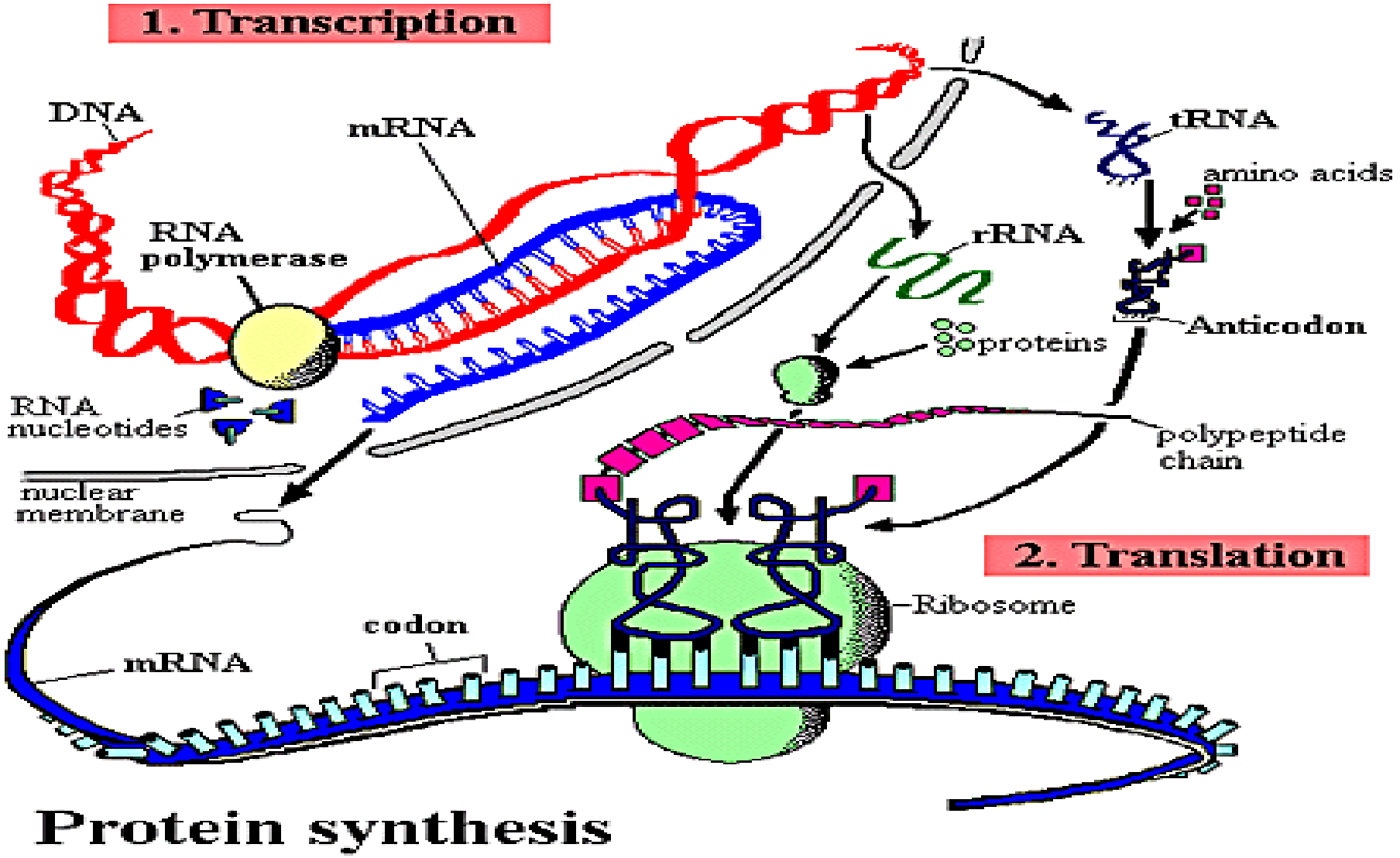
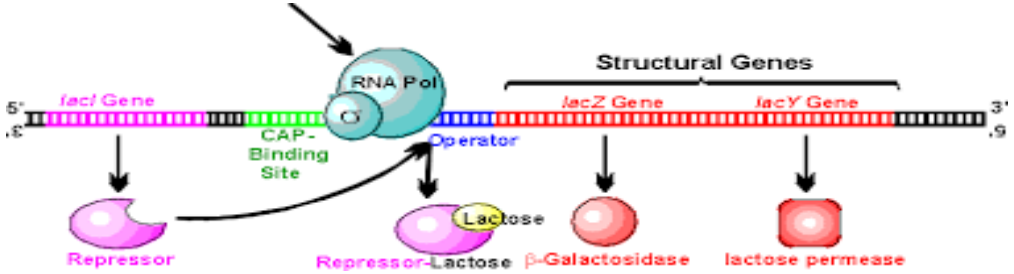
RECAP



Protein synthesis

WHAT IS GENE EXPRESSION



- Gene expression is the process by which the genetic code - the nucleotide sequence - of a gene is used to direct protein synthesis and produce the structures of the cell.
- Genes that code for amino acid sequences are known as 'structural genes'.
- The process of gene expression involves two main stages:
- **Transcription:** the production of messenger RNA (mRNA) by the enzyme RNA polymerase, and the processing of the resulting mRNA molecule.
- **Translation**: the use of mRNA to direct protein synthesis, and the subsequent post-translational processing of the protein molecule.

Lets Say

DNA –mRNA – PROTEIN

DNA expresses itself to make PROTEINS whenever required. How much ,when and where is controlled by gene…this is gene regulation

- The on and off states of all of a cell's genes is known as a GENE EXPRESSION PROFILE.
- When a gene is "on" and its protein or RNA product is being made, scientists say that the gene is being EXPRESSED.
- Each cell type has a unique gene expression profile.

Slide adapted from Genetic Science Learning Center, University of Utah © 2013

LEVELS OF REGULATION OF GENE ACTION

- The mechanism by which the expression of different genes is controlled in different tissues/and /or at different times is called gene regulation or regulation of gene expression or regulation of gene action.
- Gene regulation is very essential for growth, development and differentiation.

LEVELS OF REGULATION OF GENE ACTION

- The expression of gene may be subject to regulation at one or more of the following:
- Gene regulation is essential for viruses, prokaryotes and eukaryotes as it

increases the versatility and adaptability of an organism by allowing the cell to express protein when needed

1. Gene amplification, destruction or distribution..
2. Regulation of Transcription
3. Post transcriptional Regulation
4. Translational Regulation
5. Post translational regulation

- The regulatory mechanisms with the largest effects on phenotype act at the level of transcription.

LEVELS OF REGULATION OF GENE ACTION

- The expression of gene may be subject to regulation at one or more of the following:

1. Gene amplification, destruction or distribution..products needed in large quantities have multiple copies of genes, not required remain in extrachromosomal state…produced at specific times and digested ..this is amplification

2. Regulation of Transcription…gene regulation determines whether a given gene will be transcribed or not in a given cell at a given time(universal)

3. Post transcriptional Regulation…Control after transcription determines if the mRNA produced by a gene is available for translation

Example :After transcription has taken place, the mRNA molecule can be altered to regulate gene activity. For example, researchers have found that an mRNA molecule contains many useless bits of RNA that are removed in the production of the final mRNA molecule. These useless bits of nucleic acid are called *introns.* The remaining pieces of mRNA, called *exons,* are then spliced to form the final mRNA molecule. Thus, through removal of introns and the retention of exons, the cell can alter the message received from the DNA and control gene expression.

4. Translational Regulation…Controls if an mRNA will be translated or not eg: in autogenous regulation a ribosomal protein made by mRNA binds to its own mRNA and prevents translation.

5. Post translation….governs activity of the proteins products of genes., mainly involves –protein modification,protein degradation and feed back inhibition.

Levels of regulation in bacterial gene expression

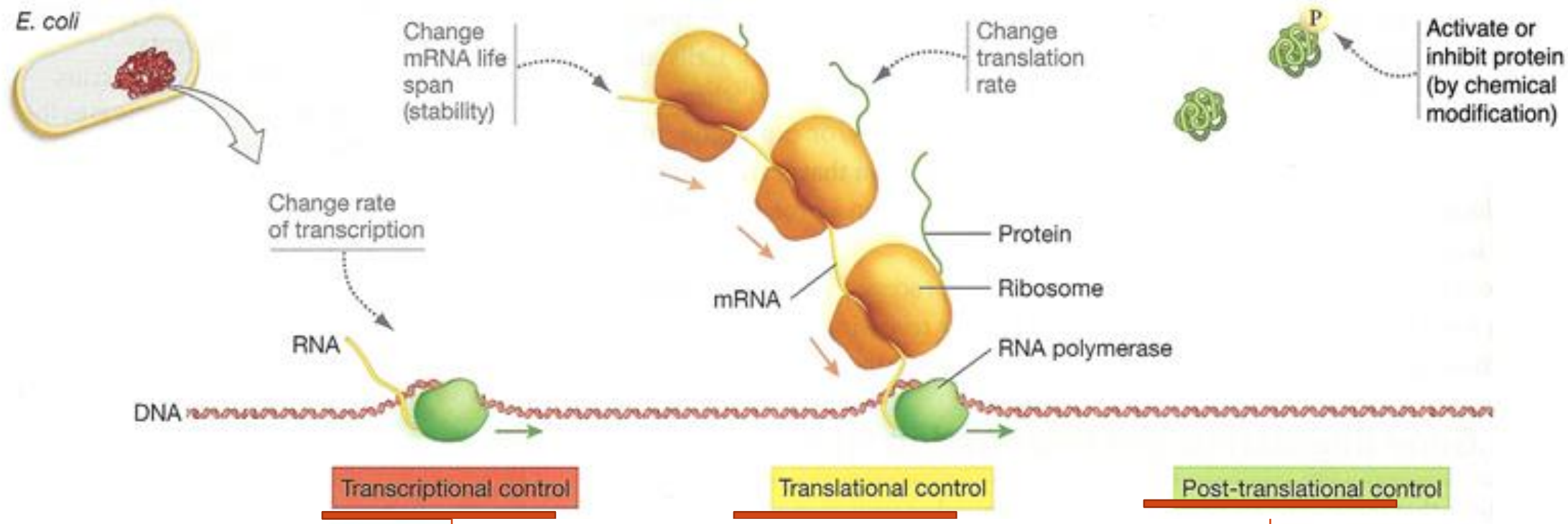


FIGURE 17.1 Gene Expression in Bacteria

✓**EXERCISE** Label the mode of regulation that is the slowest in response time, and that which is fastest. Label the most efficient and least efficient in resource use.

What are the three types of gene expression

3 types of gene expression

- Constitutive gene expression
  - → essential genes for living cells
  - → housekeeping genes
- Inducible gene expression
  - → enzymes in catabolic pathways
- Repressible gene expression
  - → enzymes in anabolic pathways

GENE EXPRESSION--CONSTITUTIVE GENE EXPRESSION

- Constitutive gene expression- Certain gene products- tRNA moecules, rRNA molecule, ribosomal proteins, RNA Polymerase subunits, and enzymes catalyzing metabolic processes - cellular HOUSE KEEPING functions- are the essential components of almost all the living cells.

 Genes that specify products – expressed in most cells. Such genes are to be expressed constituently (always)- referred to as CONSTITUTIVE GENES

Other gene products are needed for cell growth only under certain environmental conditions (aerobics and anaerobics).

Regulatory mechanisms allow the synthesis of these gene products only when they are needed

Bacteria and viruses, exhibit highly efficient mechanisms for the control of gene expression

GENE EXPRESSION-INDUCIBLE

Inducible-Genes that are transcribed and translated at higher levels in response to an inducing factor

- Example of inducible genes: Enzymes in catabolic pathway

Escherichia coli and most other bacteria are capable of growth using any one of several carbohydrates—for example, glucose, sucrose, galactose, arabinose, and lactose—as an energy source.

- If glucose is present in the environment, it will be preferentially metabolized by *E.coli* cells. However, in the absence of glucose, *E. coli* cells can grow very well on other carbohydrates.

Suppose if lactose is present :

In order to digest lactose it needs enzymes as it's a disaccharide. It neds to synthesize enzymes. To digest it. (The synthesis of these two enzymes requires considerable energy.

Cells growing in medium containing the sugar lactose, for example, as the sole carbon source synthesize two enzymes, -galactosidase and - galactoside permease, which are uniquely required for the catabolism of lactose. –

Galactoside permease pumps lactose into the cell, where - galactosidase cleaves it into glucose and galactose)

Thus, *E. coli* cells have evolved a regulatory mechanism by which the synthesis of these lactose-catabolizing enzymes is turned on in the presence of lactose and turned off in its absence.

- This process of turning on the expression of genes in response to a substance in the environment is called **induction.**

- Genes whose expression is regulated in this manner are called **inducible genes;** their products,if enzymes, are called **inducible enzymes.**

REPRESSIBLE GENES ARE

Repressible genes are whose transcription and translation decreases in response to a repressing signals.

- Enzymes in anabolic pathway.

A gene whose expression has been turned off in this way is said to be "repressed"; the process is called **repression.**

- When the expression of this gene is turned on, it is said to be "derepressed"; such a response is called **de-repression.**

- Enzymes that are components of **anabolic** (biosynthetic) **pathways** often are repressible.

Repression, like induction, occurs at the level of transcription.

- When E. coli cells are present in an environment containing enough tryptophan to support optimal growth, the continued synthesis of the tryptophan biosynthetic enzymes would be a waste of energy.

Thus, a regulatory mechanism has evolved in E. coli that turns off the synthesis of the tryptophan biosynthetic enzymes when external tryptophan is available.

Gene Expression

Types of expression	Definition	Type of genes
Constitutive (unregulated)	Genes are always ON	Housekeeping genes (regulatory genes)
Inducible (regulated)	Genes are only turned on as needed	Structural genes
Repressible (regulated)	Genes are only turned off as needed	Structural genes

In Prokaryotes there are three regulatory elements that control gene expression

1. ***Structural genes*** – genes that code for a specific polypeptide (protein).

2. ***Promoter*** – DNA segment that is recognized by RNA polymerase.

3. ***Operator*** – element that serves as a binding site for an inhibitor protein that blocks transcription.

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