The role of enzymes in metabolism

1. Most organisms are active within a limited temperature range:

(9. 1. 1) -Identify the role of enzymes in metabolism, describe their chemical composition and use a simple model to describe their specificity in substrates:

Role of enzymes in metabolism:

Metabolism is chemical reactions occurring in organisms.

Without enzymes metabolism wouldn’t be fast enough to support life.

Metabolism refers to all the chemical reactions occurring in organisms

Chemical composition:

Enzymes are made of protein.

Protein consists of one or more polypeptide chain.

These are made of long chains of amino acids connected by peptide bonds.

Structure of Enzymes

In enzymes, the polypeptide chain is folded into a 3D shape.

A part of the enzyme is called the active site. This attaches to the substrate

The substrate is molecules the enzymes act upon.

Specific of enzymes:

They are highly specific in their actions

Each enzyme acts on substrate only

This is because the shape of the active site of the enzyme fits with the shape of the substrate material

The substrate molecules bind to the active site and cause a chemical reaction

The products are the substances that the substrates become. They can either be split of joined.

Models used to explain:

The Lock and key model:

Suggests that the substrate fits perfectly into the Active site of the enzyme like a key to a lock. It is usually draw simplistically and unrigid.

The Induced fit model:

States that the binding of the substrate to the enzyme causes a temporary change of the enzyme. The new shape can fit the shape of the substrate and causes the reaction.

(9. 1. 2) Identify the pH as a way of describing the acidity of a substance

Hydrogen ions make solutions acidic

pH is a measure of the concentration of hydrogen ions per litre of solution.

pH is a measure of the acidity of a substance.

The pH scale is from 0-14:

a pH of 7 is neutral

a pH above 7 is alkaline

a pH below 7 is acidic

(9. 1. 2. 1) Identify the effect of increased temperature, change in pH and change in substrate concentrations on the activity of enzymes:

Temperature:

At high temperatures, the shapes of enzymes change to the point where they cannot accommodate the substrate, causing activity to decrease.

At incredibly high temperatures the enzyme falls apart (the chemical bonds holding the protein molecule together brake and the shapes are prematurely changed. After this it will stay inactive forever.

As temperature increases. So does enzyme activity, up until the point listed above.

pH:

Enzymes work best at an optimum pH

This is a very narrow range

Extremes of acidity or alkalinity can affect the bonds holding the shape of the enzyme, destroying the enzyme.

Substrate concentration:

An increase in the concentration of a substrate will increase the reaction until all enzymes active sites are occupied.

(9. 1. 3) Explain why the maintenance of a constant internal environment is important for optimal metabolic efficiency:

Enzymes are needed for proper metabolic function in an organism

Enzyme efficacy is affected greatly by certain factors

Temperature

pH

Substrate Concentration

Enzymes work best within a range of environmental conditions.

A stable internal environment is needed so that enzymes will always be working at optimum rate.

(9. 1. 4) Describe homeostasis as the process by which organisms maintain a relatively stable internal environment:

Homeostasis: the process by which organisms maintain a relatively stable internal environment

The internal environment of cells are kept within certain limits by the systems of the body

These systems monitor all activities of cells (what they require and the waste they produce

(9. 1. 5) Explain that homeostasis consists of two stage: detecting changes from the stable state and counteracting changes from the stable state.

Detecting changes:

The body needs to stay in a ‘ stable state’ to function properly

Changes from the stable state are caused by the external and internal environment.

Any change that provokes a response is called a stimulus

Stimuli are the organisms that react to change

Examples of an external stimuli:

Light

Day length

Sound

Temperature

Odours

Examples of internal stimuli:

Levels of C02

Oxygen levels

Water

Waste

Receptors can range from a patch of sensitive cells to complex organs such as the eyes or ears.

Counteracting Changes:

After receptors detect changes, organisms can react to them

This type of response will counteract the change to ensure the stable state is maintained.

Effectors bring about responses to stimuli.

Effectors can either be muscles or glands

Muscles bring about change by movement

Glands bring about change by secreting chemical substances.

(9. 1. 5. 1) Gather, process and analyse information from secondary sources and use available evidence to develop a model of a feedback mechanism:

Homeostasis involves the detection of the change in the environment and the response to that change

In feedback systems, the response alters the stimulus

The mechanism that brings about this change is called feedback.

In living organisms, the feedback system has 3 main parts:

Receptors:

A type of sensor that monitors the internal environment

Control Center:

Receives information from the receptors and determines the response.

Effectors:

Restores the set values. Keeps environments stable.

An example of feedback is the control of body temperature

The hypothalamus responds by initiating responses to increase or decrease temperature, until it goes back to the set value (which is 37°C)

Temperature control responses:

Keeping Warm

Keeping Cool

Shiver to generate heat

Sweating; evaporation loses heat

Hair muscles erect; insulation

Blood vessels dilate; increased blood supple, more heat lost

Increased appetite

Hair relaxes, less insulation

Blood vessels constrict; less blood flow, less heat loss

Decrease in metabolism

Increase in metabolism

Less exercise

Diagram of Feedback:

(9. 1. 6) Outline the role of the nervous system in detecting and responding to environmental changes

The nervous system regulates and maintains an animal’s internal environment and responds to the external environment.

It’s made of two parts: The Central Nervous System and the Peripheral Nervous system.

Central Nervous System:

The control center for all the body’s responses. It coordinates all the responses.

It’s made up of the brain and the spinal cord

It receives information, interprets it and initiates a response.

Peripheral Nervous System:

The branching system of nerves that connects receptors and effectors.

Transmits messages from the central nervous system and back.

Acts as a communication channel.

(9. 1. 7) Identify the broad range of temperatures over which life is found compared with the narrow limits for individual species

The Ambient temperature is the temperature of the environment

The range of temperatures over which life is found is very broad

The limits of range of temperature within individual species in much narrower

Organisms on Earth live in environments with ambient temperatures ranging from less that freezing to more than 100 degrees Celsius.

Individual organisms cannot survive this range of temperatures

Mammals can only survive temperatures from 0-45 degrees Celsius.

This means that life is found in a very wide range of temperatures, unlike individual species.

(9. 1. 8) Compare responses of named Australian ectothermic and endothermic organisms to changes in the ambient temperature and explain how these responses assist in temperature regulation:

Ectotherms are organisms that have a limited ability to control their body temperature.

Their cellular activities generate little heat.

Their body temperatures rise and fall with ambient temperature changes.

Most organisms are Ectotherms.

Plants

Fish

Invertebrates

Amphibians

Reptiles

Ectotherm responses to changing temperature:

Controlling Exposure: The goanna controls its body exposure to the sun by sun baking in the cool morning, and staying in shade during the hot hours.

Hibernation: The bogong moths “ hibernate” in hot weather (this is called aestivation). During summer, they gather in caves, their metabolism slows and the body temperature drops. This is to maintain body temperature.

Shelter: The central netted dragon stays in sheltered areas to avoid extreme heat. They can dig burrows or seek shelter in caves or crevices. This reduces the effect of heat on their body.

Nocturnal Activity: Brown snakes can change into nocturnal animals when the temperature becomes very hot. Many desert animals sleep in burrows during the day and are active at night, to escape the heat.

Endotherms are organisms whose metabolism generates enough heat to maintain an internal temperature independent of the ambient temperature.

Endotherm responses to changing temperature:

Migration: The short-tailed shearwater migrates to equatorial regions during the winter months. This is to avoid the cold weather, as the bird only breeds in warm weather.

Insulation: The superb parrot contracts the muscles controlling its feather in cold conditions, fluffing up its coat. This maintains a later of trapped air as insulation. This air reduces heat exchange with the environment.

Evaporation: The red kangaroo licks its arms to cool itself. The evaporation of the saliva cools its skin.

Nocturnal Behaviour: Hopping mice, and many other Australian Endotherms, are nocturnal. This is to prevent overheating, and to reduce moisture loss.

(9. 1. 9) Identify some responses of plants to temperature change:

Plants respond to a change in temperature by altering their growth rate.

Eucalyptus trees grow faster in spring than in winter

In extreme hot or cold, plants die but leave behind seeds.

Plants may die above the ground but leaves bulbs, roots, and rhizomes to survive underground. These will re sprout when the conditions are favourable again

Leaves hang down vertically to reduce sun exposure.