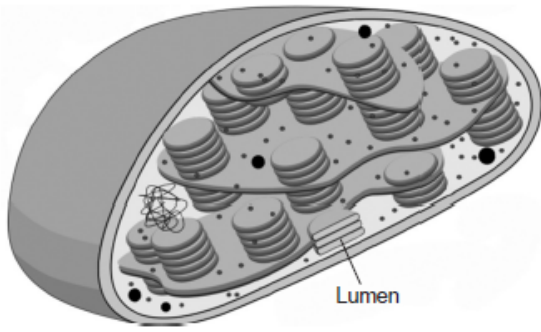
The diagram below shows the structure of a chloroplast.



What is the structure labelled X?

- A. Ribosome
- B. Stroma
- C. Inner membrane
- D. Thylakoid

The image shows a chloroplast.



[Source: adapted from <http://evolutionaryroutes.files.wordpress.com>]

During photosynthesis, what happens in the chloroplast at the location labelled lumen?

- A. Protons accumulate.
- B. Pyruvate undergoes decarboxylation.
- C. NADH is oxidized.
- D. Oxygen is produced.

The image shows a lady picking tea (*Camellia sinensis*) leaves.

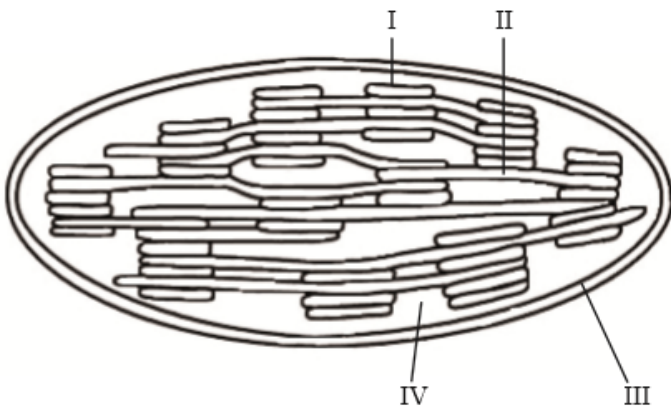


[Source: adapted from www.superstock.com]

Once the leaves have been picked, all further metabolism must be stopped. By what means could this be accomplished?

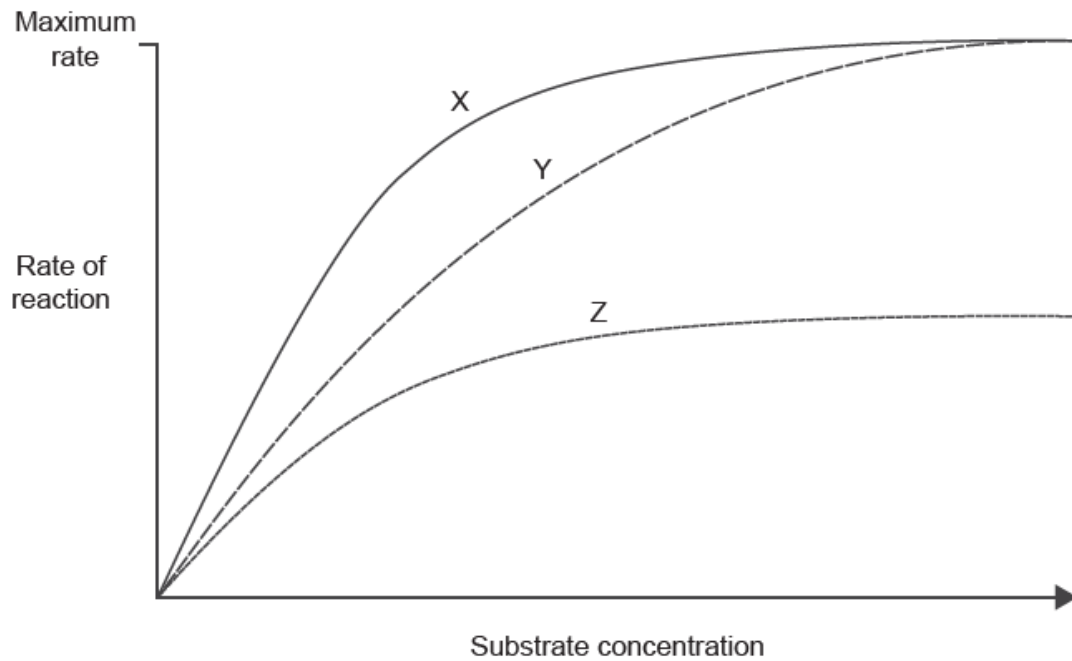
- A. Heating
- B. Adding water
- C. Mechanical cutting
- D. Spraying with anti-fungal agent

Where are the light-dependent and light-independent reactions taking place in the diagram below?



	Light-dependent	Light-independent
A.	I	IV
B.	II	III
C.	III	II
D.	IV	I

The graph shows the rate of an enzymatic reaction versus the substrate concentration, in the absence or presence of an enzyme inhibitor.



Which condition is indicated by lines Y and Z?

	Y	Z
A.	Non-competitive inhibitor present	No inhibitor present
B.	Non-competitive inhibitor present	Competitive inhibitor present
C.	Competitive inhibitor present	Non-competitive inhibitor present
D.	Competitive inhibitor present	No inhibitor present

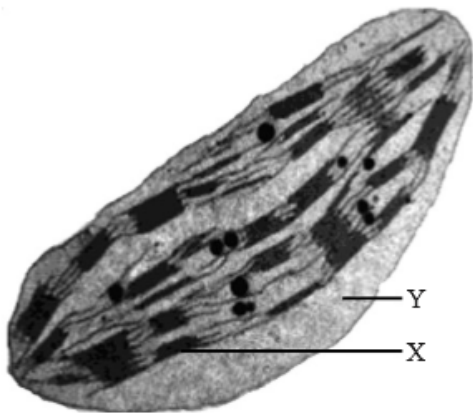
The electron micrograph below shows an organelle in a eukaryotic cell. What is the area labelled X and what is the type of reaction occurring there?



[Source: http://scienceblogs.com/clock/2006/11/cell_structure.php]

	X	Reaction
A.	matrix	photolysis
B.	stroma	Krebs cycle
C.	stroma	photolysis
D.	matrix	Krebs cycle

Questions 29 and 30 refer to the following electron micrograph of a chloroplast.

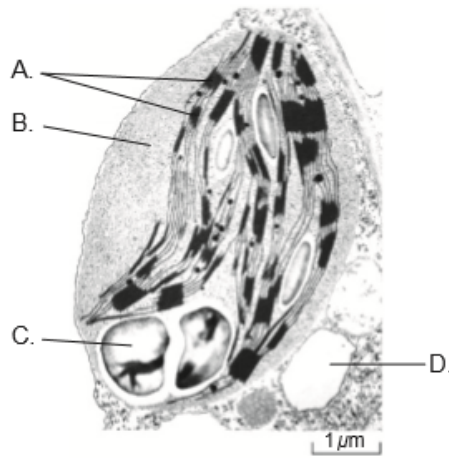


[Source: www.uic.edu/classes/bios/bios100/lecturesf04am/lect10.htm]

What is the structure labelled X?

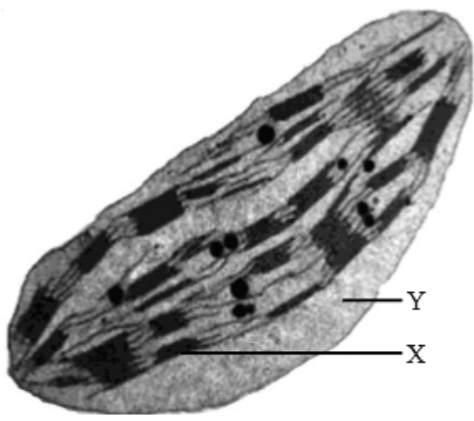
- A. Stroma
- B. Granum
- C. Crista
- D. Starch granule

The electron micrograph shows part of a plant cell. Where do the light-independent reactions of photosynthesis take place?



[Source: adapted from <http://themicroscopicplant.weebly.com>]

Questions 29 and 30 refer to the following electron micrograph of a chloroplast.



[Source: www.uic.edu/classes/bios/bios100/lecturesf04am/lect10.htm]

What is a function of Y?

- A. Carbon fixation
- B. Absorption of light
- C. Storage of glucose
- D. Production of ATP

The image shows a portion of a cell containing a mitochondrion.



[Source: 'TEM of a mitochondrion' by Prof. R. Bellairs. Credit: Prof. R. Bellairs. CC BY 4.0.]

Where do glycolysis and electron transport occur?

	Glycolysis	Electron transport
A.	P	R
B.	R	Q
C.	R	R
D.	S	Q

