REGULATION OF ENZYME ACTION

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REGULATION OF ENZYME ACTIVITY/ACTION

LEARNING OUTCOMES:

Regulation of Enzyme activity by:

A. Genetic Control
B. Control of Catalysis
C. Regulation of Hormones
D. Control by Calcium
E. Cell Compartmentation

For continuance of life, all chemical reactions must proceed at rates in accordance with the requirements of the cell or organism.

All the enzymes within the cell do not exhibit their maximum activity at all times

Regulation depends on one important property of enzyme i.e ‘specificity’i.e if an enzyme is in active or not available, no other enzymes can take its place and the reaction will stop.

Immediate regulation of enzyme activity is achieved by changes in pH, temperature, enzyme concentration and substrate concentration.

GENETIC CONTROL

Enzyme activity is actually regulated by two major mechanisms:

A. **Genetic control** and **B. Control of Catalysis**

A. GENETIC CONTROL:

- In this type of control, the synthesis of enzymes is regulated at the genetic level, which results in a change in the total amount of enzyme molecules.

- The enzymes are synthesized only when required, i.e their synthesis is SWITCHED ON and OFF whenever required.

OPERON MODEL

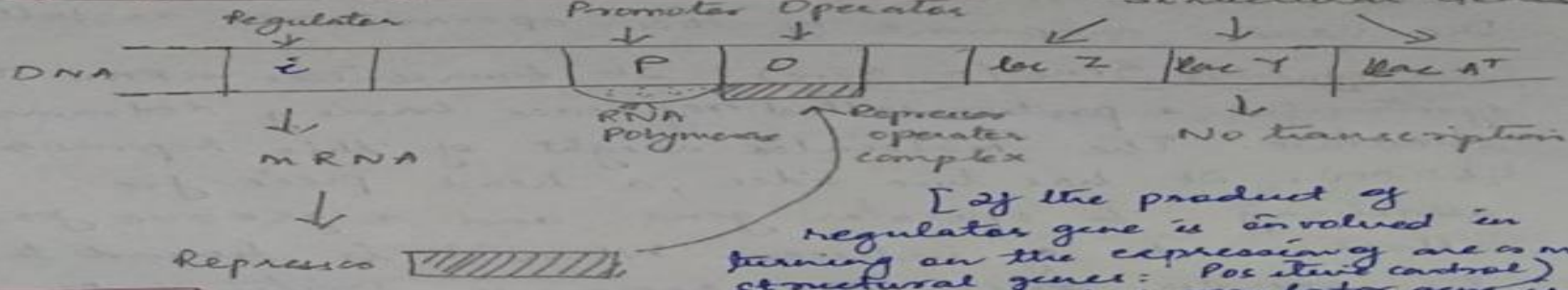
The bacterial genes which have related functions are clustered and under the control of a single promoter.

•These genes are transcribed together in a single mRNA. Thus, in prokaryotes, the genes with related functions are coordinately regulated genetic units called the 'Operons'.

•The Operon model was developed by Francois Jacob and Jacques Monod in 1961

•Awarded Nobel Prize in physiology and medicine in year 1965) to explain the regulation of genes required for utilization of lactose in *E.coli.*

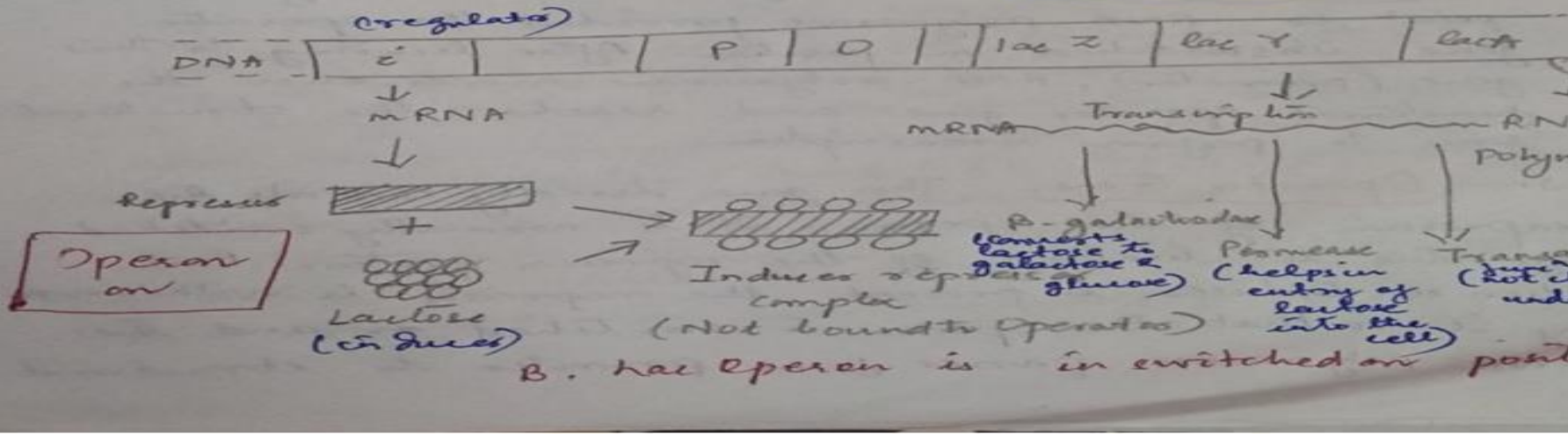
Organization of Lac - Operon :— (Negative inducible Operon)



Operon off

[If the product of regulator gene is involved in turning on the expression of one or more structural genes: Positive control)
And if product of regulator gene is involved in turning off the expression of structural genes: negative control mechanism)

A. Lac Operon is in switched off position



B. Lac Operon is in switched on position

B. CONTROL OF CATALYSIS

The activity of enzyme is regulated by altering the catalytic activity of the enzme.

Important mechanisms of this type are : Feedback inhibition, allosteric regulation and covalent modulation.

1. Feedback ihibition: (Discussed earlier)
2. Allosteric regulation (Discussed earlier)
3. Covalent modulation

3. Covalent Modulation

Enzyme activity is also controlled by covalent modifications of the enzymes.

Covalent modifications cause conformational changes in the enzymes.

These conformational changes are brought about by

i) covalent bonding of a phosphate group (phosphorylation) to the polypeptide chain or

ii) by removal of a small polypeptide chain by a process known as proteolysis.And these covalent modifications stimulate enzyme activity.

Examples of covalent modulation:

- Covalent modifications stimulate enzyme activity.
- For eg: the conversion of glycogen into glucose-1- phosphate is catalysed by an enzyme glycogen phosphorylase. Now,glycogen phosphorylase occurs in two forms:phosphorylase a the active form and phosphorylase b, the relatively inactive form. These two forms are interconvertible.
- Phosphorylase b is converted into active phosphorylase a by covalent binding of phosphate groups.The enzyme involved in this conversion is phosphorylase kinase.The process is reversible as the phosphate groups can be removed by dephosphorylation by an enzyme phosphorylase phosphatase.
- Another example: the digestive enzymes trypsin and pepsin are synthesized in their inactive forms trypsinogen and pepsinogen respectively and are brought to their active states by covalent modifocations

REGULATION BY HORMONES

Lipid derived hormones pass through the cell membrane into the cytoplasm as they are relatively small and lipid soluble.

In the cytoplasm, the lipid derivative hormones combine with certain metabolites called receptor molecules and form hormone receptor complex. This complex moves into the nucleus where it activates the related genes for enzyme synthesis.

Other hormones which are proteinaceous in nature are called primary messengers. They are unable to pass through the cell membrane, so they bind to the specific receptor site on the cell surface of the target cell. This binding is a signal that increases the concentration of another metabolite in the cytoplasm called secondary messenger which then activates the related enzyme, For eg : cAMP and Calcium ion.

CONTROL BY CALCIUM

In eukarotes, calcium is involved in the regulation of processes like, contraction, secretion, endocytosis, and more general processes like cell motility, cell growth and cell division.

The enzymes are regulated by a calcium binding protein called calmodulin that modulates the effect of cytoplasmic calcium.

Calmodulin undergoes conformational changes after binding with calcium and allters the activities of many of its target enzymes.

CELL COMPARTMENTATION

Regulation of enzyme activity is achieved by physical separation of the enzyme systems.

In eukaryotes one of the regulatory mechanisms is the separation and localisation of specific groups of enzymes in membrane bound compartments in the cell.

Different metabolic pathways take place in these different intracellular locations which are called organelles. For eg. Kreb's cycle in mitochondria and Glycolysis in the cytoplasm.

THANK YOU