Lecture 12

Regulation of Gene Expression
Negative regulation - Lac Operon
Attenuation - Tryptophan Operon

Acknowledgement: Leninger Chapter 28

Objectives

Emergence of Life
Fundamental units of life
Cellular assemblies
Protein Folding
Protein Synthesis
Gene Regulation

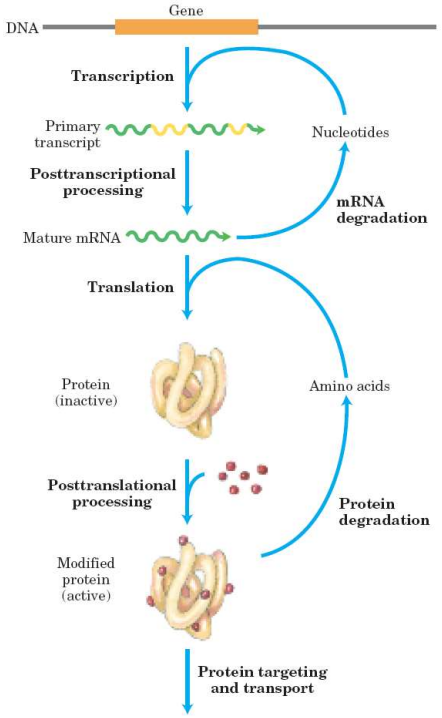
1. Understanding gene re
   a) Operons and regulons
2. Negative and positive regulation
3. Lac operon
4. Attenuation regulation operon

Genes are expressed when required

- Some proteins are expressed abundantly such as elongation f and rubisco
- Others such as DNA repair enzymes are synthesized very few number
- Requirements of gene products varies in the cell-type and in i cycle
  - Ribosomes are synthesized rapidly during the exponential growth ph the cell

What factors determine the cellular concentration of proteins

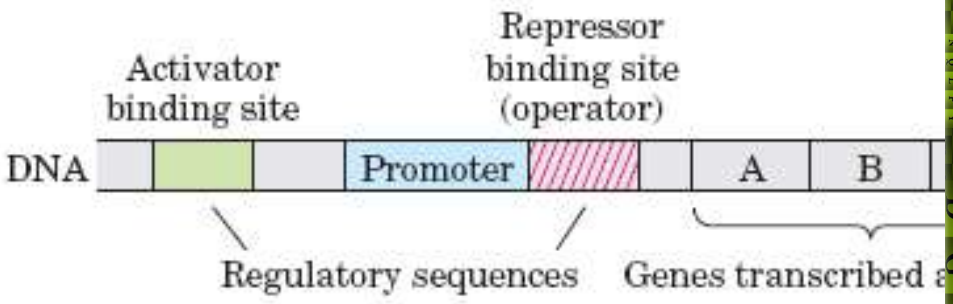
1. Synthesis of the primary RNA transcript (transcription)
2. Posttranscriptional modification of mRNA
3. Messenger RNA degradation
4. Protein synthesis (translation)
5. Posttranslational modification of proteins
6. Protein targeting and transport
7. Protein degradation



Gene regulation

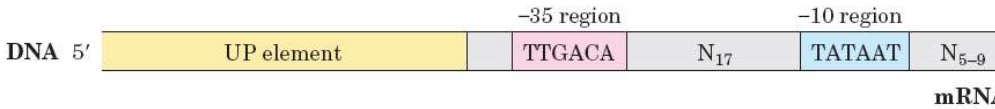
House Keeping Genes	Regulated Gen
• Constitutive gene expression	• Inducible gene expression • Repressible gen expression

Representative Prokaryotic Operon



❖Genes A, B, and C are transcribed on one polycistronic mRNA regulatory sequences include binding sites for proteins that ei activate or repress transcription from the promoter

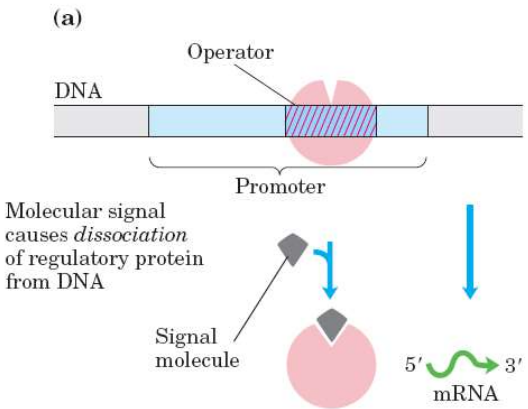
RNA polymerase

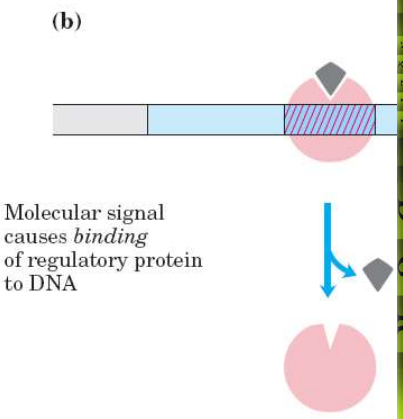


❖RNA polymerases bind to DNA and initiate transcription at promoters generally found near points at which RNA synthesis begins on the DN

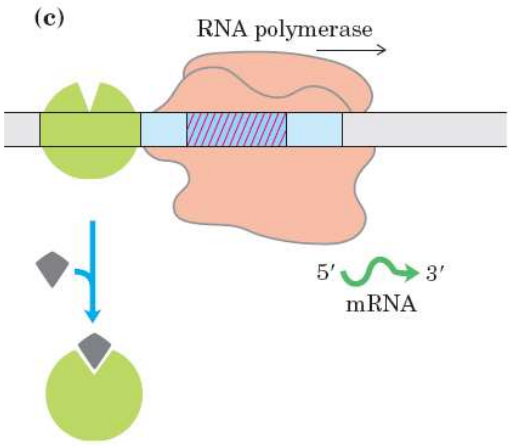
❖The regulation of transcription initiation often entails changes in how polymerase interacts with a promoter

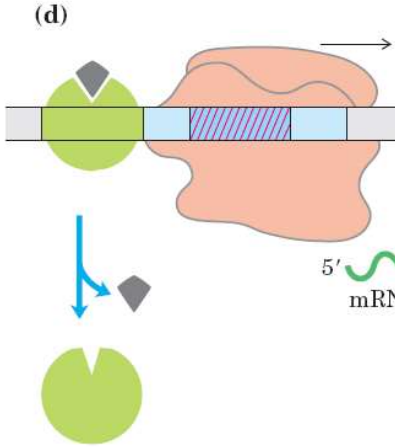
Negative Regulation of Gene Expressi



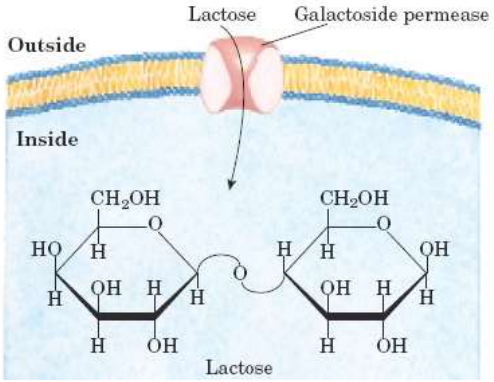


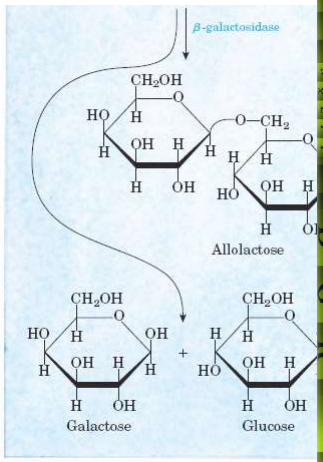
Positive Regulation of Gene Expressio



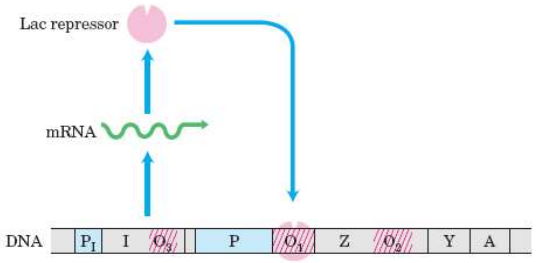


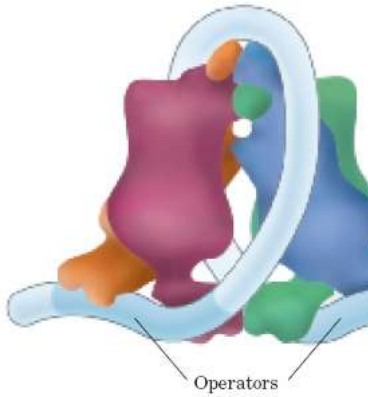
Lactose metabolism in *E. coli*





The Lac Operon

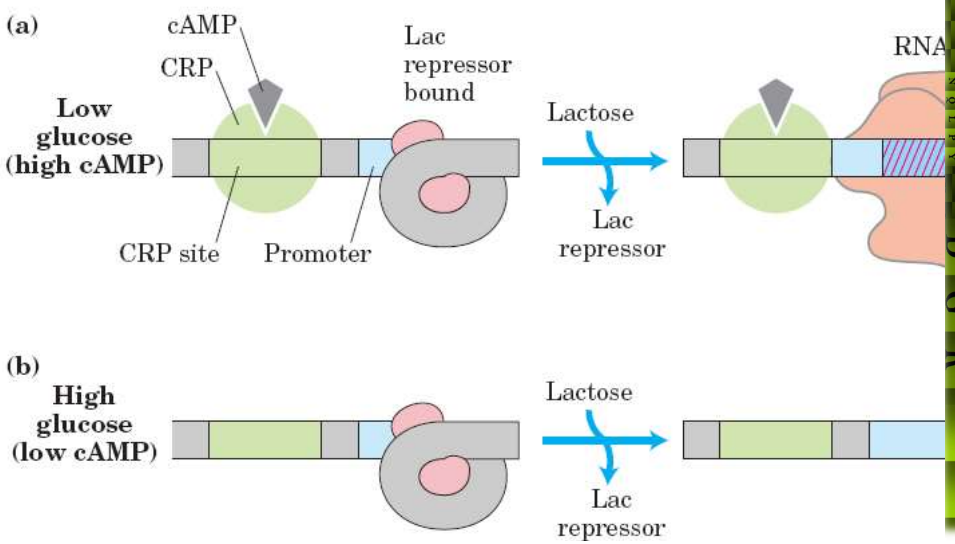




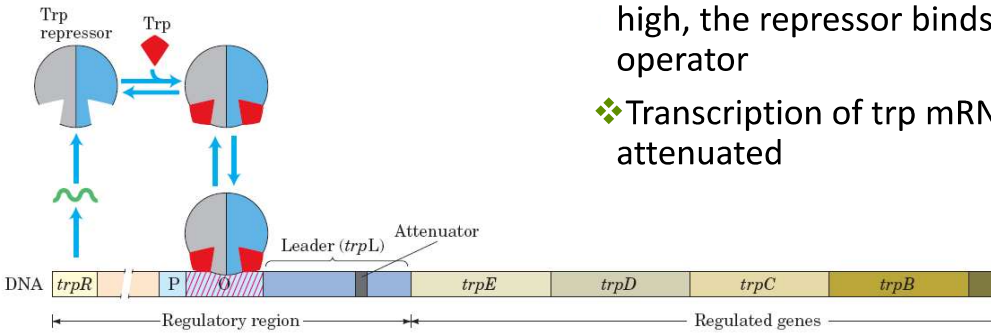
- The I gene encodes the Lac repressor. The lac Z, Y, and A genes encode beta-galactosidase, galactoside permease, and thiogalactoside transacetylase, respectively

- O_1 is the main operator for the l
- The Lac repressor binds to the m operator and O_2 or O_3, apparent forming a loop in the DNA that r wrap around the repressor

The Lac Operon

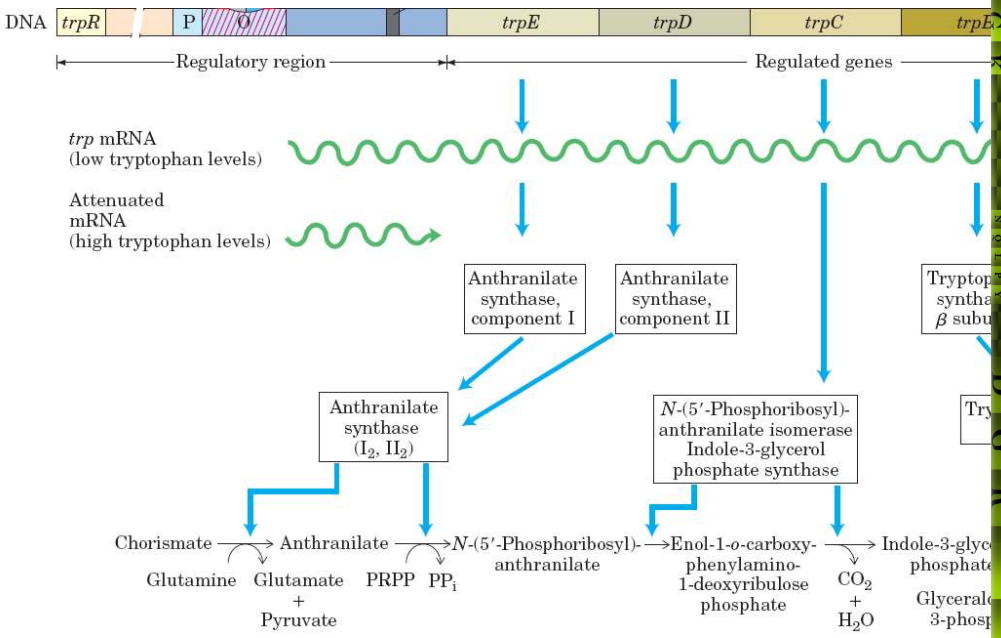


The Trp Operon

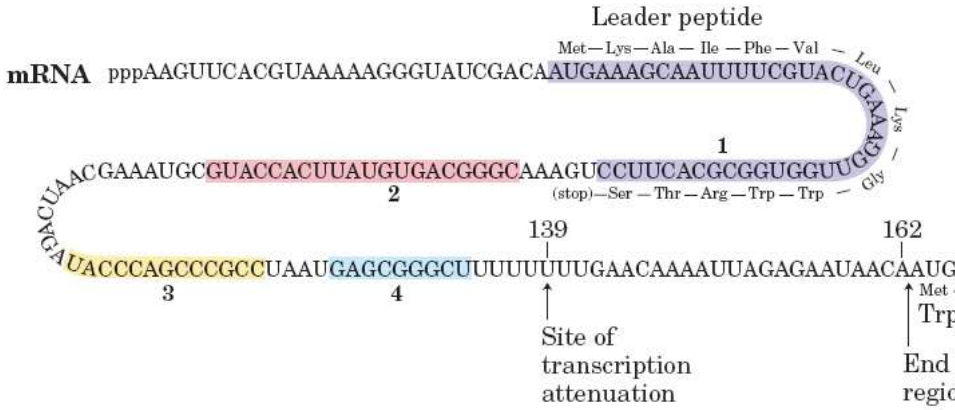


This operon is regulated by mechanisms:

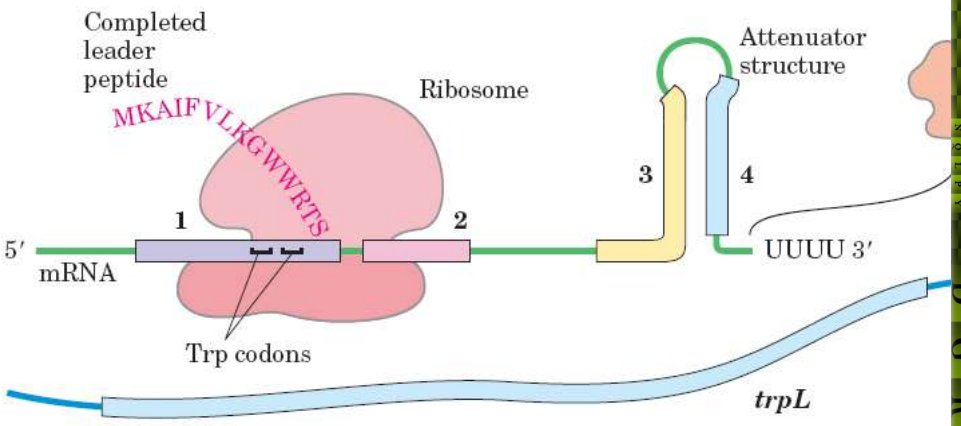
- When tryptophan levels high, the repressor binds operator
- Transcription of trp mRN attenuated



The Trp mRNA Sequence

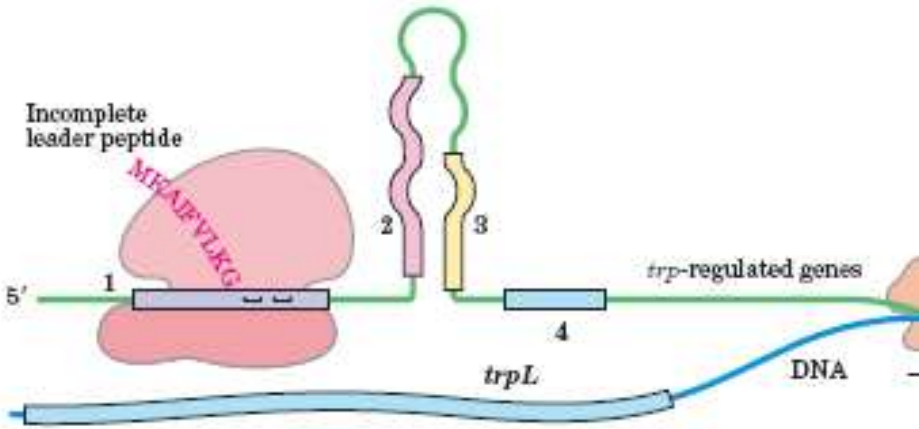


What happens at high Tryptophan leve



❖ When tryptophan levels are high, the ribosome quickly translates sequence 1 (open reading fram
leader peptide) and blocks sequence 2 before sequence 3 is transcribed. Continued transcriptior
attenuation at the terminator-like attenuator structure formed by sequences 3 and 4

What happens at low Tryptophan leve



❖ When tryptophan levels are low, the ribosome pauses at the Trp codons in sequence 1. Formatio
paired structure between sequences 2 and 3 prevents attenuation, because sequence 3 is no lon
available to form the attenuator structure with sequence 4. The 2:3 structure, unlike the 3:4 atte
not prevent transcription.