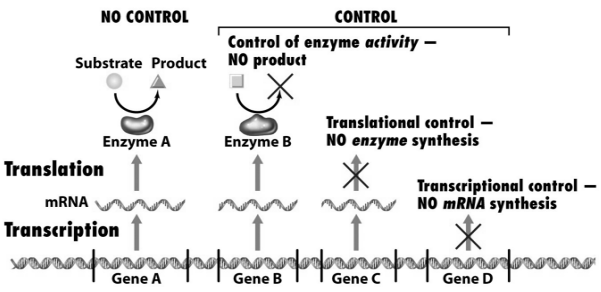
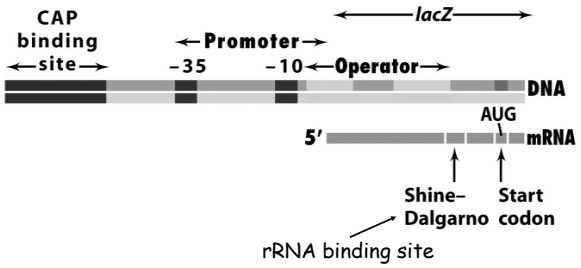
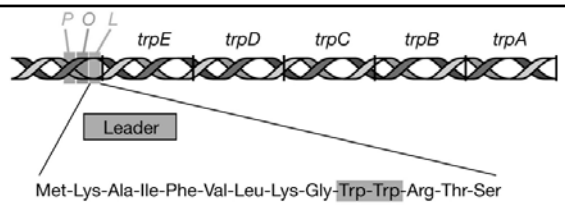
An Overview of Gene Regulation



Genetic elements involved in regulation of the lac operon

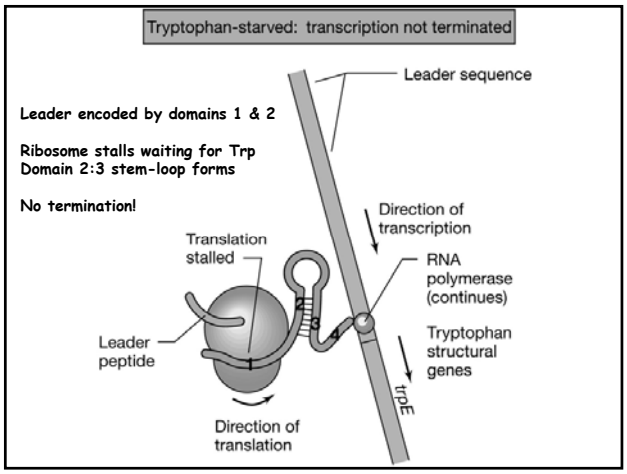


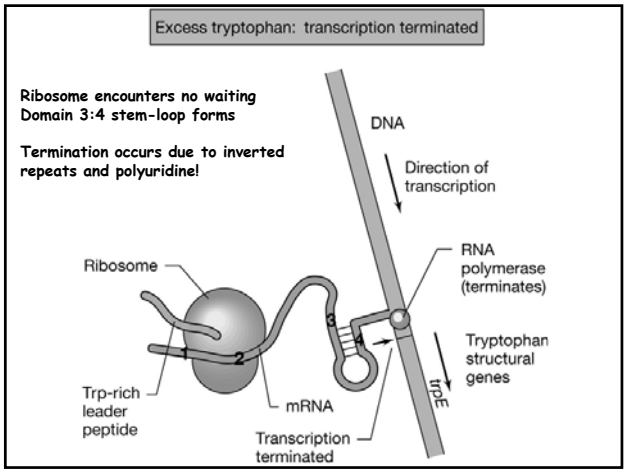
Attenuation: fine scale control after initiation of transcription

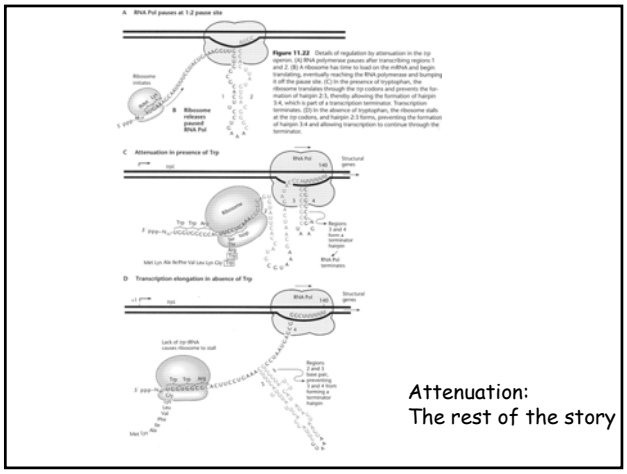


Leader peptide rich in pathway AAs

Threonine	Met-Lys-Arg-Ile-Ser-Thr-Thr-Ile-Thr-Thr-Thr-Ile-Thr-Ile-Thr-Thr-Gly-Asn-Gly-Ala-Gly
Histidine	Met-Thr-Arg-Val-Gln-Phe-Lys-His-His-His-His-His-His-His-Pro-Asp
Phenylalanine	Met-Lys-His-Ile-Pro-Phe-Phe-Phe-Ala-Phe-Phe-Phe-Thr-Phe-Pro


Tryptophan-starved: transcription not terminated
Leader sequence
Leader encoded by domains 1 & 2
Ribosome stalls waiting for Trp
Domain 2:3 stem-loop forms
No termination!
Direction of transcription
Translation stalled
RNA polymerase (continues)
Tryptophan structural genes
Leader peptide
trpE
Direction of translation


Excess tryptophan: transcription terminated
Ribosome encounters no waiting
Domain 3:4 stem-loop forms
Termination occurs due to inverted repeats and polyuridine!
DNA
Direction of transcription
RNA polymerase (terminates)
Ribosome
Tryptophan structural genes
trpE
Trp-rich leader peptide
mRNA
Transcription terminated


Attenuation:
The rest of the story

Global Control Systems

Table 8.1 Examples of global control systems known in *Escherichia coli*[a]

System	Signal	Primary activity of regulatory protein	Number of genes regulated
Aerobic respiration	Presence of O_2	Repressor (ArcA)	50+
Anaerobic respiration	Lack of O_2	Activator (FNR)	70+
Catabolite repression	Cyclic AMP concentration	Activator (CAP)	300+
Heat shock	Temperature	Alternative sigma (σ^{32})	36
Nitrogen utilization	NH_3 limitation	Activator (NR_1)/alternative sigma (σ^{54})	12+
Oxidative stress	Oxidizing agent	Activator (OxyR)	30+
SOS response	Damaged DNA	Repressor (LexA)	20+

[a] For many of the global control systems, regulation is complex. A single regulatory protein can play more than one role. For instance, the regulatory protein for aerobic respiration is a repressor for many promoters but an activator for others, whereas the regulatory protein for anaerobic respiration is an activator protein for many promoters but a repressor for others. Regulation can also be indirect or require more than one regulatory protein. Some of the regulatory proteins involved are members of two-component systems (see Section 8.12). Many genes are regulated by more than one global system. (For a discussion of the SOS response, Section 10.4.)