6.1 CHARACTERISTICS OF ENZYMES

LONG QUESTIONS

Q.1 How can you relate enzymes with metabolism? *(U.B)* Also describe activation energy. *(K.B)*

Ans:

METABOLISM AND ENZYMES

Metabolism:

Metabolism is **the set of biochemical reactions** that **occur** in **living organisms** in **order to maintain life**. These processes allow organisms to:

- **Grow**
- **Reproduce**
- **Maintain their structure**
- **Respond to their environments**

Anabolism:

Anabolism **includes the biochemical reactions** in which **larger molecules** are **synthesized**. Energy is **utilized in anabolism**.

Catabolism:

Catabolism **includes** the **biochemical reactions** in which **larger molecules** are **broken down**. Usually, **energy is released** in catabolism

Energy Transfer:

The biochemical reactions are **actually energy transfers**.

Enzymes:

During metabolism, **chemicals are transformed** from **one form** to the **other by enzymes**. Enzymes are **crucial to metabolism because** they **act as biocatalysts** and **speed up and regulate metabolic pathway.**

Enzymes **are proteins that catalyze** (i.e. speed up) **biochemical reactions** and **are not changed during the reaction**.

Substrate:

The molecules at which enzymes act are called substrates

Products:

Enzyme converts them into different molecules, called products.

ACTIVATION ENERGY

Definition:

"The **minimum amount of energy required** to **start the biochemical reaction** is called **activation energy**."

Need:

The **need for activation energy** acts as a **barrier** to the **beginning of reaction**. Enzymes **lower such barriers** by **decreasing the requirement** of **activation energy.**

Lowering of Activation Energy:

Enzymes lower the activation energy in several ways:

- **They may alter the shape of substrate** and **reduce the requirement of energy** for this change.
- Some enzymes do so **by disrupting the charge distribution on substrates.**
- Enzymes also **lower activation energy by bringing substrate in correct orientation to react.**

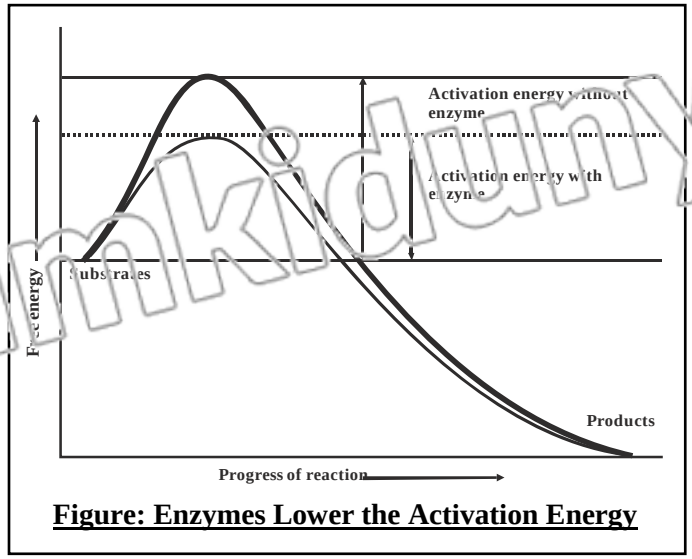


Figure: Enzymes Lower the Activation Energy

Q.2 Describe the characteristics of enzymes. ***(K.B)***

(LHR 2012, 2013, GWR 2013, 2015, DGK 2014, 2015 MTN 2015, BWP 2015, SGD 2014) (Ex Q. No 2)

Ans: **CHARACTERISTICS OF ENZYMES**

Introduction:

In **1878, German Physiologist Winhelm Kuhne first used the term Enzyme.**

Biochemical Nature:

Enzymes are **globular proteins**. Like all proteins, they are **made up of long**, **linear chains of amino acids** that **fold to produce** a **three-dimensional molecule**.

Rates of Reaction:

Most enzyme reaction rates are **millions of times** faster than **those of comparable uncatalyzed reactions**. As with all catalysts, **enzymes are not consumed** by the **reactions they catalyze.**

Specificity:

Enzymes are **usually very specific for the type of reaction** and for the **nature of their substrates**.

Active Site:

Only a **small portion** of **enzyme molecule** is **directly** involved in **catalysis**. It is **catalytic region** is known as active site. **It recognizes** and **binds substrate** and **then carries out reaction**.

Regulation of Enzyme Activity:

Enzyme production can be **enhanced** or **diminished** by a **cell according to needs.** Enzyme activity can also **be regulated by inhibitors** and **activators**.

Need for Cofactors:

Some enzymes do not need any **additional components to work**. However, **others require some components which are called** 'Co-factors'.

Cofactors are **non-protein molecules** or **ions**. Cofactors can be **Inorganic** (e.g. Metal ions) and **organic** (e.g. Flavin and Heme).

Types of Cofactors:

Cofactors can be of two types:

i. Prosthetic Groups:

If the **organic cofactors** are **tightly bound to enzyme**, they are called prosthetic groups.

ii. Coenzymes:

If the **organic cofactors** are **loosely attached with enzyme**, they are called coenzymes. Coenzymes **transport chemical groups** from **one enzyme to the other**.

Some important vitamins act as coenzymes e.g.

- **Riboflavin**
- **Thiamine**
- **Folic acid**

Regulation of Metabolic Pathways:

Several enzymes can work together in a specific order, creating metabolic pathways. In a metabolic pathway, one enzyme takes the product of another enzyme as a substrate. After the reaction, the product is passed on to the next enzyme.

Q.3 Describe the uses of enzymes. ***(Application Based)*** **(LHR 2012, 2014, DGK 2014,15, SGD 2015, RWP 2015)**

Ans:

USES OF ENZYMES

Enzymes are **extensively used in different industries** for **fast chemical reactions**. For example;

Food Industry:

Enzymes **that break starch** into **simple sugars** are used in the production of:

- **White bread**
- **Buns**

Brewing Industry:

Enzymes **break starch** and **proteins**. The products are used **by yeast for fermentation** to **produce alcohol**.

Paper Industry:

Enzymes **break starch to lower its viscosity**, which **aids in making paper**.

Biological Detergent:

- **Protease enzymes** are used for the **removal of protein stains from clothes**.
- **Amylase enzymes** are used in **dish washing to remove resistant starch residues**.

Q.4 Describe in detail the factors that affect the rate of enzyme action. ***(U.B)***

(BWP 2014, SGD 2014, RWP 2015) (Ex Q. No 4.6)

Ans:

Enzymes are **very sensitive** to the **environment** in which **they work**. Any factor that can change the chemistry or shape of enzyme molecule can affect its activity. Some of such factors are as follow:

i **Temperature**

ii. Substrate concentration

iii pH

i. Temperature: **(GRW 2012)**

Effect:

Increase in temperature speeds up the **rate of enzyme-catalyzed reactions**, but only **up to a point.**

Optimum Temperature:

Every **enzyme works** at its **maximum rate** at a **specific temperature** which is called optimum temperature for that enzyme.

Denaturation:

When **temperature** rises to a certain limit, heat adds in the **activation energy** and also provides kinetic energy for the reaction. So the reactions are **acceierated**. But when the temperature is raised well above the **optimum temperature**, heat energy increases the vibrations of atoms of enzyme and the **globular structure** of **enzyme** is lost. This is known as **denaturation** of enzyme.

Outcome of Denaturation:

Denaturation results in a **rapid decrease** in rate of **enzyme action** and it may be **blocked** completely.

Example:

The optimum temperature for maximum working speed of enzymes in human body is **37°C**.

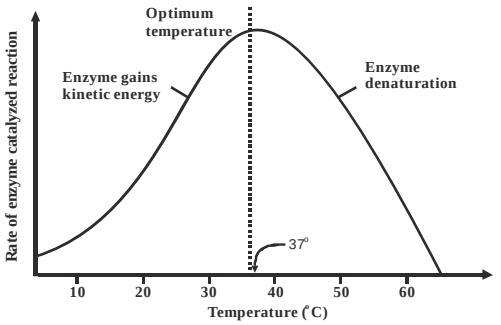


Figure: Effect of Temperature on Enzyme Activity

ii. Substrate Concentration: **(LHR 2014)**

Increase in Substrate Concentration:

If enzyme molecules are **available in a reaction,** increase in the substrate **concentration** increases the rate of **reaction**.

Constant Enzyme Concentration:

If **enzyme concentration** is kept constant, and the amount of **substrate** is increased, a point is reached where any further **increase** in the substrate does not increase the rate of reaction any more.

Saturation:

When the **active sites** of all **enzymes are occupied**, at **high substrate** concentrations, any more **substrate molecules** do not find free active sites. This state is called **saturation of active sites** and reaction rate does **not increase**.

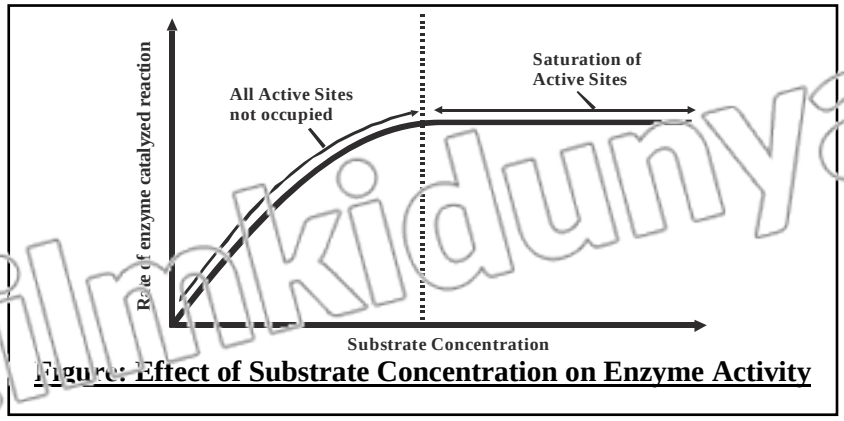


Figure: Effect of Substrate Concentration on Enzyme Activity

iii. pH:

Optimum pH:

All enzymes work **at their maximum rate in** a **narrow range of pH**, called as the **optimum pH.** Every enzyme has its specific optimum pH value.

Effect of pH Change:

A **slight change** in **optimum pH** of **an enzyme causes retardation** in **enzyme activity** or **blocks it completely**. Change in pH can **effect the ionization of amino acids at the active site**.

Examples:

- **Pepsin** (working in stomach) is active in acidic medium, i.e. low pH.
- **Trypsin** (working in small intestine) shows its activity in alkaline medium i.e. high pH

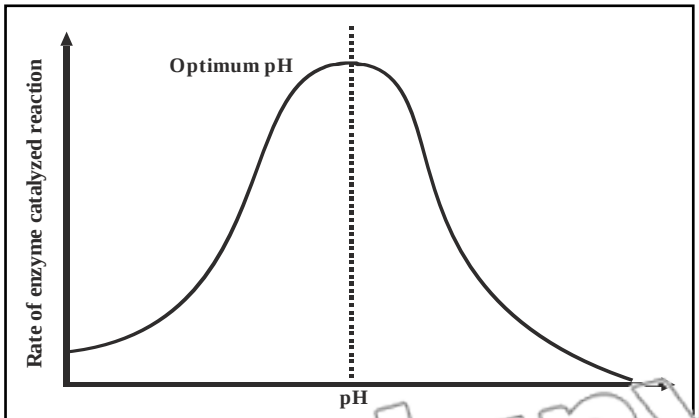


Figure: Effect of pH on Enzyme Activity

SHORT QUESTIONS (Topic 6.1)

Q.1 Define metabolism. *(K.B)* **(LHR 2012, GRW 2015, SWL 2014)**

Ans: Page no 181.

Q.2 Who gave the concept of metabolism? *(K.B)* **(SWL 2015)**

Ans:

CONCEPT OF METABOLISM

The concept of metabolism was first of all given by Ibn-e-Nafees, who stated that, "The body and its parts are always undergoing change."

Q.3 What is the difference between catabolism and anabolism? ***(K.B)***

(LHR 2014, 2016, DGK 2015, BWP 2015, SGD 2014, 2015, RWP 2015)

Ans: **DIFFERENTIATION**

The difference between catabolism and anabolism is as follows:

Catabolism	Anabolism
Definition	
Catabolism includes the biochemical reactions in which larger molecules are broken down.	Anabolism includes the biochemical reactions in which larger molecules are synthesized.
Energy	
Energy is released in catabolism.	Energy in utilized in anabolism.
Example	
• Cellular respiration	• Photosynthesis

Q.4 What are enzymes? ***(K.B)***

Ans: **ENZYMES**

Enzymes are proteins that catalyze (i.e. speed up) biochemical reactions and are not changed during the reaction.

Q.5 What is the role of enzymes in metabolism? ***(K.B)***

Ans: **ROLE OF ENZYMES IN METABOLISM**

During metabolism, chemicals are transformed from one form to the other by enzymes. Enzymes are crucial to metabolism because they act as biocatalysts and speed up and regulate metabolic pathway.

Q.6 What is the difference between substrate and product? ***(A.B)***

(LHR 2013, GRW 2013, LHR 2014)

Ans: **DIFFERENTIATION**

The difference between substrate and product are as follows:

Substrate	Product
• The molecules at which enzymes act are called substrates.	• Enzyme acts upon substrate and converts it into different molecules called products.

Q.7 Define activation energy. ***(U.B)*** **(LHR 2015, BWP 2015)**

Ans: Page no 181.

Q.8 How do enzymes lower activation energy? ***(K.B)*** **(MTN 2014, 2015, SWL 2015, FSD 2014, 2015)**

Ans: Page no 181.

Q.9 How enzymes can be categorized on the basis of their sites? **(GRW 2015)**

Ans: **DIFFERENTIATION**

The difference between intracellular and extracellular enzymes is as follows:

Intracellular Enzymes	Extracellular Enzymes
Definition	
If the enzymes work within the cell, they are called as intracellular enzymes.	If the enzymes work outside the cell, they are called as intracellular enzymes.
Example	
• Enzymes of glycolysis working in the cytoplasm	• Pepsin enzyme working in the stomach cavity

Q.10 Who first used the term enzyme? ***(K.B)*** **(LHR 2015)**

Ans: Page no 182.

Q.11 Write down the two characteristics of enzymes? ***(K.B)*** **(LHR 2016, SGD 2015)**

Ans: Page no 182.

Q.12 Define active site. ***(K.B)*** **(LHR, GRW 2015, SWL 2014)**

Ans: Page no 182.

Q.13 What are cofactors? ***(U.B)*** **(GRW 2014, 2015)**

Ans: Page no 182.

Q.14 Write difference between cofactors and coenzymes. ***(U.B)***

(SWL 2015, MTN 2015, DGK 2015, SGD 2015)

Ans: **DIFFERENTIATION**

The difference between cofactors and coenzymes is as follows:

Cofactors	Coenzymes
Definition	
Some enzymes need some components which are called cofactors.	If organic cofactors are loosely attached with enzymes. They are called Coenzymes.
Chemical Nature	
Cofactors are non-proteins molecules or ions.	Coenzymes are vitamins in nature.
Examples	
Cofactors can be: • Inorganic e.g. metal ions • Organic e.g. heme	• Riboflavin • Thiamine • Folic acid

Q.15 What is the difference between prosthetic group and coenzymes? ***(U.B)***

(LHR 2014, GRW 2015)

Ans: **DIFFERENTIATION**

The difference between prosthetic group and coenzymes is as follows:

Prosthetic Group	Coenzymes
Definition	
If the organic cofactors are tightly bound to enzyme, they are called prosthetic groups."	If the organic cofactors are loosely attached with enzyme, they are called coenzymes.
Example	
• Heme	• Riboflavin • Thiamine • Folic acid

Q.16 Name the vitamins which act as coenzymes. ***(K.B)*** **(MTN 2015)**

Ans: Page no 183.

Q.17 Give any two uses of enzymes. / What is the main use of enzymes in food industry? ***(A.B)***

(LHR, GRW 2013, 2014, 2016, MTN 2015, SGD 2014, 2015, RWP 2014)

Ans: Page no 183.

Q.18 Name only factors affecting the rate of enzyme action. ***(U.B)*** **(LHR 2015, RWP 2014)**

Ans: Page no 183.

Q.19 Define optimum temperature. ***(U.B)*** **(LHR 2014, 2016, SGD 2015, RWP 2015)**

Ans: Page no 184.

Q.20 What do you mean by denaturation of enzyme? *(U.B)*
(LHR 2013, 2016, GRW 2014, 2015, DGK 2014)

Ans: Page no 184.

Q.21 Birds have higher body temperature than mammals. What would happen to activity of a bird's enzyme if it is given temperature of 37°C? *(U.B)*

Ans: **BIRDS TEMPERATURE 37 °C**

If a bird is given temperature of 37°C, the reaction rate will slow down as the bird's body has higher temperature than mammals.

Q.22 What is meant by saturation of active sites?

Ans: Page no 184.

Q.23 Every enzyme works at a specific pH. Justify the statement OR what is meant by optimum PH? **(LHR-2014)**

Ans: Page no 185.

MULTIPLE CHOICE QUESTIONS (Topic 6.1)

1. The term metabolism is derived from: *(K.B)* **(LHR 2012, SWL 2015)**
(A) Greek word (B) Latin Word
(C) Italian word (D) French word

2. The term metabolism is derived from the Greek word means: *(K.B)* **(FSD 2014, BWL 2014)**
(A) Split (B) Change
(C) Division (D) Break

3. The concept of metabolism was first of all given by: *(K.B)*
(A) Ibn-e-Nafees (B) Winhelm Kuhne
(C) Emil Fischer (D) Daniel Koshland

4. Which of the following is an attribute of anabolism? *(K.B)*
(A) Complex molecules are broken into simpler ones
(B) Energy is released
(C) Larger molecules are synthesized
(D) None of these

5. Which of the following is not true about enzymes? *(K.B)*
(A) They act as biocatalysts (B) Enzymes speed up biochemical reactions
(C) They lower the activation energy (D) They increase the activation energy

6. Chemically enzymes are: *(K.B)* **(LHR 2016)**
(A) Proteins (B) Carbohydrates
(C) Lipids (D) Fats

7. Another name used for "enzyme" is: *(U.B)*
(A) Metabolite (B) Substrate
(C) Biocatalyst (D) Activator

8. To which group of molecules enzymes belong? *(K.B)*
(GRW 2013, 2014, GRW 2013, MTN 2013, LHR 2013, 2015)
(A) Carbohydrates (B) Proteins
(C) Nucleic acids (D) Lipids

9. The molecules on which enzymes act are called: *(K.B)* **(DGK 2014, SWL 2014, GRW 2012)**
(A) Substrates (B) Coenzymes
(C) Proteins (D) Enzyme substrates complexes

10. Which one is not attribute of enzyme? *(U.B)*
(A) Specific in nature (B) Protein in chemistry
(C) Consumed in reaction (D) Increases rate of reaction

11. Enzymes lower the activation energy in the ways: *(A.B)*
(A) They may alter the shape of substrate
(B) Some enzymes do so by disrupting the charge distribution on substrates
(C) They may lower activation energy by bringing substrates in the correct orientation to react
(D) All of these

12. Enzyme increases the rate of reaction by: *(U.B)*
(A) Decreasing the activation energy of the reaction
(B) Increasing the activation energy of the reaction
(C) Increasing the free energy of the reaction
(D) Decreasing the free energy of the reaction

13. Almost all the enzymes are: *(U.B)* **(DGK 2014, 2015)**
(A) Vitamins (B) Proteins
(C) Carbohydrates (D) Fats

14. When the term enzyme was used for the first time? *(K.B)*
(A) 1874 (B) 1876
(C) 1878 (D) 1880

15. Who first time used the term enzyme? *(K.B)* **(SGD 2014, GRW 2015)**
(A) Winhelm Kuhne (B) Daniel Koshland
(C) Emil Fischer (D) Ibn-e-Nafees

16. The catalytic region of enzyme is called: *(U.B)* **(BWP 2015)**
(A) Cofactor (B) Coenzyme
(C) Prosthetic group (D) Active site

17. If organic cofactors are tightly bound to enzyme, they are called: *(U.B)*
(A) Coenzymes (B) Prosthetic groups
(C) Cofactors (D) Vitamins

18. If organic cofactors are loosely attached with enzyme, they are called: *(U.B)*
(A) Coenzymes (B) Prosthetic groups
(C) Both A and B (D) None of these

19. Which one is an organic cofactor? *(K.B)*
(A) Flavin (B) Heme
(C) Both A and B (D) None of these

20. Which of the following vitamins act as coenzyme? *(K.B)* **(LHR 2013)**
(A) Riboflavin (B) Thiamine
(C) Folic acid (D) All of these

21. The enzymes used for the removal of protein stains from clothes? *(A.B)* **(LHR 2012, SWL 2015)**
(A) Protease (B) Amylase
(C) Lipase (D) All of these

22. Which enzymes are used in dish washing to remove resistant starch residues? *(A.B)* **(LHR 2012)**
(A) Protease (B) Amylase
(C) Lipase (D) All of these

23. If an enzyme solution is saturated with substrate, the most effective way to obtain an even faster yield of products would be: *(U.B)*

(A) Add more of the enzymes (B) Add more substrate
(C) Add a inhibitor (D) Increase the temperature

24. Above optimum temperature the enzyme lost its activity because: *(U.B)*

(A) Charge distribution reverts (B) Denaturation of enzyme structure
(C) Substrate detaches (D) Denaturation of substrate structure

25. If a bird's enzyme is allowed to show activity at 37oC, the rate of will be: *(U.B)*

(A) Decreased (B) Increased
(C) Unchanged (D) Zero

26. The enzyme present in small intestine is: *(K.B)*

(A) Pepsin (B) Trypsin
(C) Amylase (D) Ptyalin

27. The optimum temperature for the maximum working speed of human enzymes is: *(A.B)*
(FSD 2015, MTN 2015, RWP 2015)

(A) 35°C (B) 37°C
(C) 39°C (D) 43°C

28. When there is an increase in temperature, the rate of enzyme catalyzed reactions: *(U.B)*

(A) Increases (B) Decreases
(C) Remains constant (D) All of these

6.2 MECHANISM OF ENZYME ACTION

LONG QUESTIONS

Q.1 Describe mechanism of enzyme action. *(Application Based)*
(SWL 2014, 2015, GRW 2012, 2013, 2014, LHR 2015, RWP 2015) (Ex Q. No 7)

Ans:

MECHANISM OF ENZYME ACTION

When **enzyme attaches** with **its substrate, a temporary enzyme-substrate** (ES) **complex is formed**. Enzyme catalyzes the reaction and **the substrate** is **transformed** into product. After it, the ES **complex breaks,** and **the enzyme** and **product are released.**

E + S → ES Complex → E + P

Lock and Key Model: **(BWP 2015) (SGD 2015)**

In order to explain the mechanism of enzyme action, a **German chemist Emil Fischer** in **1894**, proposed **'Lock and Key Model'** for **enzyme action**.

Model:

According to this model:

"**Both enzyme** and **substrate possess specific shapes** that **fit exactly into one another**."

Enzyme Specificity:

This model explains **enzyme specificity for its substrates.**

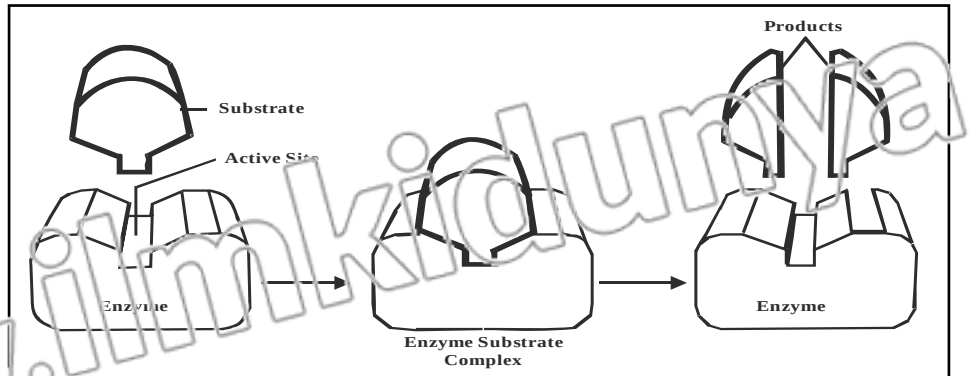


Figure: Lock and Key Model of Enzyme Action

Induced-Fit Model: **(GWR 2014, 2015, MTN 2014)**

In **1958**, an **American biologist Daniel Koshland** suggested **a modification** to **lock** and **key model** and **proposed 'Induced-fit model'.**

Model:

According to this model,

"The **active site is not a rigid structure** rather it **is molded into** the **required shape** to **perform its function."**

Advantage:

This model is **more acceptable** than **lock** and **key model.**

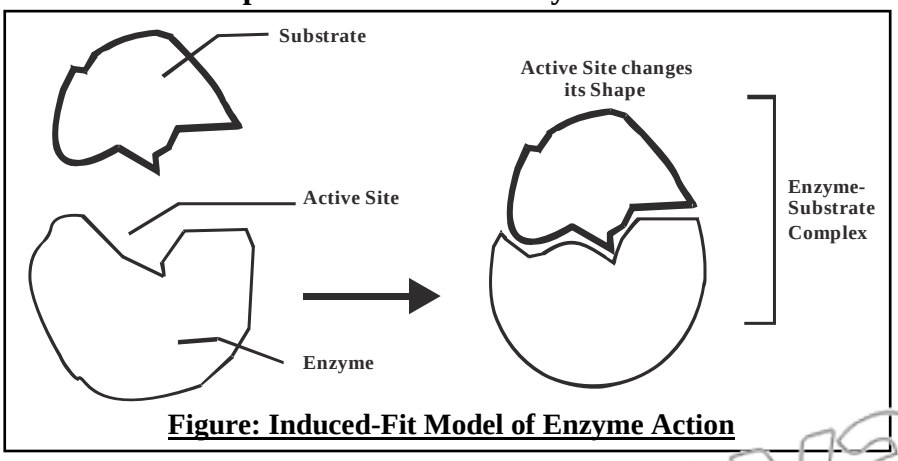


Figure: Induced-Fit Model of Enzyme Action

SHORT QUESTIONS (Topic 6.2)

Q.1 **Describe the mechanism of enzyme action?** ***(K.B)*** **(LHR-2015)**

Ans: Page no 190.

Q.2 **Describe lock and key model for enzyme action.** ***(A.B)***

(LHR 2012, GRW 2013, 2014, SWL 2014, MTN 2014, SWL 2015, DGK 2015, FSD 2014)

Ans: Page no 190.

Q.3 **What is induced fit model?** ***(A.B)***

(SWL 2014, DGK 2014, MTN 2015, BWP 2015, SGD 2014, RWP 2015)

Ans: Page no 191.

Q.4 **Which model describe the active site rigidity and in what way?** ***(U.B)***

Ans: Page no 191.

Q.5 How enzyme's active site change its shape? ***(U.B)***

Ans: Page no 203

MULTIPLE CHOICE QUESTIONS (Topic 6.2)

1. Who proposed lock and key model? ***(K.B)*** **(FWP 2015, MTN 2014)**

(A) Winhelm Kuhne (B) Daniel Koshland
(C) Emil Fischer (D) Ibn-e-Nafees

2. How many enzymes have been discovered? ***(K.B)***

(A) 1000 (B) 2000
(C) 6 (D) 3000

3. Who proposed induced-fit model? ***(K.B)*** **(SGD 2015)**

(A) Winhelm Kuhne (B) Ibn-e-Nafees
(C) Emil Fischer (D) Daniel Koshland

4. When was lock and key model proposed? ***(K.B)*** **(DGK 2015, GRW 2012)**

(A) 1894 (B) 1896
(C) 1898 (D) 1890

5. When was induced-fit model proposed? ***(K.B)*** **(GRW 2015)**

(A) 1952 (B) 1954
(C) 1956 (D) 1958

6. Which of the following is not true about induced fit model? ***(U.B)***

(A) This model explains specificity of enzymes.
(B) It is more acceptable model.
(C) According to this model active site is not rigid structure.
(D) Active site is molded into the required shape.

7. Enzymes change its shape according to its subtract its a concept of. ***(U.B)***

(A) Winhelm Kuhne (B) Ibn-e-Nafees
(C) Emil Fischer (D) Daniel Koshland

6.3 SPECIFICITY OF ENZYMES

LONG QUESTIONS

Q.1 Explain specificity of enzymes. ***(U.B)*** **(SWL 2015, FSD 2014, FSD 2015) (Ex Q. No 8)**

Ans:

SPECIFICITY OF ENZYMES

Number:

There are **over 2000** known enzymes.

Substrate Specificity:

Each enzyme is **involved in one specific chemical reaction**. Enzymes are also **substrate specific**.

Examples:

Some examples of specificity of enzymes are as follow:

Protease:

The **enzyme protease**, which **breaks peptide bonds** in **proteins**, will **not work on starch**.

Amylase:

Starch is broken down by amylase.

Lipase:

Lipase enzyme acts **only on lipids** and **digests them into fatty acids** and **glycerol**.

Determination of Specificity:

Specificity of different enzymes is determined by the **shapes of their active sites**. Active sites **possess specific geometric shapes** that **fit with specific substrates**.

Diagrammatic Presentation:

In the following diagram, only the **substrate 3** will exactly fit in the active site of the enzyme. The **substrates 1 and 2 cannot fit.**

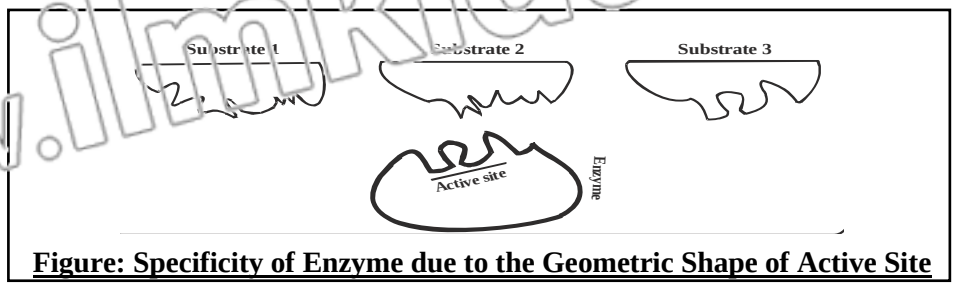


Figure: Specificity of Enzyme due to the Geometric Shape of Active Site

SHORT QUESTIONS (Topic 6.3)

Q.1 Define specificity of enzymes. ***(K.B)***

Ans: Page no 192.

Q.2 Shape of enzymes is specific with respect to substrate. Justify the statement. ***(K.B)***

Ans: Page no 193.

MULTIPLE CHOICE QUESTIONS (Topic 6.3)

1. Number of discovered enzymes so far: ***(K.B)***

(A) 1000 (B) 1500
(C) 2000 (D) 2500

2. Starch is broken down by an enzyme called: ***(A.B)*** **(SGD 2014, LHR 2014)**

(A) Lipase (B) Pepsin
(C) Amylase (D) All of these

3. The enzyme that acts on lipids: ***(A.B)*** **(SGD 2015, RWL 2014, SWL 2014)**

(A) Protease (B) Lipase
(C) Amylase (D) Pepsin

4. The product(s) formed from lipids after activity of lipase enzyme: ***(K.B)***

(A) Amino acids (B) Fatty acids
(C) Glycerol (D) both b & c

5. The peptide bonds in proteins are broken down by: ***(A.B)***

(A) Protease (B) Lipase
(C) Amylase (D) All of these

6. The enzyme present in small intestine is: ***(K.B)***

(A) Pepsin (B) Trypsin
(C) Amylase (D) Ptyalin

ANSWERS KEYS

MULTIPLE CHOICE QUESTIONS

6.1 CHARACTERISTICS OF ENZYMES

1	A	**6**	A	**11**	B	**16**	D	**21**	A	**26**	B
2	B	**7**	C	**12**	A	**17**	B	**22**	B	**27**	B
3	A	**8**	B	**13**	B	**18**	A	**23**	A	**28**	A
4	A	**9**	A	**14**	C	**19**	C	**24**	B		
5	D	**10**	C	**15**	A	**20**	D	**25**	A		

6.2 MECHANISM OF ENZYME ACTION

1	C	**5**	D
2	B	**6**	A
3	D	**7**	D
4	A		

6.3 SPECIFICITY OF ENZYMES

1	C	**4**	B
2	C	**5**	A
3	B	**6**	B

REVIEW QUESTIONS

MULTIPLE CHOICE QUESTIONS

1. What is true about enzymes? ***(U.B)***
(a) They make biochemical reactions to proceed spontaneously
(b) They lower the activation energy of a reaction
(c) They are not very specific in their choice of substrates
(d) They are needed in large quantities

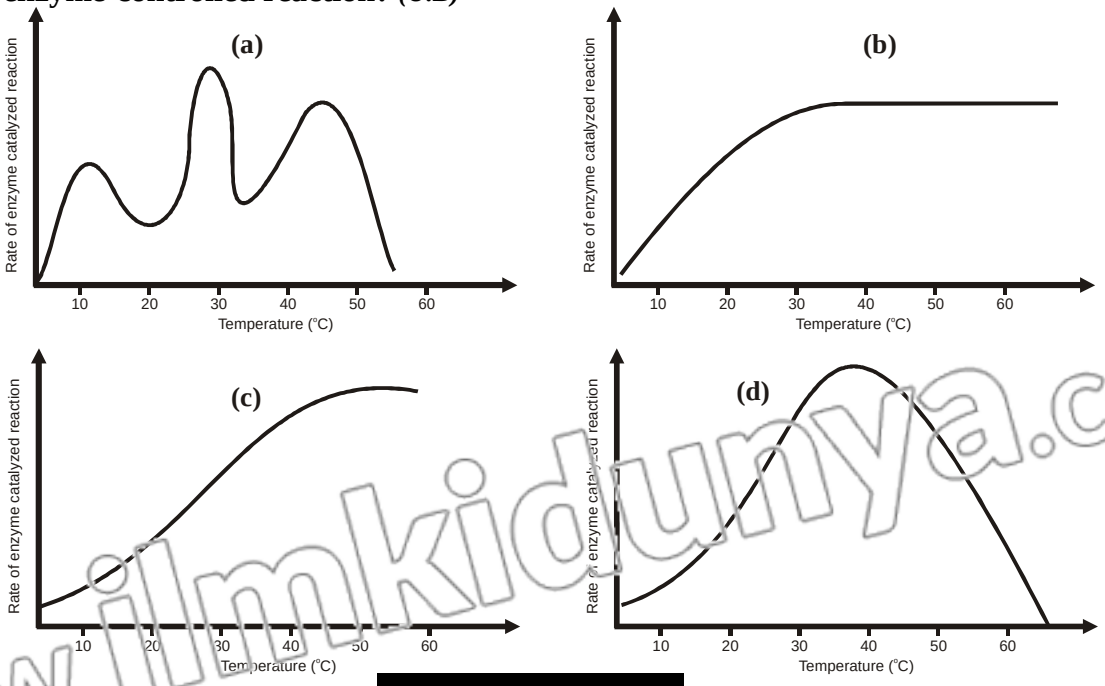
2. To what category of molecules do enzymes belong? ***(K.B)***
(a) Carbohydrates (b) Lipids
(c) Nucleic acids (d) Proteins

3. What is true about cofactors? ***(U.B)***
(a) Break hydrogen bonds in proteins (b) Help facilitate enzyme activity
(c) Increase activation energy (d) Are composed of proteins

4. Prosthetic groups are: ***(K.B)***
(a) Required by all enzymes (b) Loosely attached with enzyme
(c) Proteins in nature (d) Tightly bound to enzyme

5. When we add more substrate to an already occurring enzymatic reaction and there is no increase in the rate of reaction, what would you predict? ***(U.B)***
(a) All active sites have been occupied by substrate molecules
(b) The enzyme molecules have denatured
(c) More substrate acted as an inhibitor
(d) More substrate has disturbed the pH of the medium

6. Which of these graphs correctly shows the effect of temperature on the rate of enzyme-controlled reaction? ***(U.B)***



ANSWERS KEY

1	b	4	d
2	d	5	a
3	b	6	d

UNDERSTANDING THE CONCEPTS

1. How would you define enzymes? Describe their characteristics. ***(K.B)***

Ans: See the SQ.6 and LQ.2 of **(Topic 6.1)**

2. What do you mean by activation energy and why is it referred to in the definition of enzymes? ***(K.B)***

Ans: See the LQ.1 of **(Topic 6.1)**

3. In a range of 0-35° C, the rate of reaction of an enzyme is proportional to temperature. Above 35°C and below 0°C, enzyme activity slows down and eventually stops. Explain why? ***(U.B)***

Ans: **EFFECT OF CHANGE OF TEMPERATURE IN ENZYME ACTIVITY**

Temperature is an important factor which affects enzyme activity.

Increase in Temperature:

Increase in temperature speeds up the rate of enzyme-catalyzed reactions, but only up to a point. When temperature increases from 0^oC to 35^oC, heat adds in the activation energy and also provides kinetic energy for the reaction. So the reactions are accelerated.

Optimum Temperature:

Every enzyme works at its maximum rate at a specific temperature which is called optimum temperature for that enzyme. For this reaction, 35^oC is the optimum temperature for the enzyme.

Denaturation:

When the temperature is raised above 35^oC, heat energy increases the vibrations of atoms of enzyme and the globular structure of enzyme is lost. This is known as denaturation of enzyme. Denaturation results in a rapid decrease in the rate of enzyme action and it may be blocked completely.

Below 0^oC:

Below 0^oC, the enzyme does not have sufficient energy to start a reaction so rate of reaction slows down.

4. How does pH affect enzyme activity? ***(A.B)***

Ans: See the LQ.4 of **(Topic 6.1)**

5. What characteristics of enzymes make them specific for substrates?

Ans: **CHARACTERISTICS OF ENZYMES**

Enzymes are highly specific for their substrates. This feature can be attributed to special characteristics of enzymes like:

- Active site geometry
- Charge

6. Briefly describe the factors that affect the activity of enzymes. ***(A.B)***

Ans: See the LQ.4 of **(Topic 6.1)**

7. Describe the lock and key mechanism of enzyme action. ***(K.B)***

Ans: See the LQ.1 of **(Topic 6.2)**

SHORT QUESTIONS

1. Define cofactor and coenzyme. ***(K.B)***

Ans: See the SQ.14 of **(Topic 6.1)**

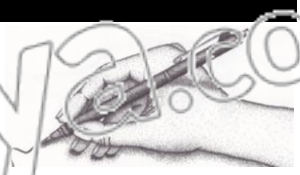
2 What is the main use of enzymes in paper industry? ***(A.B)***

Ans: **USE OF ENZYMES IN PAPER INDUSTRY**

Enzymes break starch to lower its viscosity, which aids in making paper.

KIPS ASSIGNMENT

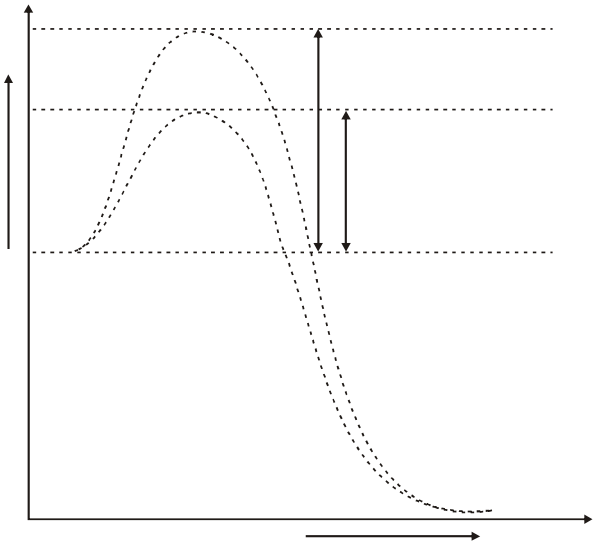
LET'S DRAW & LABEL



(A) Enzymes Lower the Activation Energy

Instructions:

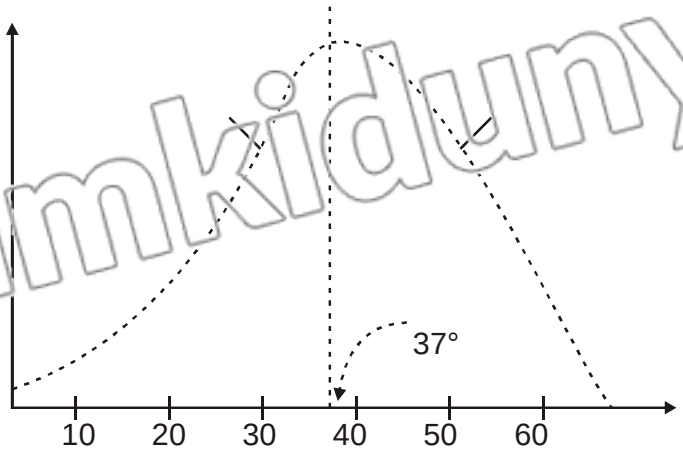
- Draw the x and y axis using scale.
- Along the x axis draw 3 parallel lines with uneven spaces as shown in figure.
- Now draw the curves by free hands skills showing activation energy.
- Finally, mark the arrows and show the labels.



(B) Effects of Temperature on Enzymes Activity

Instructions:

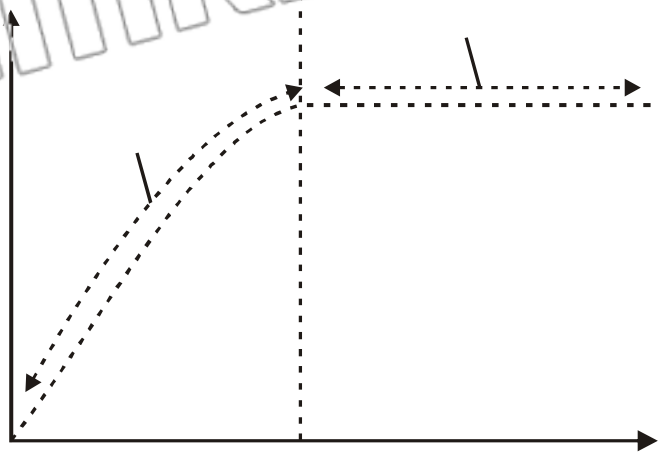
- Draw the x and y axis using scale.
- Draw the curve as shown in figure.
- Now mark the labels as giving in book.



(C) Effects of Substrate Concentration on Enzyme Activity

Instructions:

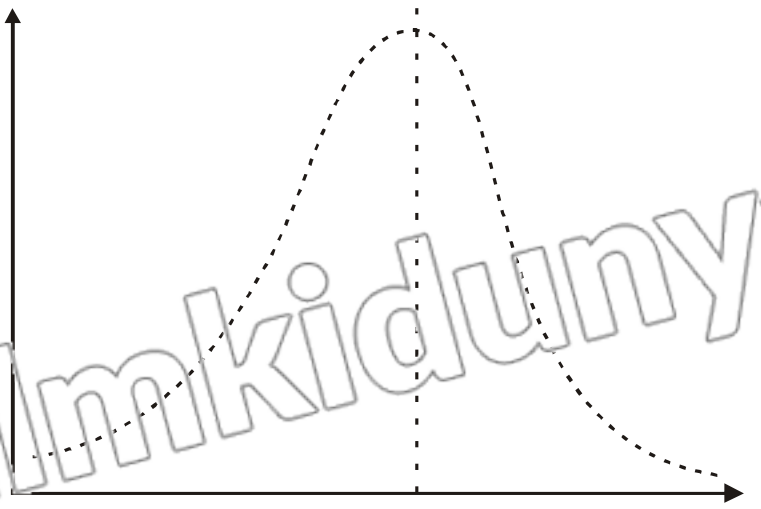
- Draw the x and y axis using scale.
- Now draw the curve showing saturation of active sites.
- Now mark the labels as given in book.



(D) Effects of pH on Enzymes Activity

Instructions:

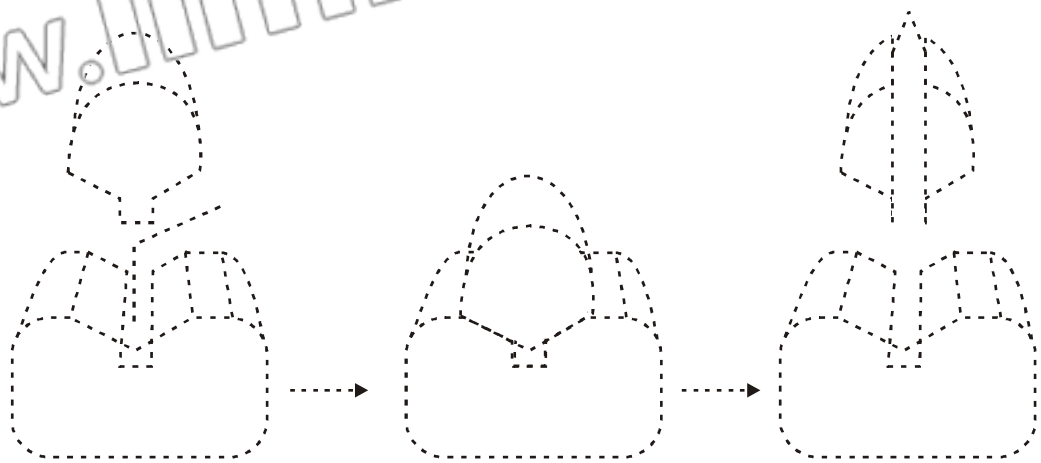
- Draw the x and y axis using scale.
- Now draw the curve showing optimum pH.
- Now mark the labels as given in book.



(E) Lock and Key Model of Enzyme Action

Instructions:

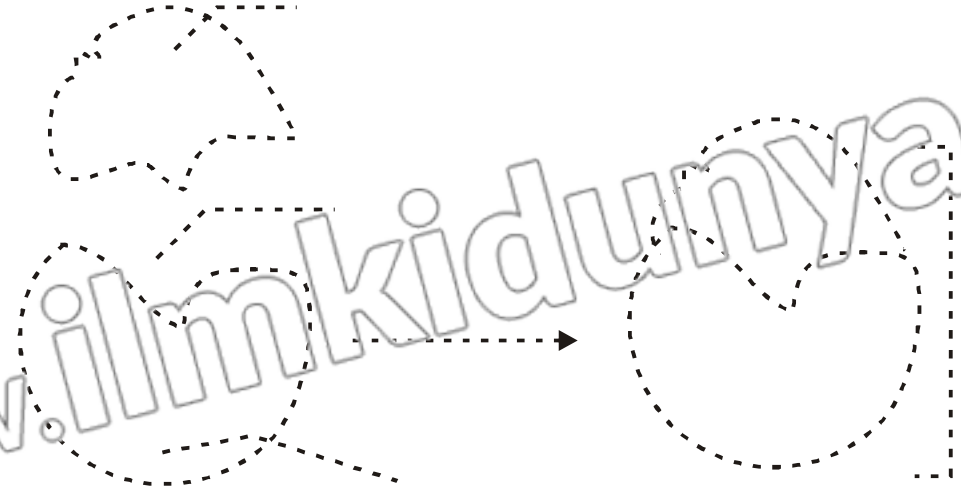
- Draw the enzyme's active site by curves.
- Draw the substrate like a key.
- Now show enzymes substrate complex.
- Finally break the substrate in products.
- Mark the labels as given in book.



(F) Induced Fit Model of Enzyme Action

Instructions:

- Draw the enzyme's active site by curves.
- Draw the substrate like a key.
- Now show enzymes substrate complex by showing some adjustment of active cell.
- Mark the labels as given in book.



SELF TEST

Time: 40 min **Marks: 25**

Q.1 Four possible answers A, B, C and D to each question are given, mark the correct answer. **(6×1=6)**

1. The concept of metabolism was first of all given by: *(K.B)*

(A) Ibn-e-Nafees **(B)** Wilhelm Kuhne

(C) Emil Fischer **(D)** Daniel Koshland

2. Enzymes lower the activation energy in the ways: *(A.B)*

(A) They may alter the shape of substrate

(B) Some enzymes do so by disrupting the charge distribution on substrates

(C) They may lower activation energy by bringing substrates in the correct orientation to react

(D) All of these

3. If organic cofactors are tightly bound to enzyme, they are called: *(U.B)*

(A) Coenzymes **(B)** Prosthetic groups

(C) Activators **(D)** Vitamins

4. Which enzymes are used in dish washing to remove resistant starch residues? *(A.B)*

(A) Protease **(B)** Amylase

(C) Lipase **(D)** Pepsin

5. When was induced-fit model proposed? *(K.B)*

(A) 1952 **(B)** 1954

(C) 1956 **(D)** 1958

6. The peptide bonds in proteins are broken down by: *(A.B)*

(A) Protease **(B)** Lipase

(C) Amylase **(D)** All of these

Q.2 Give short answers to following questions. **(5×2=10)**

1. What is the difference between catabolism and anabolism? *(K.B)*

2. How do enzymes lower activation energy? *(A.B)*

3. What are cofactors? *(K.B)*

4. What do you mean by denaturation of enzyme? *(U.B)*

5. Draw a diagram showing effects of substrate concentration on enzyme activity. *(K.B)*

Q.3 Answer the following Questions in detail. **(5+4=9)**

(a) Describe mechanism of enzyme action. *(K.B)* **(5)**

(b) Describe the characteristics of enzymes. *(K.B)* **(4)**

Note:

Parents or guardians can conduct this test in their supervision in order to check the skill of students.