Specificity of enzymes

The proteolytic enzymes are those utilizing proteins or any of the various protein derivatives as substrates. Some years ago these enzymes were classified according to the size of the molecules they supposedly cleave. Thus, pepsin and chymotrypsin were classed as proteases, since they were thought to start the hydrolysis of only large protein molecules. The low molecular weight peptides were supposedly hydrolyzed by another group of proteolytic enzymes, the peptidases, such as polypeptidase and dipeptidase.

Enzymes are highly specific in their action when compared with the chemical catalysts. The occurrence of thousands of enzymes in the biological system might be due to the specific nature of enzymes. Three types of enzyme specificity are well-recognised

1. Stereo specificity,
2. Reaction specificity,
3. Substrate specificity,

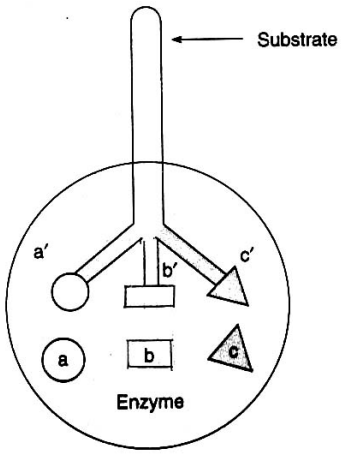


Fig. 6.8 : Diagrammatic representation of stereo-specificity (a', b', c')—three point attachment of substrate to the enzyme (a, b, c).

Specificity is a characteristic property of the active site

1. Stereo specificity or optical specificity : Stereoisomers are the compounds which have the same molecular formula, but differ in their structural configuration. **The enzymes act only on one isomer** and, therefore, exhibit stereo specificity e.g. L-amino acid oxidase and D-amino acids act on L-and D aminoacids respectively.

Hexokinase acds on D hexoses

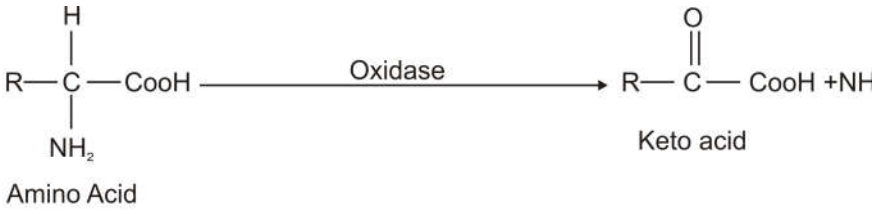
Glucokinase on D-glucose;

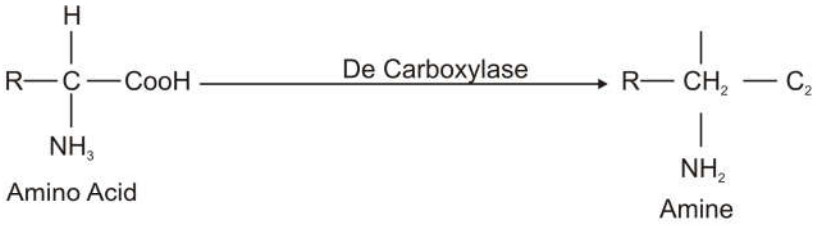
Amylase acts on α-glucosidic linkages;

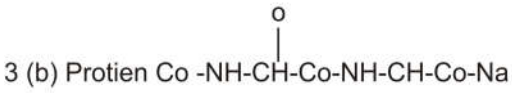
Cellulose cleaves β-glycosidic bonds.

Stereo specificity is explained by considering three distinct regions of substrate molecule specifically binding with three complementary regions on the surface of the enzyme (fig. 6.8). The class of enzymes belonging to **isomerases do not exhibit stereo specificity,** since they are specialized in the inter conversion of isomers.

2. Reaction specificity: The same substrate can undergo different types of reactions, each catalysed by a separate enzyme and this is referred to as reaction specificity. An amino acid can undergo transamination, racemisation etc. The enzymes however, are different for each of these reactions.



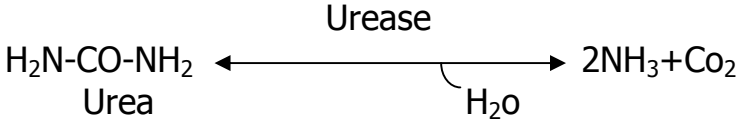




Enzymes	Nature of (R)
Pepsin	Try Phe Leo
Trypsin	Arg, Lys
Chymotrypsin	Tyr Phe
Elastase	Leu Me^+

3. Substrate specificity: The substrate specificity varies from enzyme to enzyme. It may be either absolute, relative or broad.

a) **Absolute substrate specificity:** Certain enzymes act only on one substrate e.g. glucokinase acts on glucose to give glucose-6-phosphate, urease cleaves urea to ammonia and carbon dioxide.



b) Relative substrate specificity : Some enzymes act on structurally related substances. This, in turn, may be dependent on the specific group or a bond present. The action of trypsin and chymotrypsin is a good example for group specificity (refer fig. 8.7) Trypsin hydrolyses peptide linkage involving arginine or lysine. Chymotrypsin cleaves peptide bonds attached to aromatic amino acids (phenylalanine, tyrosine and tryptophan). Examples of bonds specificity glycosidases acting on glycosidic bonds of carbohydrates, lipases cleaving ester bonds of lipids etc.

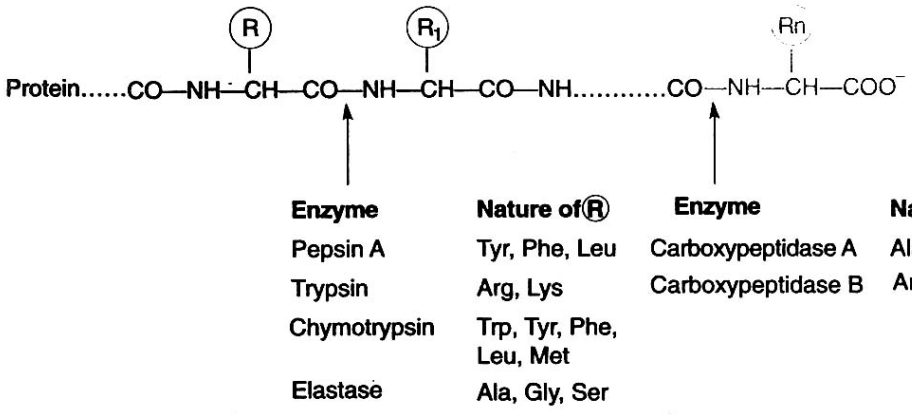
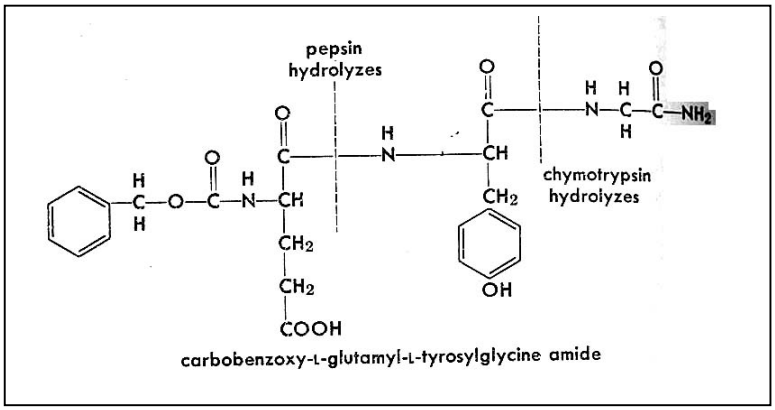


Fig. 8.7 : Digestion of proteins—Specificity of enzyme cleavage of peptide bonds.

c) Broad specificity: Some enzymes act on closely related substrates which is commonly known as broad substrate specificity, e.g. hexokinase acts on glucose, fructose, mannose and glucosamine and not on galactose. It is possible that some structural similarity among the first four compounds make them a common substrate for the enzyme hexokinase. Chymotrypsin hydrolyzes the original molecule as indicated at the peptide bond between tyrosine and glycine amide. This



action is not altered by removing the carbobenzoxy group, but if the carboxyl group of glycine amide is regenerated, the resulting compound is resistant to the enzyme. The latter alteration does not affects the action of pepsin, however. It was further found that tyrosine or phenylalanine must be present in the position indicated for either of these enzymes to be active. The amino acids also must be the natural antipodes. Pepsin in general appears to bring about scission at the peptide linkages involving the amino groups of the aromatic amino acids. The enzyme trypsin generally hydrolyzes peptides containing lysine or arginine. It is interesting that neither of these enzymes requires free terminal amino or carboxyl groups in their substrates.

These enzymes are ultimately excreted or destroyed. The increase of non-functional enyzmes in the blood is associated with damage or dysfunction of creation tissued and subsequent release of their internal contents including enzymes in the blood.