3.6 Enzymes – *summary of mark schemes*

3.6.1	Define *enzyme* and *active site*. Mark Scheme A. active site: the site (on the surface of an enzyme) to which substrate(s) bind / the site (on the enzyme) where it catalyzes a chemical reaction;
3.6.2	Explain enzyme–substrate specificity. Mark Scheme A. (enzyme has) a specific shape; B. (substrate has) a specific / complementary shape; C. active site of enzyme binds to specific substrate; D. (active site works as a) lock and (substrate as a) key; E. chemical properties of substrate and enzyme attract / opposite charges; F. enzyme / active site is not rigid and substrate can induce slight changes in shape; G. allows substrates of similar structure to bind with same enzyme; H. induced fit; I. causes weakening of bonds in substrate to lower activation energy;
3.6.3	Explain the effects of temperature, pH and substrate concentration on enzyme activity. Mark Scheme A. enzymes have an active site; B. that fits the substrate precisely; C. changes in the chemical environment of the enzyme can lead to a shape / conformational change in the protein; D. leading to a change in the shape of the active site; E. may interfere with the binding of the substrate with the active site; TEMPERATURE F. increase in temperature can increase molecular motion leading to disruption of intermolecular interactions; G. more kinetic energy / faster movement of molecules means more collisions between enzyme / active site and substrate; H. increases chance of enzyme substrate collisions so enzyme activity increases; I. optimal temperature; J. optimum temperature is temperature at which rate of enzyme-catalyzed reaction is fastest; K. at high temperatures enzymes are denatured and stop working; L. denatured means change of structure in enzyme / protein resulting in loss of its biological properties / no longer can carry out its function; M. too much kinetic energy / vibrations breaks bonds that give enzyme specific shape; PH N. enzymes have an optimal pH; O. optimum pH is one at which rate of enzyme-catalyzed reaction is fastest; P. lower activity above and below optimum pH / graph showing this; Q. too acidic / basic pH can denature enzyme; R. change shape of active site / tertiary structure altered; S. substrate cannot bind to active site / enzyme-substrate complex cannot form; T. altering pH can alter intermolecular interactions within the protein; SUBSTRATE CONCENTRATION U. the more substrate, the more product / more enzyme-substrate complex forms; V. random collisions more frequent; W. as substrate concentration increases enzyme activity increases; X. at high substrate concentration enzyme reaches maximum activity; Y. active sites saturated; Z. additional substrate will not lead to a greater rate of product formation at this point; AA. activity levels off / plateau; BB. labelled sketch-graph showing above relationship;
3.6.5	Explain the use of lactase in the production of lactose-free milk.

	Mark Scheme A. lactose intolerance high in some human populations / Asian / African / native American and Australian aboriginal populations; B. lactase used to produce lactose-free / low-lactose milk; C. lactase breaks down lactose to glucose and galactose; D. source of lactase is usually yeast / many sources such as bacteria, moulds; E. milk passed over immobilized lactase / lactase bound to inert substance; F. increase sweetness of milk; G. no need to add extra sugar in manufacture of flavoured milk drinks / frozen desserts; H. can add (harmless) bacterium such as L.acidophilus which has same effect on lactose as in yoghurt;