REGULATION OF PROTEIN SYNTHESIS

The genes can be switched on or off depending on:

1. Position of a cell in the body. 2. Stage of body development. 3. The external environment.

There are 2 types of genes:

Constitutive gene expressed continuously (same amount at all time). Synthesize enzyme needed all time (e.g: enzyme of glycolysis).

Regulated gene expressed according to presence or absence of chemical stimuli

(synthesize on call). Synthesize enzyme needed for metabolism of lactose or synthesis of amino acid according to need.

N.B: Both types of genes have regulatory mechanisms but the controls of constitutive gene are invariant but control of regulated genes is modified.

Regulation of genes exerted at:

- The transcriptional level (gene transcribed when conditions are suitable).

• The transnational level (mRNA translated when ribosomal machinery is active).

Operon System

In E. coli control of gene activity, i.e. repression or induction is operative at the transcriptional level (need genetic controlling elements). These elements are DNA segments lay very close to the genes which they control respond to environmental signals and allow or disallow mRNA synthesis (transcription).

The operon was first described by Jacop and Monod in 1961 as a controlling element for the genes involved in lactose utilization in E.coli. The elements necessary in gene regulation in E.coli are:

- The Structural gene whose transcription to be regulated.
- Promoter is a sequence of nucleotides act as recognition site for RNA polymerase binding between them initiates transcription of structural genes.

• Operator is a sequence of nucleotides between promoter & structural gene binding between it & regulator protein promotes or prevents transcription.

• Regulator protein produced by regulator gene which not needs to be close to the operon.

• Effector molecule may be inducer as sugar (lactose and galactose) or co-repressor as amino acid (histidine). It can bind to the regulator protein and change its ability to interact with the operator so promote or prevent transcription.

Types of operon:

Inducible operon work on catabolism e.g. Lac operon (break down of lactose).

Repressible operon work on biosynthesis e.g. Histidine operon (amino acid synthesis as histidine).

Lac Operon in E. coli

• It consists of three structural genes involved in lactose degradation in E.coli:

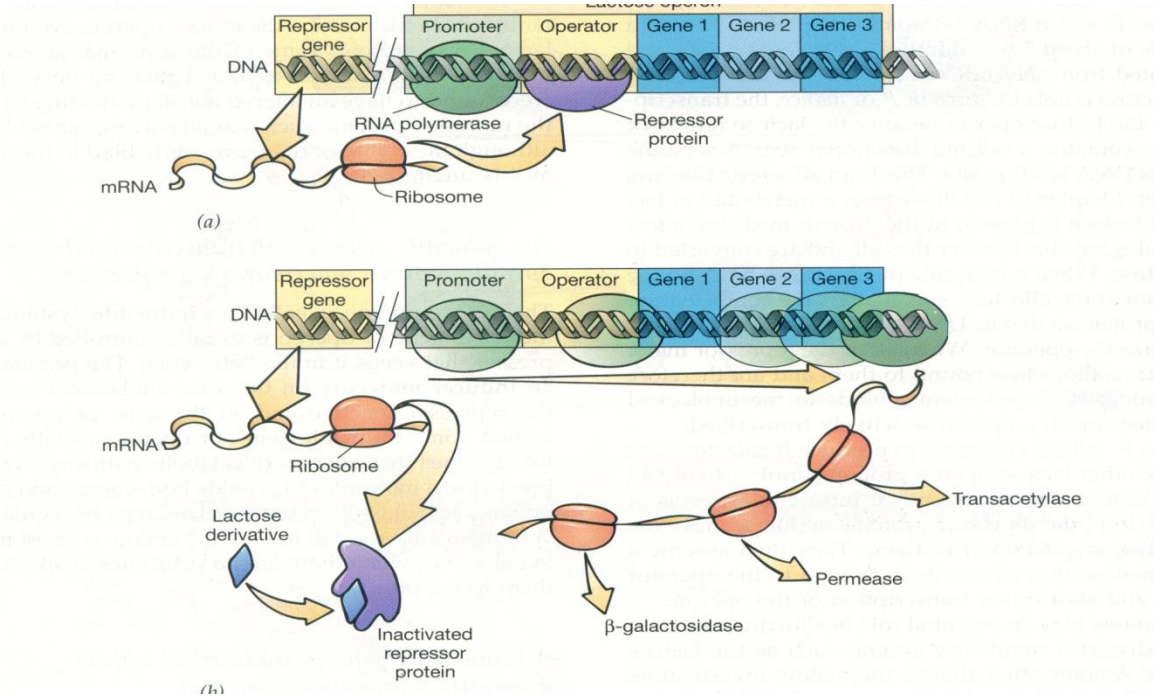
1. Lac z: specifies an enzyme (ß-galactosidase catalyzes hydrolysis of lactose into galactose and glucose).

2. Lac y: specifies a protein (M-protein or galactoside permease located in bacterial membrane facilitates uptake of lactose from external medium).
3. Lac a: specifies enzyme (thiogalactoside transacetylase, unknown function deletions of it bacteria behave normally).

In inducible operon if effector (inducer as lactose) present, inducer bind with repressor (inactive complex) cannot bind with operator so RNA polymerase bind to promoter then initiate

transcription of enzyme need for catabolism (operon on).

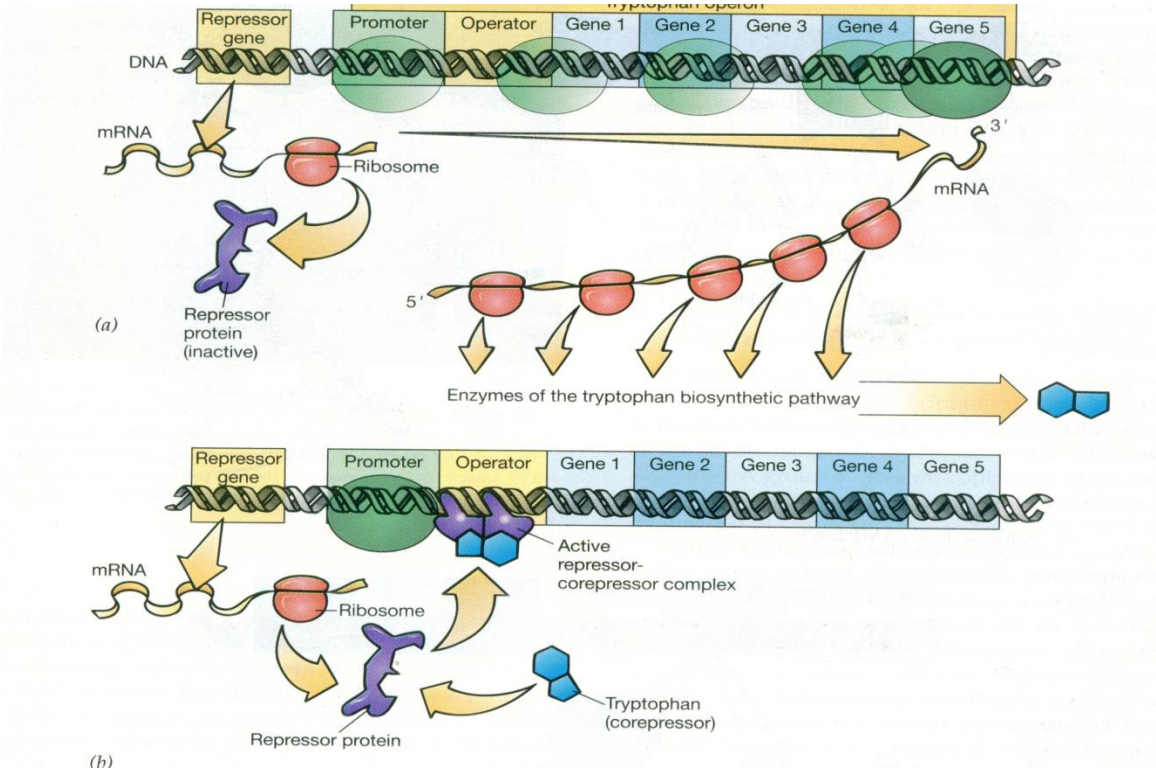
If inducer not presents to bind with repressor (active repressor) bind with operator so RNA polymerase cannot bind to promoter inhibit transcription of enzyme need for catabolism (operon off).



Histidine Operon in Salmonella typhimurium

- The synthesis of histidine from phosphoribosyl pyrophosphate takes place in 10 steps which involve 9 enzymes (two steps are controlled by one enzyme).

In repressible operon if effector (co-repressor as histidne) presents co-repressor bind with repressor (active complex) bind with operator so RNA polymerase cannot bind to promoter lead to inhibition of transcription of enzyme need for synthesis (operon off). If co-repressor not present to bind with repressor (inactive repressor) cannot bind with operator so RNA polymerase bind to promoter and initiate transcription of enzyme need for synthesis (operon on).


Repressor gene
Promoter
Operator
Gene 1
Gene 2
Gene 3
Gene 4
Gene 5
DNA
mRNA
Ribosome
3′
mRNA
5′
Repressor protein (inactive)
(a)
Enzymes of the tryptophan biosynthetic pathway
Repressor gene
Promoter
Operator
Gene 1
Gene 2
Gene 3
Gene 4
Gene 5
Active repressor-corepressor complex
mRNA
Ribosome
Tryptophan (corepressor)
Repressor protein
(b)