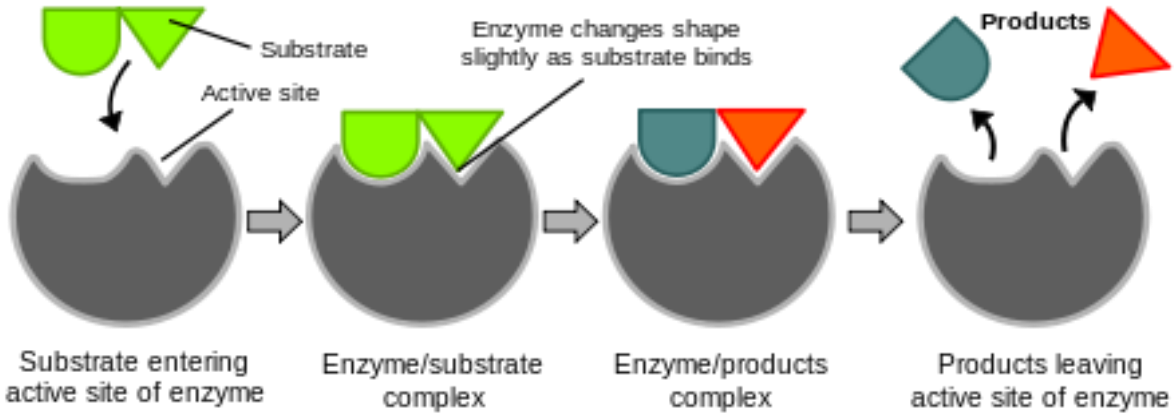
Understandings:

1. Explain the enzyme-substrate specificity.

- When enzymes catalyse the reactions, they bind with reactants called substrate (basically the same thing). However, the enzyme-substrate specificity is essentially the characteristic that one enzyme only may catalyse one chemical reaction. It is like a key-lock relationship!

How it does that is due to the uniqueness in active site. This is the area where the reactants bind and they must "fit" both chemically and structurally in order to be catalysed.



2. Explain how enzymes work.

- Substrate binds to enzyme's active site. This can only happen when the molecules moves really close to the active site. This is called collision and due to the random movements, not the high speed. They must also be aligned correctly when binding.

Enzyme helps to make those reactants into product.

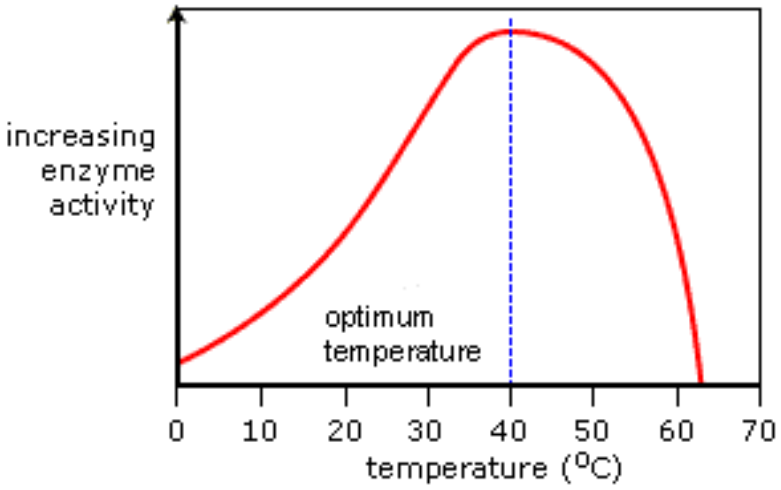
Product leaves the enzyme.

3. State and explain the factors that affect the rate of enzyme activity.

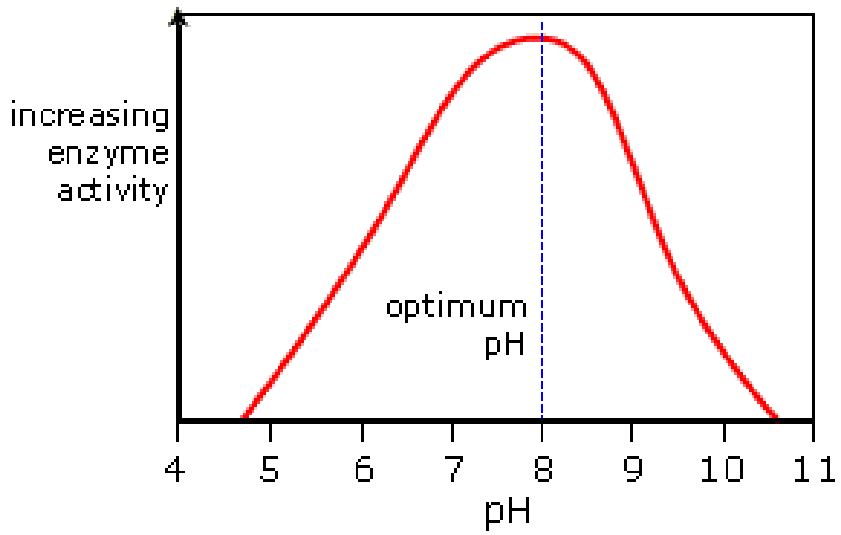
- Temperature: The enzyme activity will increase as temperature increases because the kinetic energy will increase the probability of collision between the enzyme and substrate. However, when it reaches a limit it will get denatured and stop working because the vibration is so strong that the vital bonds in the enzyme breaks.

All enzymes have different optimum temperature, but in our human body, it is around 37 degree Celsius.

The characteristic in the graph is that the drop after denaturation is steeper than the increase.

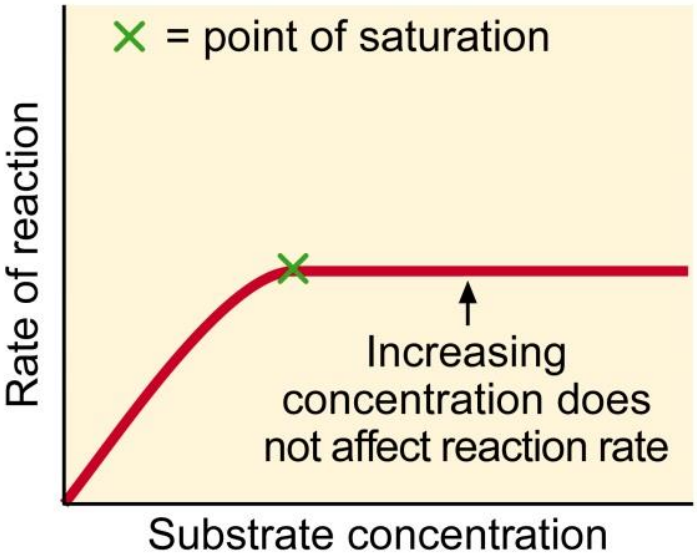


pH: Most enzymes in our body has its optimum pH around 7, which is neutral. But protease is an exception, which is an enzyme in our stomach. This is why our stomach is known to be acidic. Both alkali and acids can denature enzymes.



Substrate concentration: The enzyme activity/rate of reaction will increase as the concentration goes up because of the same reason as temperature. It has a higher chance of colliding to trigger a reaction. UNTIL all the active sites of enzyme are already in full use so that the overflowing substrates has to "stand in line" to react. That point is called saturation.

Although more substrate will affect rate of reaction less and less, it never reaches maximum because the collision is still random and there is always a free enzyme.



4. State that enzymes can be denatured.

- When enzymes are denatured, they usually become insoluble in water and hence form precipitate. This is indeed why egg stiffens when we boil, steak it. Look in 2.4 proteins to see what it actually chemically happens when it is denatured.

5. Outline uses of immobilized enzymes.

- Immobile enzyme is just as it sounds – not moving enzymes. We can extract enzymes, and make them catalyse! Yeast is an example and large industries use other enzymes as well.

In addition, this extraction of enzyme disproved vitalism and clearly showed that reactions like fermentation can be artificially made.

But why use immobile enzymes? Well, this is due to several reasons.

1. Since we have full control over enzymes, the reaction can be stopped and started whenever we want, and separate.
2. We can recycle it!
3. These are stable because since they do not move, they have fewer fluctuations of pH and temperature.

Applications and skills:

1. Explain the uses of lactose-free milk.

- If someone is lactose intolerant, it means that the person cannot digest the lactose because they don't have the enzyme lactase that can break down the carbohydrate lactose to glucose and galactose. It can make you feel dizzy or cause pain in stomach etc.

How do we get the lactase? Basically, we extract from yeast *Kluveromyces lactis*. We cultivate the yeast and then extract lactase, purify it and then apply it to food.

A lactose-reduced product simply means that they have added lactase enzymes in the product so that it can break down the carbohydrate. But one should not confuse between dairy-free products and lactose-free products. Dairy-free products are lactose-free since no milk is present at all, but lactose-free products can still have milk in it.

So we have 4 basic uses for lactase:

1. Some are lactose intolerant as mentioned.
2. Galactose and glucose is sweeter hence less sugar needs to be added.
3. Glucose and galactose give a smoother texture for ice cream! Yum!
4. Bacteria ferment (making from carbs to alcohol and carbon dioxide) glucose and galactose faster than lactose. This is good for cheese and yoghurt production.

It is important that you know at least three of these four!

Extra notes

- When processing these foods, it is often done at low temperatures and temperatures definitely lower than the acting enzyme's optimum condition. The reasons for this are to:

1. Reduce the risk of denaturation of other proteins.
2. It costs less in lower temperature.
3. Bacteria thrive less in lower temperatures.
4. It is easier to control the rate of reaction.

2. Design experiments that test rate of enzyme activity, with temperature, pH and substrate as independent variable.

- Ok

3. Practical involving enzyme activity!

- Yes!

TOK:

1. Development of some techniques benefits particular human populations more than others. For example, the development of lactose-free milk available in Europe and North America would have greater benefit in Africa/Asia where lactose intolerance is more prevalent. The development of techniques requires financial investment. Should knowledge be shared when techniques developed in one part of the world are more applicable in another?