Name:
Date:

QB3 – Enzyme Conditions, Active Sites, and Inhibitors

1. How do enzymes affect chemical reactions in the body?
   Enzymes **speed up** chemical reactions.

2. What is the optimum temperature for enzymes in the body?
   a. 0 °C
   b. 25 °C
   c. 30 °C
   d. 40 °C ✓

3. Explain how enzymes change when the temperature becomes too high.
   Enzymes are very temperature sensitive, and work best at an optimum temperature. When the temperature becomes too high, the enzyme has **too much energy**, this **destabilises** the enzyme. The excess energy will cause the complex to **vibrate rapidly**, and start to **break down the bonds which hold the protein in its specific tertiary structure**. This changes the shape of the active site of an enzyme, and makes it **unable to bind effectively** to a substrate. This is called **denaturing**.

4. Predict what will happen to the rate of reaction for an enzyme if the solution is made gradually more basic.
   Enzymes are very pH sensitive, and only work in a very narrow pH range. Increasing the basicity will **alter the concentration of H^+ and OH^- ions**. These ions can interact with the bonding which gives the enzyme its tertiary structure, and cause the **bonds to break down** in a process known as **denaturing**. Also, the **ions can interact with the active site** of the enzyme, interfering and **preventing it from accepting a substrate**. Both of these effects will **reduce the rate of reaction**.

5. With reference to enzymes and substrate concentration, what does the 'point of saturation' mean?
   This is the point at which **all of the enzymes in a system are working at their full capacity**, and are catalysing reactions. Further increasing the concentration of the substrate won't affect the rate of reaction, because the **enzyme concentration** is now the **limiting factor**.

6. Explain the lock and key theory of enzyme action.
   This model assumes that each **enzyme active site acts as a lock**, and **only accepts a complementary key** (**substrate**). This model **doesn't allow any flexibility** in the structure of the enzymes active site, and assumes that a substrate has a **perfect natural fit** within the active site.

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7. What forms when an enzyme interacts with its complementary substrate?
   An **enzyme-substrate complex**.

8. Explain the induced-fit theory of enzyme action.
   The induced-fit model **allows flexibility** in the structure of the **active site**. In this model, the active site can **mould slightly around the substrate**, to form an enzyme-substrate complex. In this case the substrate doesn't need to have an exact fit, it just needs to be complementary.

9. Why must a substrate be complementary in order to bind to an enzyme?
   Enzymes have a **very specific active site**. An active site will only accept a substrate which has a **complementary shape**, so it can **fit into the active site**, and **complementary interactions**, so that it can **bind to the active site**.

10. Explain how inhibitors are able to reduce the activity of an enzyme. In doing so, describe the two main types.
    Inhibitors **bind to an enzyme** and **block the active site**, **preventing a substrate from binding**. This reduces the activity of an enzyme. There are two main types of inhibitors, competitive, and non-competitive.
    Competitive inhibitors have a **similar shape to the substrate**, and therefore competitively **bind directly to the active site** of the enzyme.
    Non-competitive inhibitors don't have a similar shape to the substrate. Instead they **bind away from the active site**, and **trigger a conformational change** in the structure of the enzyme. This **indirectly changes the structure of the active site**, so that the **substrate cannot bind to the active site**.

11. Using the following words and phrases, explain the biochemistry behind enzyme binding.
    Enzymes. Proteins. Biological catalysts. Substrate. Speeds up. Rate. Active site. Tertiary structure. Complementary. Lock and key. Perfect fit. Degree of flexibility. Induced fit.

    Enzymes are types of **proteins** which act as **biological catalysts** on a **substrate**. A catalyst is a species which **speeds up** the **rate** of a chemical reaction without itself being used. The substrate binds to the enzyme at the **active site**. The active site is part of the **tertiary structure** of the protein, which is the overall 3D arrangement of the polypeptide chain in space. The substrate is **complementary** to the active site, and can be modelled in two different ways. One model is the **lock and key**, where each enzyme is considered to be a lock, into which a key (substrate) will fit. This model assumes that each substrate has a **perfect fit** to the active site of the enzyme, however this is not the case. Each enzyme has a **degree of flexibility**, which is deemed the **induced fit** model, where an active site can mould very slightly to accommodate a specific substrate.

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