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Regulation of Gene Expression :→

- Gene regulation is the mechanism of switching off and switching on the genes depending upon the require-ments of the cells and the state of developement.

- There are two types of gene

(1) Housekeeping genes :- These are genes which are continuously expressing themselves in all the cells of body. These genes are constitutive genes.

(2) Non-constitutive genes or Luxury genes or Regulated genes :- These are genes which are not expressing their effects all the time in all the cells.

Gene regulation are of two types.

+ve Regulation
* In this case specific protein (activator) is required for trans-cription to begin.

-ve Regulation
* In this case binding of specific protein (repressor) inhibits transcription from occuring

In Eukaryotes gene regulation could be exerted at

(a) Transcriptional level (formation of primary transcript)

(b) Processing level (Regulation of splicing)

(c) transport of m-RNA from nucleus to cytoplasm

(d) translational level.

* The genes in a cell are expressed to perform a particular function or a set of functions.

for example

Lactose $\xrightarrow{\beta\text{-galactosidase}}$ Glucose + Galactose

↓ Bacteria use them as source of energy.

If Bacteria do not have lactose around them to utilize for energy source, they would no longer require the synthesis of the enzyme β-galactosidase.

∴ We can say " It is the metabolic, physiologi-cal or environmental conditions that regulate the expression of genes.

** The development and differentiation of embryo into adult organisms are also a result of the co-ordinated regulation of expression of several sets of genes.

⇒ In Prokaryotes, control of the rate of trans-criptional initiation is the predominant site for control of gene expression

- In a transcription unit, the activity of RNA polymerase at a given promoter is in turn regulated by interaction with accessory proteins which affect its ability to recognise start site

* These regulatory proteins can act both positively (activators) and negatively (repressors).

* The accessibility of promoter regions of prokaryotic DNA is in many cases regulated by the interaction of proteins with sequences termed operators.

* The operator region is adjacent to the promoter elements in most operons and in most cases the sequences of the operator bind a repressor proteins.

For eg. Lac operator is present only in Lac operon and it interects specifically with Lac repressor only.

The Lac Operon :-

* francois Jacob (Geneticist) & Jacque Monod (Biochemist) in 1961 were first to explain a transcriptionally regulated system. They propose this model of regulation by studying metabolism in E. coli. This is known as OPERON MODEL.

In Lac operon, a polycistronic structural gene is regulated by a common promoter and regulatory genes. such arrangement is very common in bacteria and is referred to as OPERON. other such operons are Lac operon, trp operon, ara operon, his operon, val operon etc.

(i) structural gene :- Trancribes m-RNA for Polypeptide synthesis

(ii) Operator gene :- It is a gene which receives the products of regulator gene. It allows the functioning of the operon when it is not covered by the biochemical produced by regulator gene.

(iii) Promoter Gene :- Provide attachment site for RNA polymerase.

(iv) Regulator gene :- It synthesises a regulator protein which can act +vely as activator and negatively as repressor. It controls, the activity of operator gene.

* Lac operon consists of one regulatory gene (the i-gene here the term 'i' does not refer to inducer, rather it is derived from the word inhibitor) and three structural genes (z, y and a)

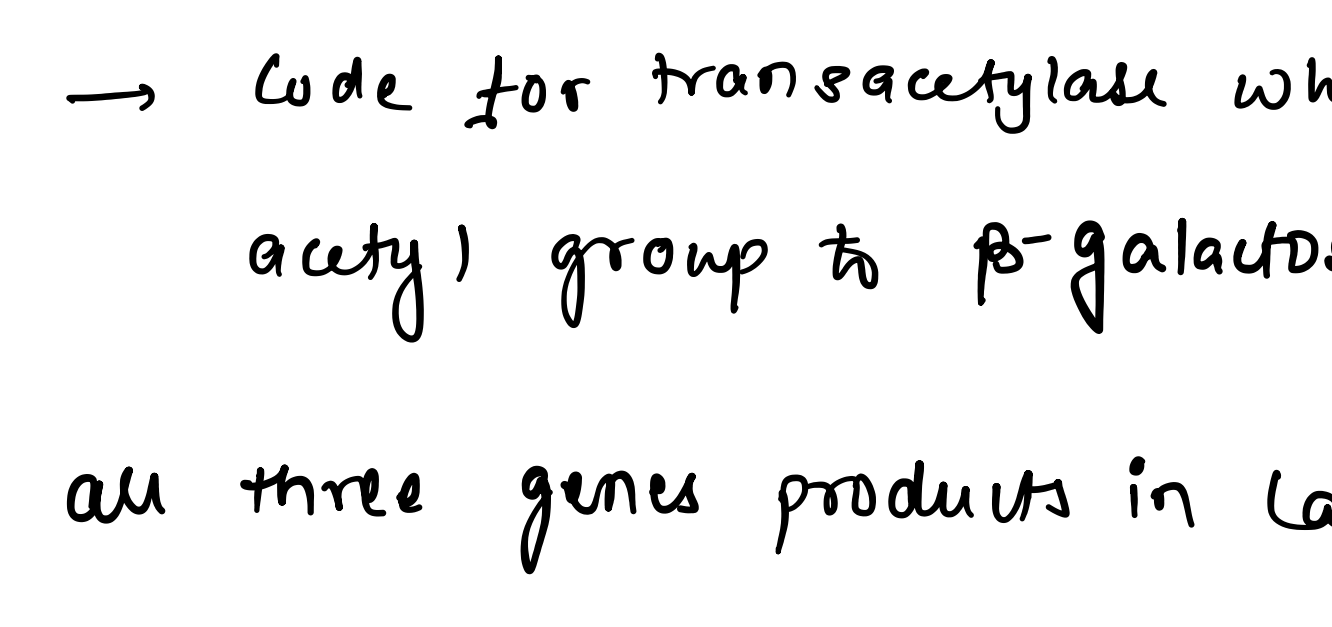
i-gene → Code for repressor of lac operon

z-gene → code for beta-galactosidase (β-gal) which is primarily responsible for the hydrolysis of the disaccharide, lactose into its monomeric units, galactose and glucose.

y-gene → Code for permease, which increases the permeability of the cell to β-galacto sides.

a-gene → Code for transacetylase which transfer acetyl group to β-galactoside

Hence, all three genes products in lac operon are required for metabolism of lactose.



* Lactose is the substrate for the enzyme β-galactosidase and it regulates switching on and off of the operon. Hence it is termed as Inducer.

* In the absence of a preferred carbon source such as glucose, if lactose is provided in the growth medium of the bacteria, the lactose is transported into the cells through the action of permease (Remember, a very low level of expression of lac operon has to be present in the cell all the times otherwise lactose can not enter the cells). The lactose then induces operon in the following manner.'

* The repressor of the operon is synthesized (all the time - Constitutively) from the i-gene.

* The repressor protein binds to the operator region of the operon and prevents RNA-polymerase from transcribing the operon.

* In the presence of an inducer, such as lactose or allolactose, the repressor is inactivated by interaction with the inducer. This allow RNA-Polymerase access to the promoter and transcription proceeds

* Essentially, regulation of lac operon can also be visualised as regulation of enzyme synthesis by its substrate.

* Remember, glucose or galactose can not act as inducers of Lac operon.

* Regulation of lac operon by repressor is referred to as negative regulation.

* Lac operon is under control of Positive regulation as well.