enzymes. Enzymes was first discovered in the 19th century by Edward Buchner when he found yeast turning sugar into alcohol.

Properties (Characteriscs) of enzymes

a. Enzymes are active in small amounts i.e. only a small amount of enzyme is necessary to convert a large amount of substrate into product. The same substrate could be utilized by different enzymes e.g.

Phosphate hexose

Fructose Glucose-6-phosphate (substrate)

-6- Isomerase

Phosphate

Phosphogluco mutase glucose-6-phosphate dehydrogenase

Glucose-1-phosphate 6-phosphoglucolactone

b. The same enzyme could act on different chemical reactions e.g.

Sucrose + Inorganic	Sucrose gluycosyl	B-D-glucose-1-phosphate
Phosphate	transferease	+
Sucrose + L-sorbose	sucrose glucose	glucose-sorboside
(monosaccharide)	transferease	+
		Fructose

c. Enzymes work at narrow range of temperature. Optimum temperature for their working is 40°C and they become denatured (killed) at 60°C.

d. Enzymes work at specific pH. Most function around neutral pH (pH 5-7). However, pepsin (found in stomach) works at pH 2-3 and trypsin (found in the duodenum) works at pH 8.5

e. Atalytic actions of enzymes may be specific. Thus an enzyme which catalyses one-reaction may not catalyse another e.g.

i. invertase works only on sucrose

sucrose invertase glucose + fructose

1. amylase works only on starch

   starch amylase maltose

2. Maltase works only on maltose

   Maltose maltase glucose

3. zymase works only on glucose

   Glucose zymase CO_2+ethanol

1. Enzymes are not destroyed by the reactions they catalyzed and could therefore be used and used again.
2. Enzymes could be poisoned by chemical compounds like mercury chloride (HgCl2), silver chloride (AgCl2) and hydrogen cyanide (HCN).These inactivate the enzymes for example HCN blocks the enzymes involve in respiration.

Mechanism of action (working) of enzymes

This is explained by two hypotheses

1. Chemical hypothesis

   A B

Chemically, energy needed could be inform of heat (temperature) to activate passive A by bombarding A's molecules so that they could become activated and later turned into B's molecules.

The energy above average that is required A molecules to react and be converted into B molecules is the activation energy of the reaction.

Enzymes are believed to catalyze reaction by lowering the activation energy.

E.g. in

2H2O2 catalase 2H2O+2O2

The activation energy in the absence of catalase is 18,000 cal/mol while in the presence of catalase, it is 6,400 cal/mol.

ii. Lock and Key hypothesis: The enzymes is believed to be the padlock and substrate the key. Enzymes (the padlock have active centres which must fit the substrate (the key) before chemical reaction could take place.

(Diagram)

Classification of enzymes

Enzymes are generally of 2 types, namely

i. Intracellular enzymes (enzymes working inside the cell).

ii. Extracellular enzymes (enzymes working outside the cell).

Enzymes are classified as follows;

1. According to substrate they act upon: Examples are arginase which acts on arginine, tryrosinase which acts on tyrosine, lipase which acts on lipids, proteinases which acts on proteins and carbohydrases which acts on carbohydrates and maltase which acts on maltose.
2. According to the type of reactions they catalyse: Examples are hydrolyses (hydrolytic enzymes), oxidases (oxidation reaction enzymes), phosphorylases (phosphate adding and deleting enzymes). In both cases above, the suffix ase or in is added to the name of the substrate or reaction type.

Specific enzymes types

i. Hydrolyses(hydrolytic enzymes)

These catalyse the addition of the elements of water to specific bond of the substrate

$RCO - OR \quad HOH \quad RCOOH + R`OH$

e.g. lipases, carbohydrates, proteases.

ii. Oxidases (oxidation reduction enzymes)

these catalyse the removal or addition of hydrogen, oxygen or electrons from or to the substrate, which is thereby oxidized or reduced in the process.

$RH + HA \quad R + AH_2$ (removal of H_2)

$RO + \frac{1}{2}O_2 \quad RO_2$ (addition of O_2)

$R^{2+} \quad R^{3+} + e-$ (removal of electron)

e.g. dhydrogenases and oxidases.

iii. Phosphorylase

these catalyse the addition or removal of elements of phosphoric acids e.g. glucose + phosphate

Hexokinase glucose 1 phosphate

iv.Carboxylase: These catalyse the removal or addition of CO_2 e.g.

Ribulose 1, 5-diphosphate Carboxydismutase Ketoacid

(5C) (6C)

v. Isomeraes: These carry out breaking of double bonds e.g. lysozyme (found in tears, nasal mucus and egg) which dissolves certain air-borne cocci (bacteria) by breaking the double bonds of the polysaccharides in their walls.

Estimation of rates of enzyme activities

i. Use of turnover number: This is the number of moles of substrate converted per minute by 1 mole of enzyme. Succinic dehydrogenase has turnover number of 1150 while carbonic anhydrase has turnover number of 36,000,000.

ii. Manometric gases evolved as a result of enzyme activities are measured manometrically e.g oxidase, caboxylaes

iii. Spectrophotometric uses that fact that the different quantities of product have different optical density at the same wavelength. The wavelength used depends on the enzymes type involved e.g. for amylase, the wavelength is 490nm and for proteases it is 700nm

iv. Coloration method: works on the basis that the substrate and product have different colours with a known dye. The disappearance of the colour with time is taken note of e.g.

Starch + iodine + E (blue-black colour)

Amylase

Maltose + iodine + E (iodine colour)

v. Chemical estimation: This involves titration, chromatography and electrophoresis techniques. E.g. lipases are estimated by breaking lipids into fatty acids and glycerolusing lipases and the liberated fatty acids quantities determined using titration with NaOH and phenolphthalein as an indicator.

Units of enzyme activities are mg product/ml/min, mg product/min/mg protein e.g. maltose

Maltase glucose

Enzymes Inhibitors

These are compounds which prevent, limit or stop enzymes activities. They ae divided into competitive inhibitors and non-competitive inhibitors.

i. Competitive inhibitors have similar shape to the substrate and can therefore fit into the active centres of the enzymes. The lower enzymes activities e.g. the inhibition by malonic acid of the enzymes succinic dehydrogenase which catalyses the conversion of succinic acid into fumaric acid.

COOH
H-C-H
H-C-H + Enzyme Fumaric + Enzyme
COOH acid

Succinic acid

COOH

H-C-H + enzyme no reaction

COOH
Maltonic acid

Competition inhibition could be overcome by increasing the concentration of the substrate

ii. Non-competitive inhibitors either undergo chemical reactions with the enzymes and thereby altered the configuration of the enzymes or form bond with enzymes substrate complex to form an inactive compound. They normally stop the working of enzymes and effect cannot be overcome by increasing the concentration of the substrate.

E I EI

E + S + I ESI

Examples are effects of poisons, heavy meals (Hg, Au, Ag), cyanide and carbon monoxide on the enzyme system.

Commercial uses of enzymes

a. Papain obtains from plants e.g. pawpaw leaves protease is sold as meat tenderizer (Adolf's). It beaks down protein into peptones and makes the meat soft
b. Protein digesting subtilisin (from Bacillus subtilis) is incorporated into presoak laundry agents and detergents for cleaning purposes. It is effective in removing protein containing stains (chocolate or coffee) from clothes, carpets etc.
c. Synthetic amylase is used in beer industry to break down starch substances into maltose
d. Synthetic cellulose is used in the textile industry to break down clothes into pieces or yarns

Plant Hormones

Also called phytohormones and they are substances that regulate plant growth and development. Phytohormones are divided into groups, namely:

i. Growth promoters
ii. Growth inhibitors

Growth promoters are further divided into auxins, gibberellins, cytokinins and ethylene while growth inhibitors consists of abscisic acid, phenolics e.g caffeine, glycosides, alkaloids and actinomycin D.

Auxins

These are substances which are chemically and/or biologically similar to indole-3-acetic acid (IAA). Auxins consists of natural auxins and synthetic auxins. The most important natural auxins is IAA while other example are indoleethanol(Iethanol), indoacetonitrile(IAN), and indolepyruvic acid (IPA). Site of production of natural auxins

is the stem apical tip while site of activity is the cell. Synthetic auxins are laboratory-made auxins and examples are 2, 4-dichlorophenoxyacetic acid (2,4-D).

Indole-3-butyic acid (IBA)

Naphthalene acetic acid (NAA)

PHYSIOLOGICAL EFFECTS OF AUXINS ON PLANTS

(a) Cell enlargement

(b) Rooting of twig

(c) Permeability of cell membrane

(d) Maturation of fruits

(e) Inhibition of abscission and fruit fall

(f) Apical dominance

(g) Geotropism and phototropism

(h) Parthenocarpy

(i) Herbicides (synthetic ones only)

Transport of auxin is through the phloem

Gibberellins

More than 50 gibberellin types have been isolated. They are numbered as

GA_1 GA_{34}

GA_1 $C_{19}H_{22}O_6$ = CA2 = $C_{19}H_{26}O_6$

GA3=$C_{19}H_{22}$ O6 GA4 = C19H24O5

GA5 = C19H22O5, GA6 = C19H24O4

Physiological effects of gibberellis on plants

a. Cell elongation

b. Parthenocarpy

c. Promotion of cambial activity

d. Induce new ma and protein synthesis

e. Inhibiting leaf senescence
f. Overcoming of genetic dwarfism
g. Induction of flowering
h. Mobilization of stored carbohydrates during germination
i. Breaking of dormancy of dormant seeds and buds

Cytokinins

These are compounds with kinetin like action. They are degradation products of DNA and RNA coconut milk contains cytokinins. Examples ribosylzeatin (from maize), 6-methylaminopurine (from microbes RNA), kinetin (from maize) and 6-benzyl aminopuyrine (from microbes RNA). Cytokinins are synthesized in the roots and transported through the xylem.

Physiological effects of cytokinins on plants

(a) Cell divisions with auxin e.g. in tissues culture
(b) Cell enlargement with auxin or gibberelin
(c) Root initiation and growth
(d) Breaking of dormancy of dormant seeds and buds
(e) Inhibition of leaf senescence
(f) Stimulation of water loss by transpiration
(g) Promotion of bud formation in leaf cuttings

Abscisic acid (ABA)

This is a growth inhibitor which has opposite effects to growth promoters e.g. promotion of dormancy, promotion of senescences and abscission. Other inhibitors are phenolics, glycosides, alkaloids.

Transport of ABA is though the phloem

Ethylene (C_2H_4)

This is a gas at room temperature and it is found in plants as a gas.

Physiological effects of ethylene on plants

(a) Frit ripening

(b) Inhibition of geotropism otiolated pea stems in ethylene are not affected by gravity

(c) Promoter of dormant bud and seed germination

(d) Inhibition of auxin transport

(e) Promotion of enzyme synthesis e.g. amylase

(f) Promoter of leaf senescence and abscission

Transport of ethylene is through the intercellular spaces.

Economic importance of plant hormones

(a) Synthetic auxons are used as herbicides

(b) Control of dwarfism in plants using gibberellins

(c) Formation of fruits without fertilization from flowers (parthenocarpy) IAA

(d) Flowr initiation gibberellins

(e) Breaking of dormancy of dormant seeds and buds gibberellins and kinetin

(f) Fruit ripening ethylene

(g) As antitranspirants ABA

(h) Acceleration of leaf and fruit fall ABA and ethylene

(i) Inhibition of fruit ripening and senescence auxins, gibberellins, cytokinins

Chemical structures of some plant hormones:

(Diagram)

ENDOCRINE SYSTEMS

Introduction (Hormones in Human being)

Two communication systems (by which coordination of activities is brought about) exists in most animals one of these is the system. It consists of specialized cells, neurons, which transmit electrical impulses from one part of the body to another. The

other is the endocrine system. This system achieve control of body functions through chemical substances i.e. hormones, which are transported throughout the body is the blood. There is a close connection between the activities of these two systems.

Chemical co-ordination in animals, like chemical co-ordination in plants, involves (1) the release of chemicals from cells into the extra cellular fluid (ECF) (2) the transport of these substances (3) the effect of the chemical substances on the activities of other cells.

Various groups of special clusters of cells those sole functions is the production and release of the various chemical co-ordinations (Hormones) exist in the different part of the human body. These clusters of cells are the endocrine glands. They are often referred to as ductless glands because their secretions i.e. the hormones pass directly into the blood that drains the gland. The hormones are then varied to all the other cells of the body. More often hormones exert their effect only on certain body structures referred to as “Target organs”.

THYROID GLAND

The thyroid gland is a double-lobed structure located in the neck. It has a rich supply of blood. The thyroid gland releases the iodine containing amino acids,