

GENE REGULATION **AND PROBLEMS OF** **DEVELOPMENT**

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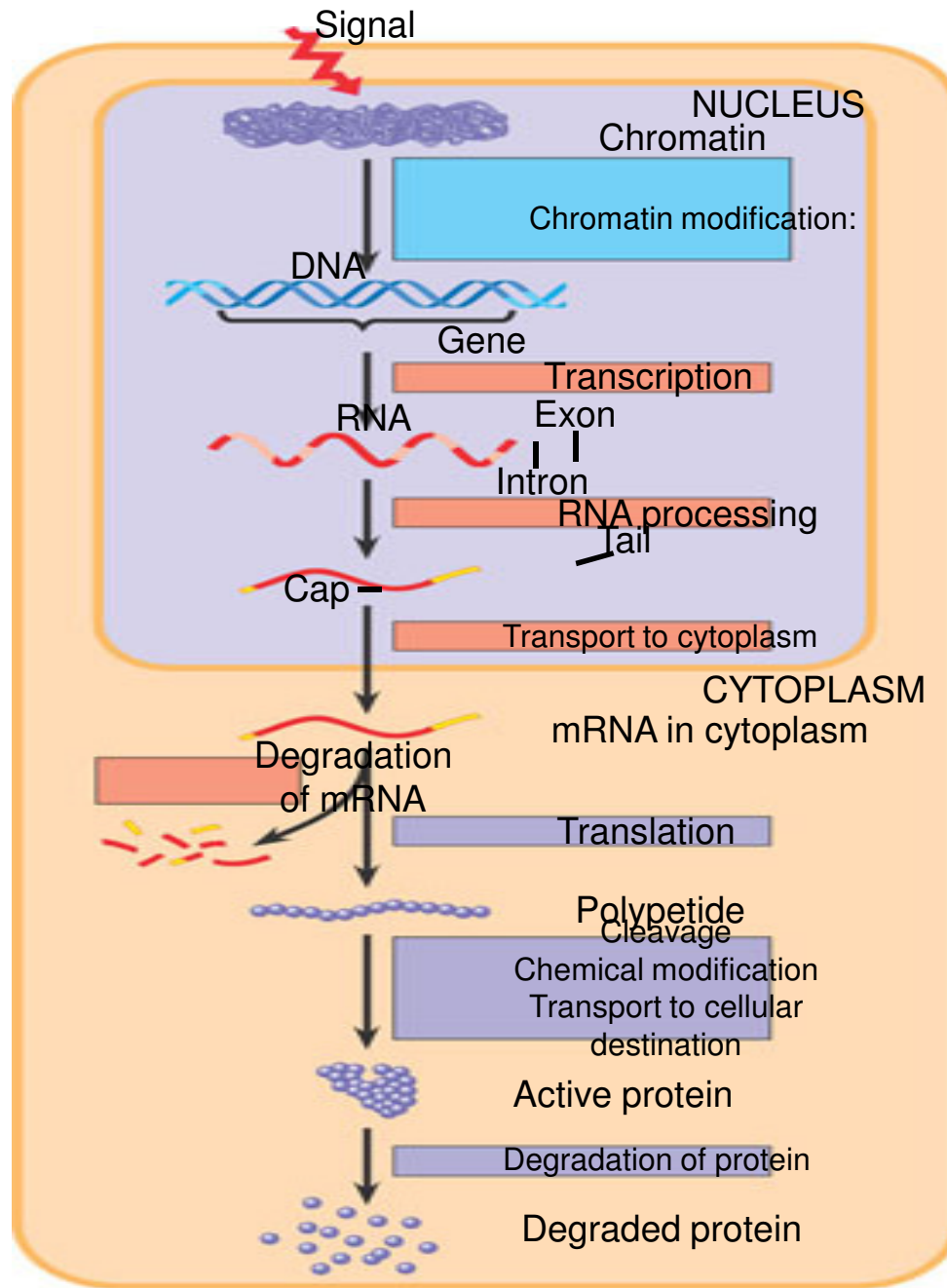
GENE REGULATION

Gene is a segment of DNA that codes for a unit of function (polypeptide, rRNA, tRNA) or regulates some functional unit.

Gene expression refers to the molecular mechanism by which a gene shows its potential in the phenotype of an organism.

Regulation of Gene Expression

The mechanism which stimulates the expression of certain genes and inhibits the expression of others as required in the cell is called control or regulation of gene expression.



Gene available for transcription

Primary transcript

mRNA in nucleus

CYTOPLASM
mRNA in cytoplasm

Types of Genes

1. Constitutive Genes
2. Non Constitutive Genes
3. Structural Genes
 - a) Polypeptide-coding genes
 - b) Polyprotein-coding genes
 - c) RNA-coding genes
4. Regulator Genes
5. Operator Genes

6. Promoter Genes
7. Terminator Genes
8. Split Genes
9. Overlapping Genes
10. Non functional Genes
11. Transposons (Jumping Genes)
12. Modifier Genes
13. Pseudogenes

Gene Regulation

How Does A Cell Know?

Which Gene To **Express**

&

Which Gene Should Stay
Silent?

Gene Regulation

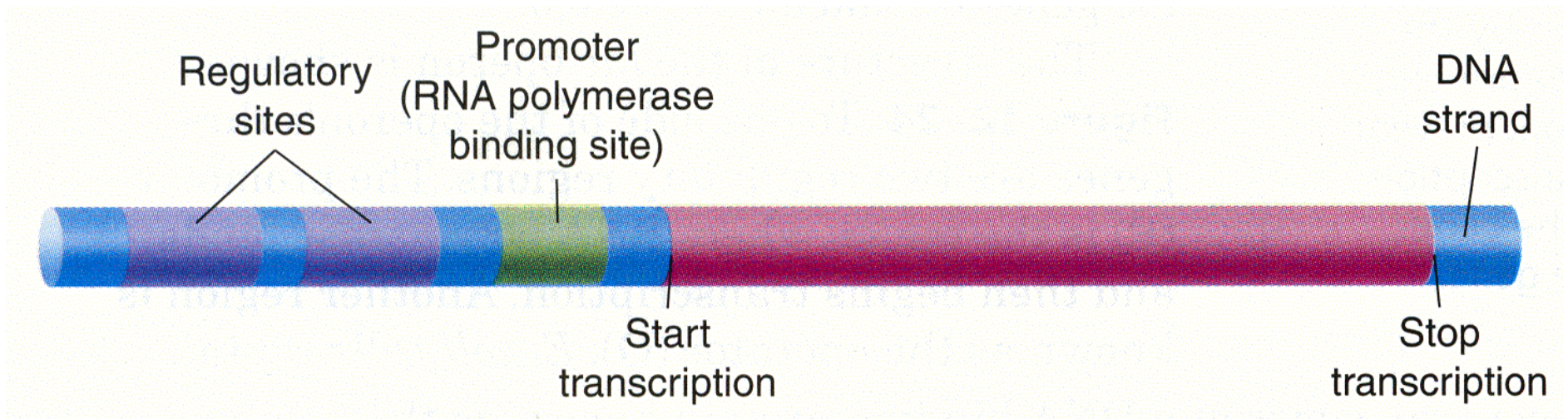
- When a Gene is **Expressed**:
 - It Is Transcribed Into mRNA

- When a Gene is **Silent**:
 - It Is Not Transcribed

Gene Regulation

- Expression Regulated By
 - **Promoters**
 - RNA Polymerase Binding Sites
 - Certain DNA Base Pair Sequences
 - **Start & Stop Base Pair Sequences**
 - **Regulatory Sites**
 - DNA Binding Proteins
 - Regulate Transcription

Gene Regulation



Types of operons

- 1 Inducible Operon

e.g lac operon

- 2 Repressible Operon

e.g trp operon

Prokaryote Gene Regulation: lac Operon

- **What is an Operon?**
 - **Group of Genes That Operate Together**
- **For Example:**
 - **E. coli ferments lactose**
 - **To Do That It Needs Three Enzymes (Proteins), It Makes Them All At Once!**
 - **3 Genes Turned On & Off Together. This is known as the lac Operon (lactose Operon)**

Gene Regulation: lac Operon

The lac Operon

- Regulates Lactose Metabolism
- It Turns On Only When Lactose Is Present & Glucose is Absent.

Lactose is a **Disaccharide**

- **A Combination of Galactose & Glucose**

To Ferment Lactose E. coli Must:

1. Transport Lactose Across Cell Membrane
2. Separate The Two Sugars

Gene Regulation: lac Operon

Each Task Requires A Specific Protein

but

Proteins Not Needed If Glucose Present

(why waste energy if you already have food?)

so

Genes Coding For Proteins Expressed

Only When There Is No Glucose

Present But Lactose Is Present

Gene Regulation: lac Operon

Key Concept:

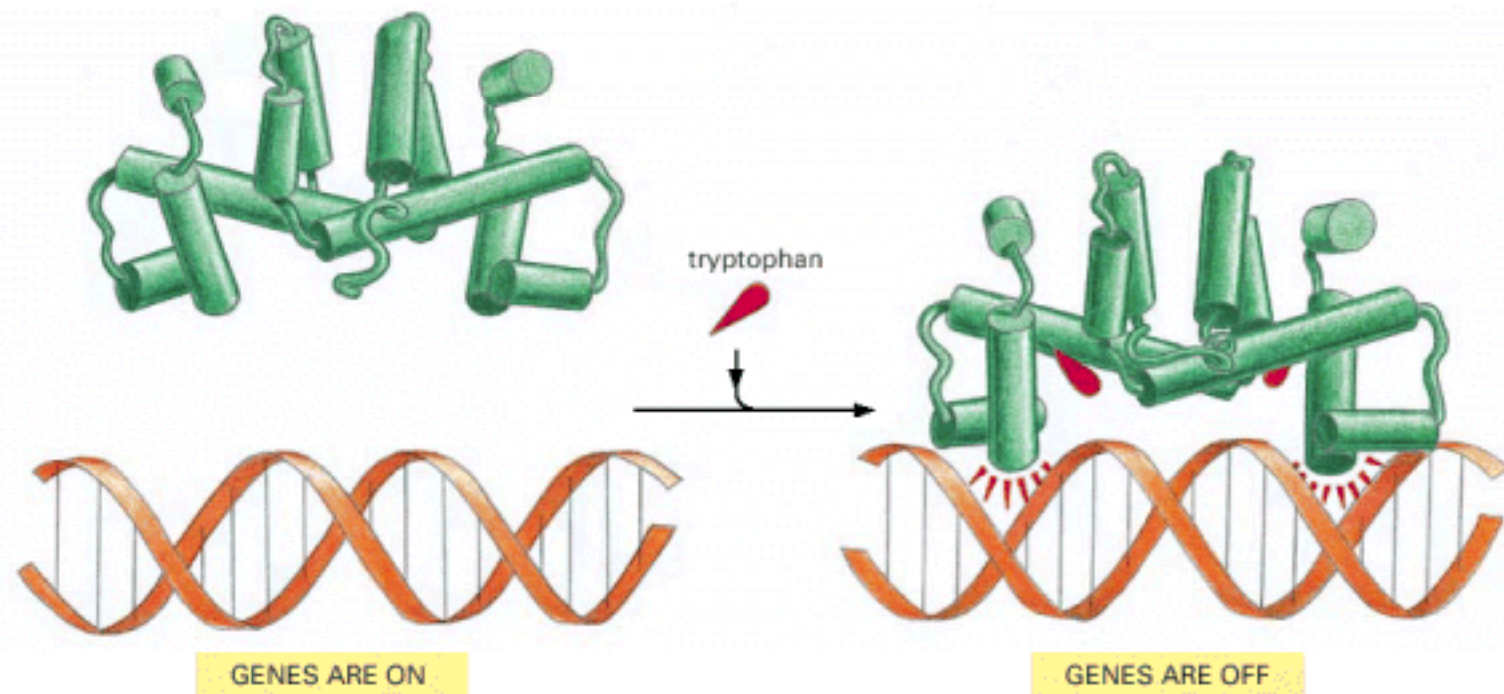
The lac Genes Are:

Turned Off By Repressors

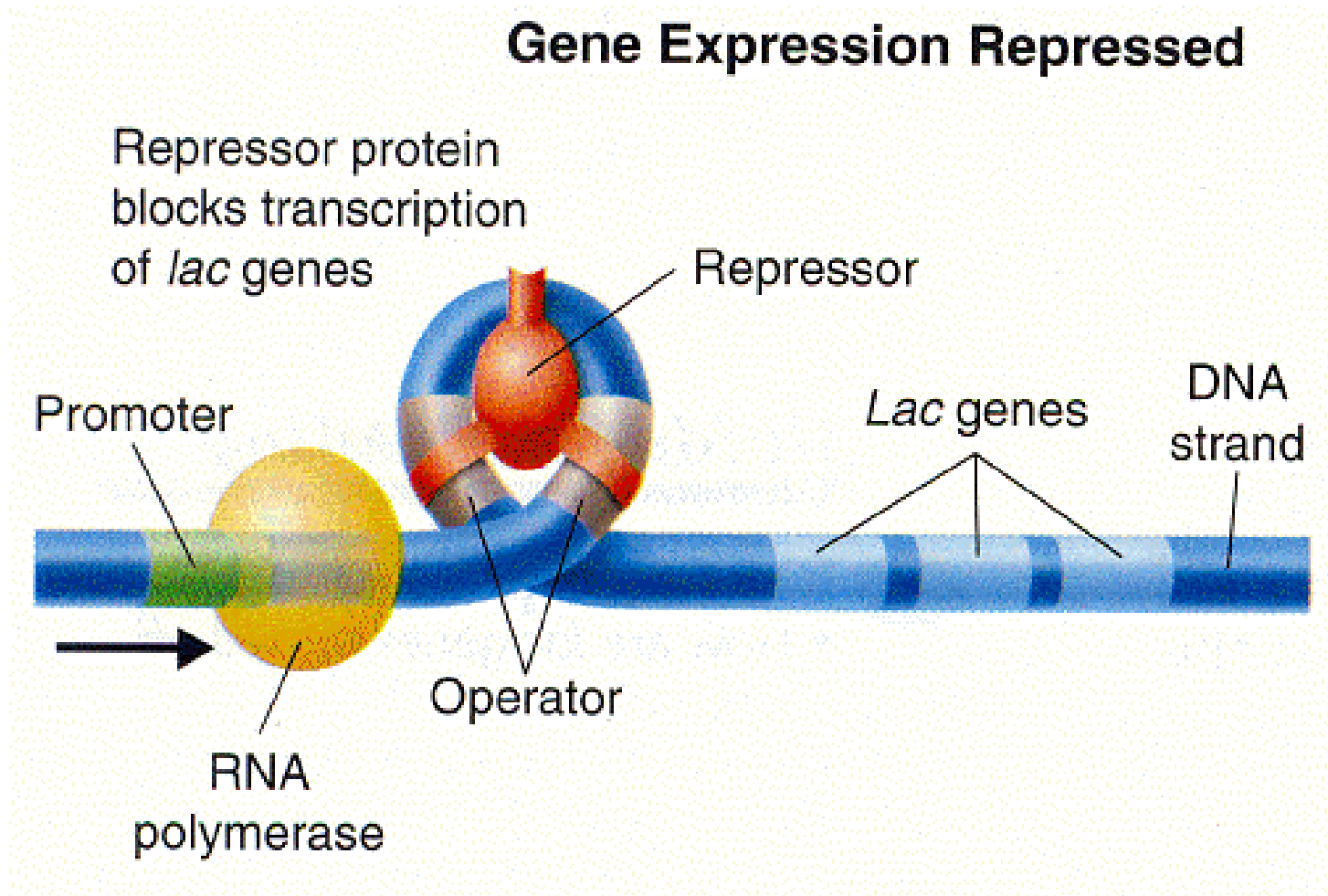
And

**Turned On By The Presence
Of Lactose**

How do genetic switches work?

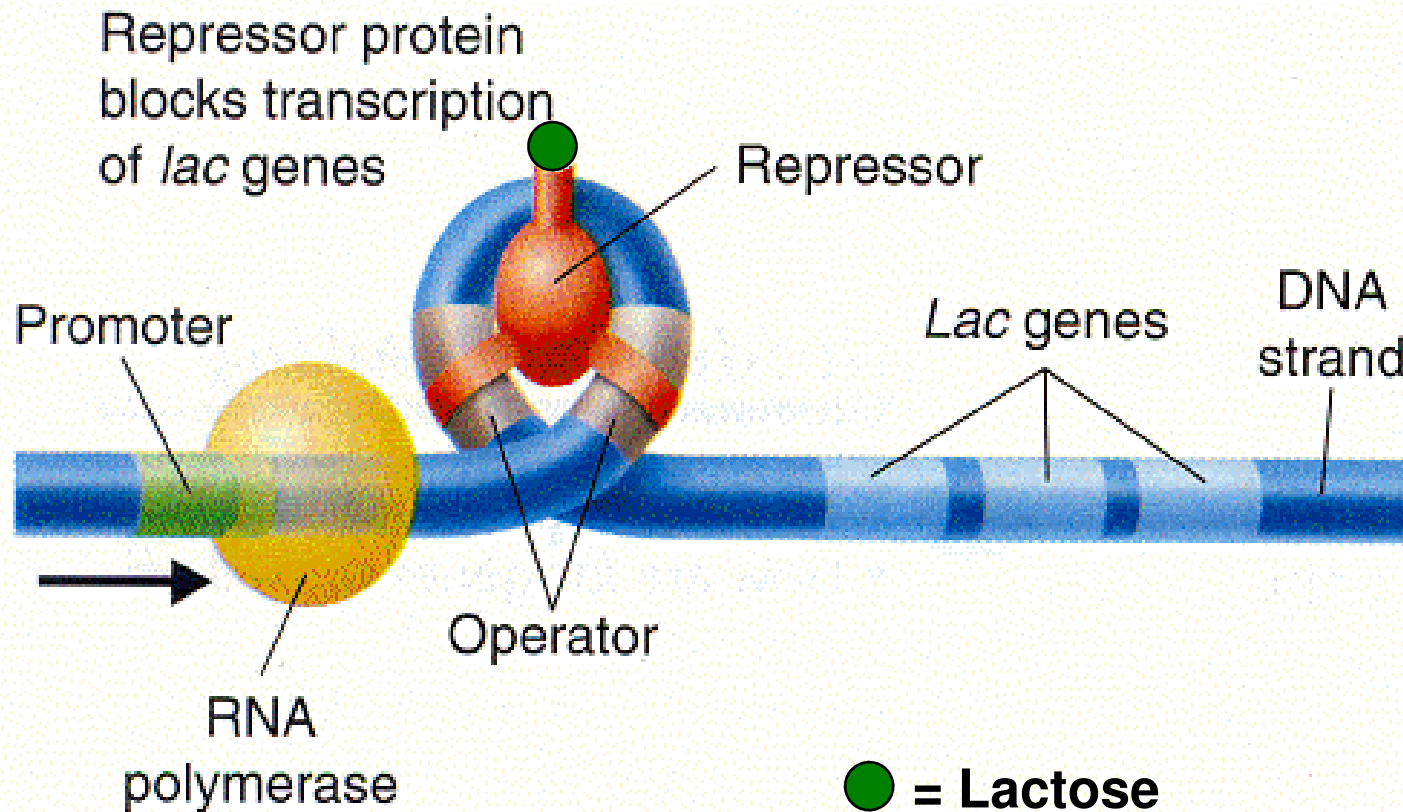


Gene Regulation: lac Operon

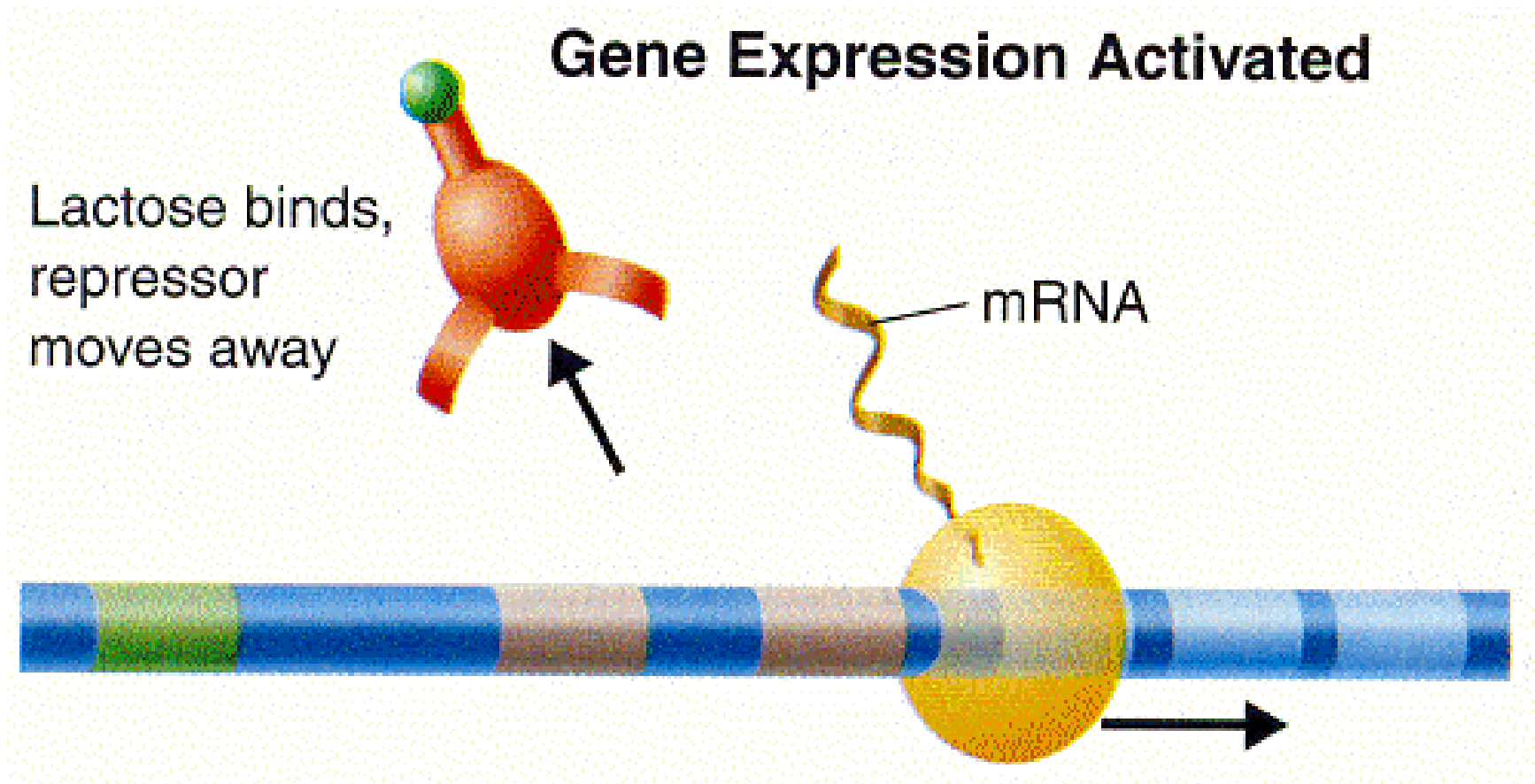


Gene Regulation: lac Operon

ADD LACTOSE

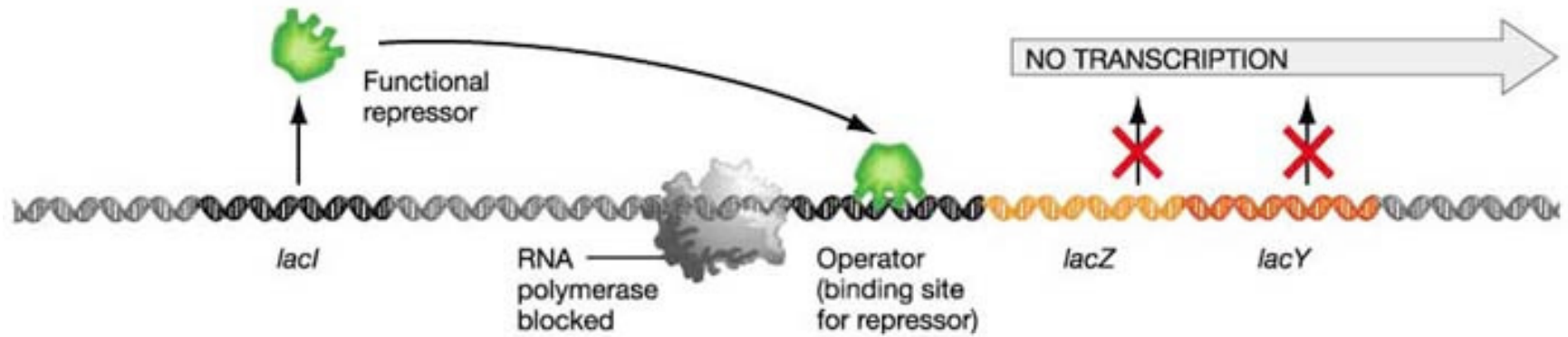


Gene Regulation: lac Operon

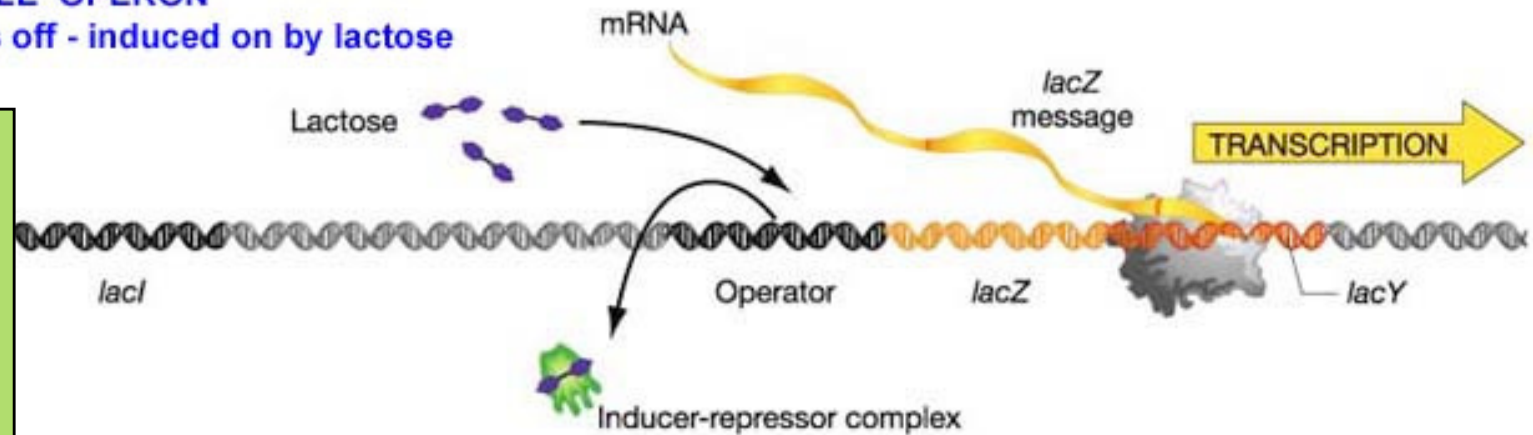


Lac operon

Inducible operons are normally off



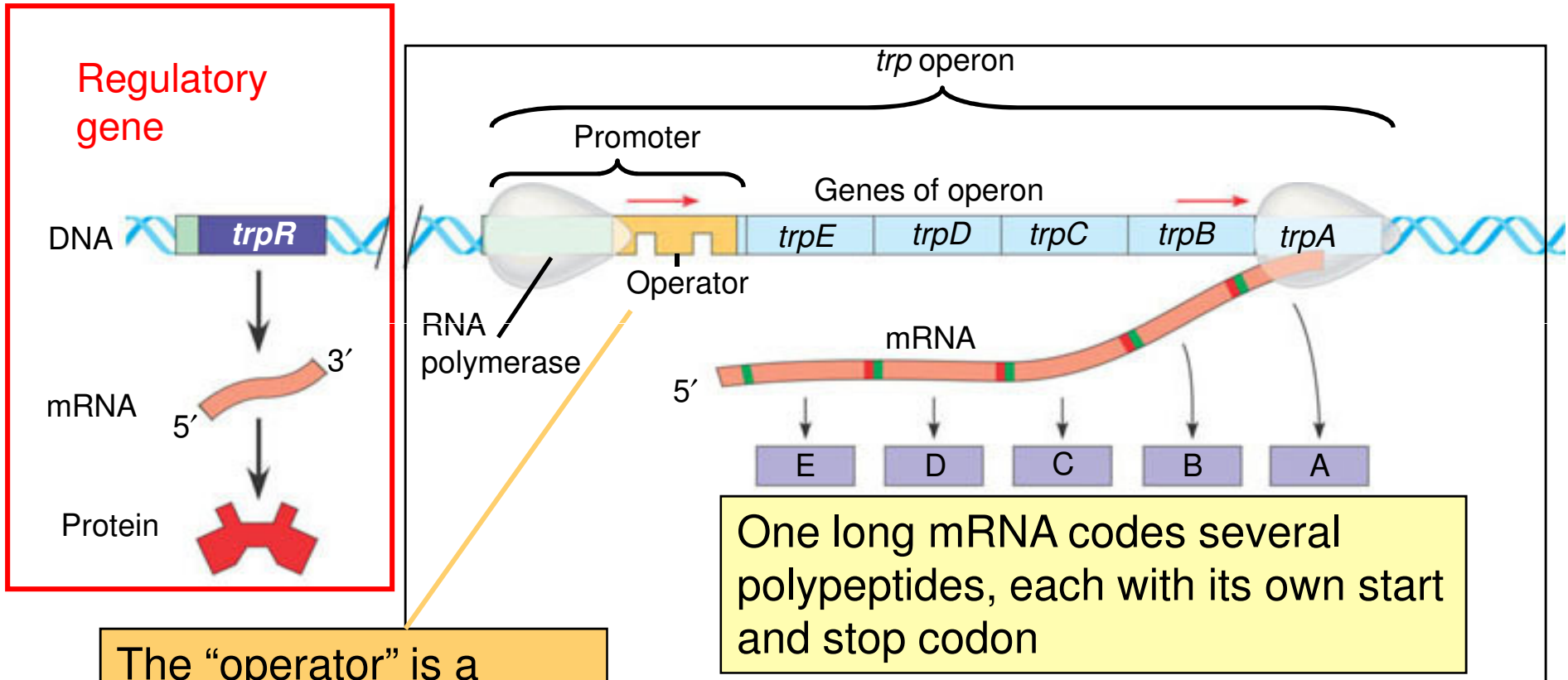
INDUCIBLE OPERON
always off - induced on by lactose



When lactose is present, repressor can no longer bind DNA. Transcription occurs

The *trp* operon:

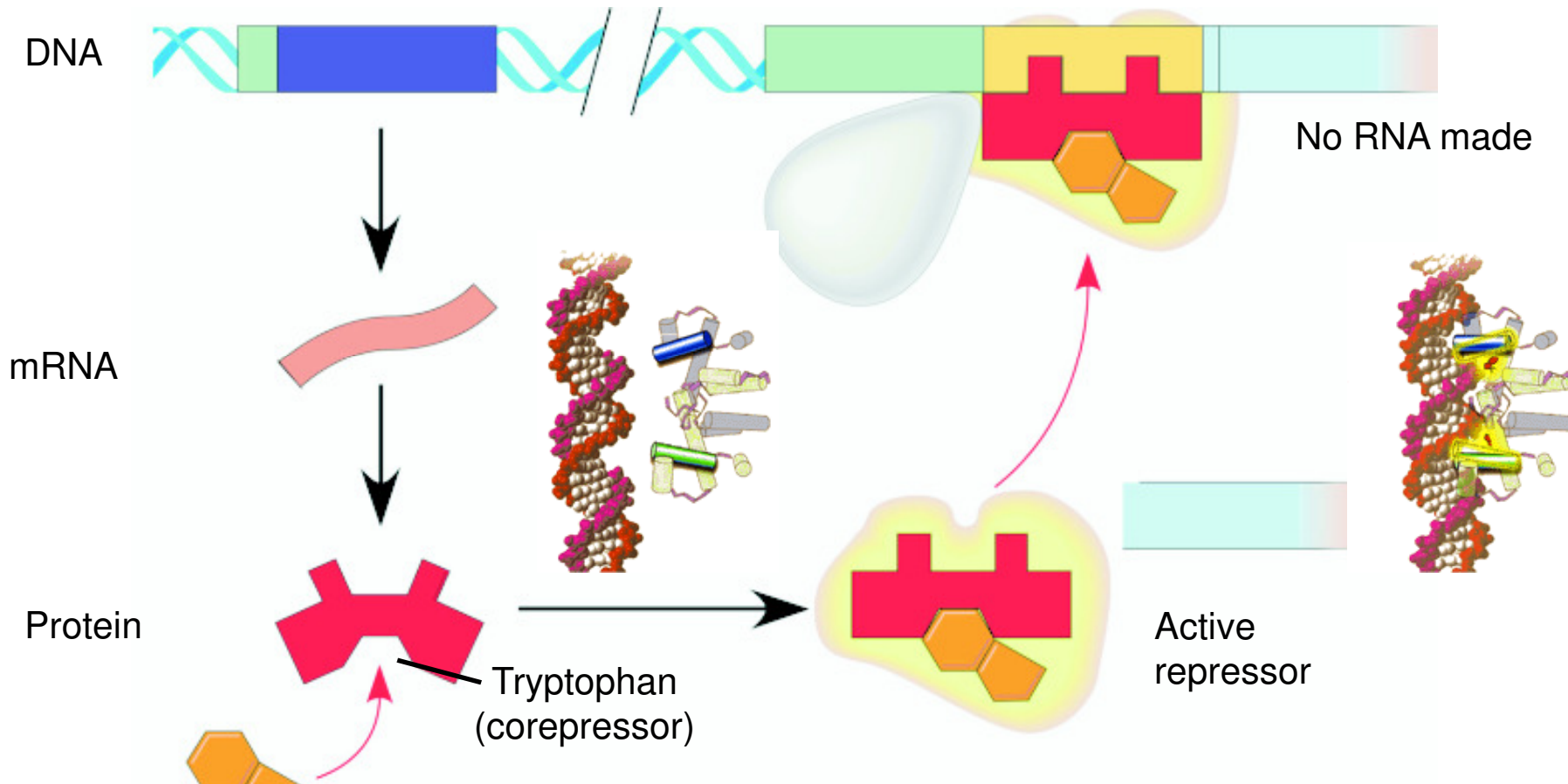
Tryptophan absent -> repressor inactive -> transcription



The "operator" is a particular sequence of bases where the repressor can bind

Trp operon

Active repressor can bind to operator and block transcription



Tryptophan present -> repressor active -> operon "off".

Figure 18.21b

Eukaryotic Gene Regulation

Key Concept:

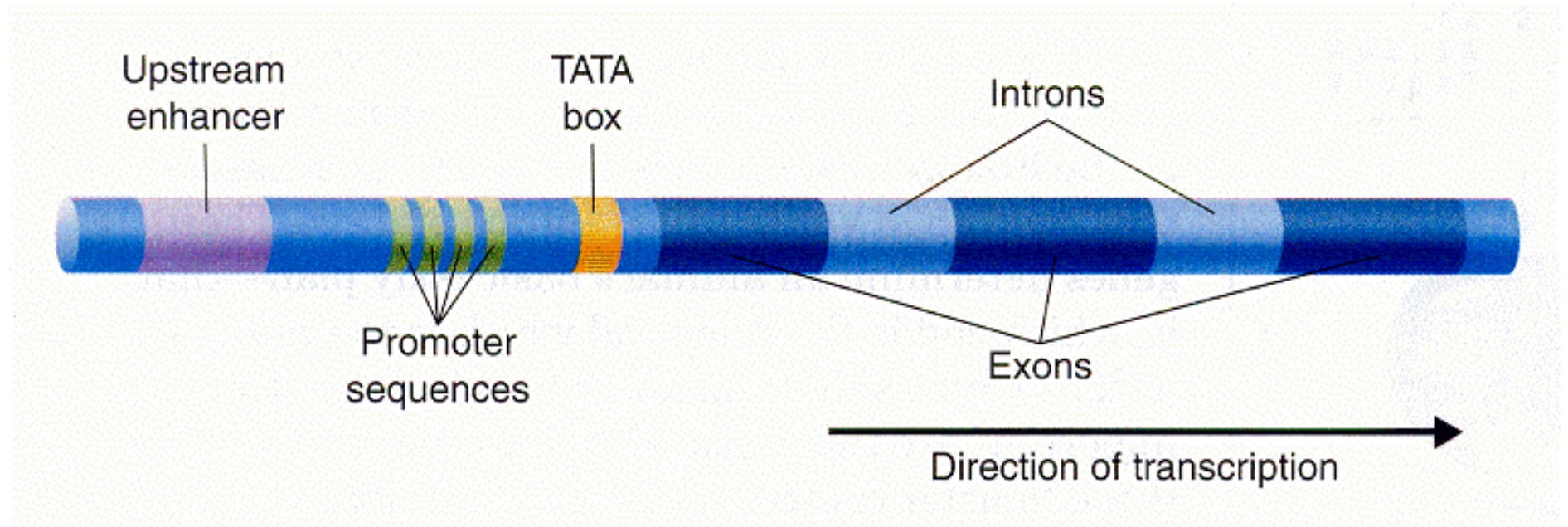
Most Eukaryotic Genes Are Controlled Individually

And Have Regulatory Sequences

That Are Much More Complex

Than Prokaryotic Gene Regulation

Eukaryotic Gene Regulation



Gene Regulation in Prokaryotes and Eukaryotes

- Prokaryotes
 - Operons
 - 27% of E. coli genes
 - (Housekeeping genes not in operons)
 - simultaneous transcription and translation
- Eukaryotes
 - No operons, but they still need to coordinate regulation
 - More kinds of control elements
 - RNA processing
 - Chromatin remodeling
 - Histones must be modified to loosen DNA

Problems of Development

- All cells have Identical Genetic Information.
- Why different cells perform different functions.

Main Events of Development

- 1 Determination
- 2 Differentiation

Molecular basis of differentiation