### 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;