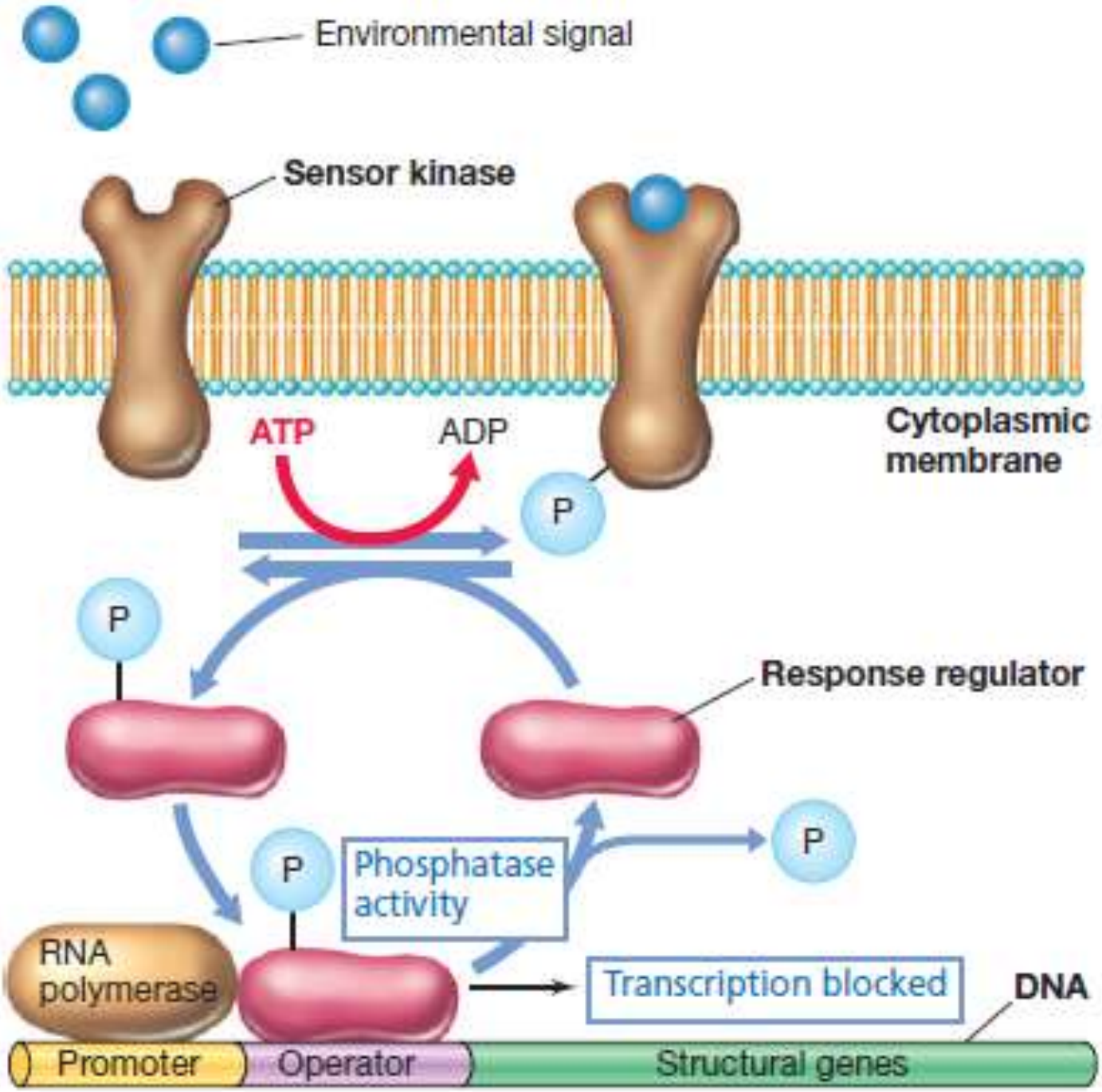
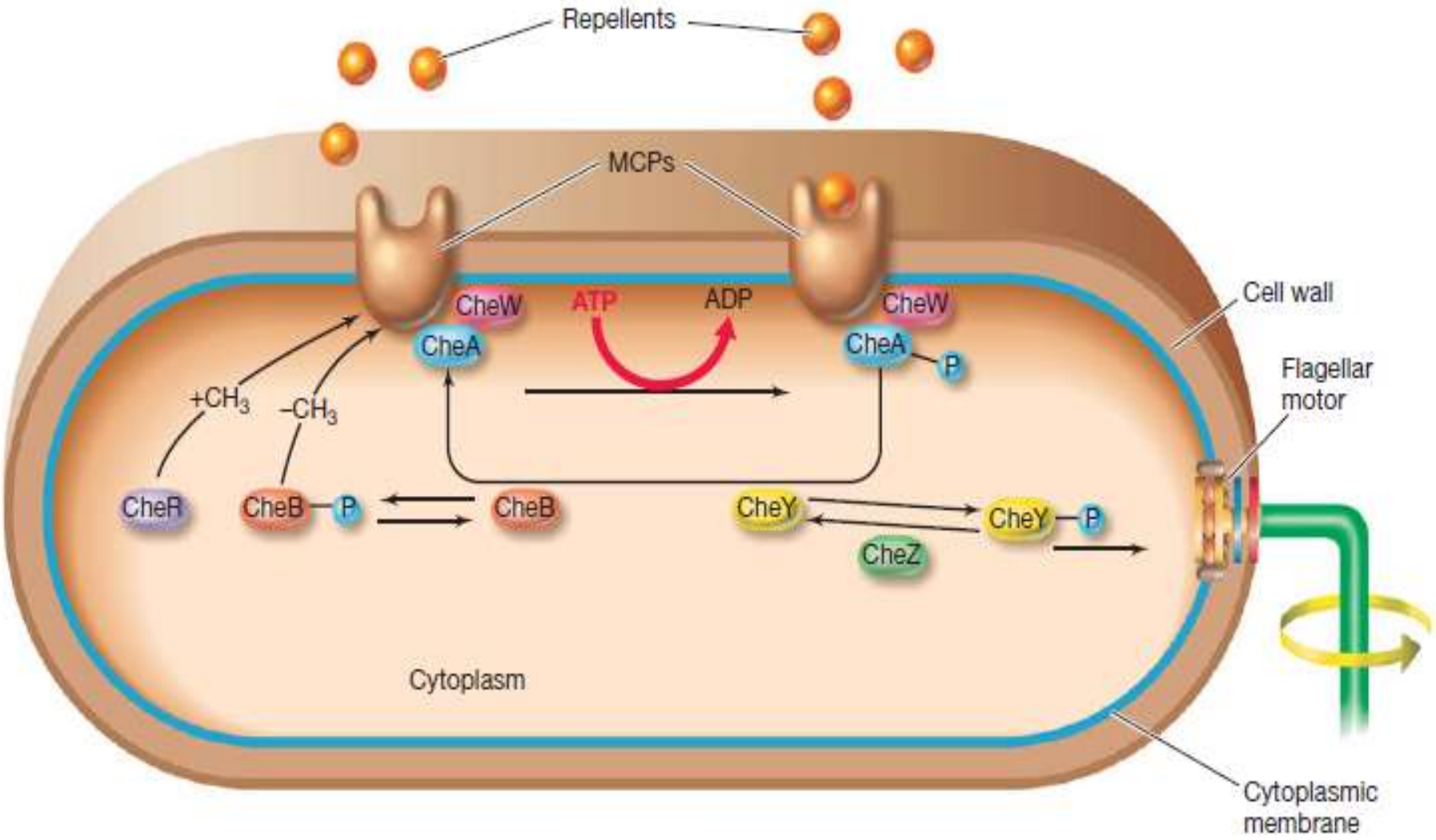
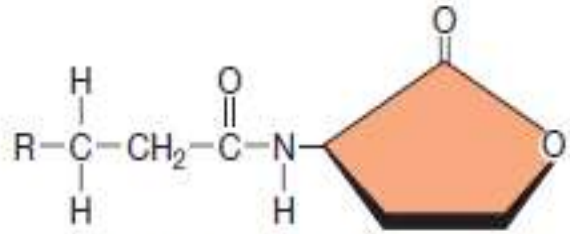
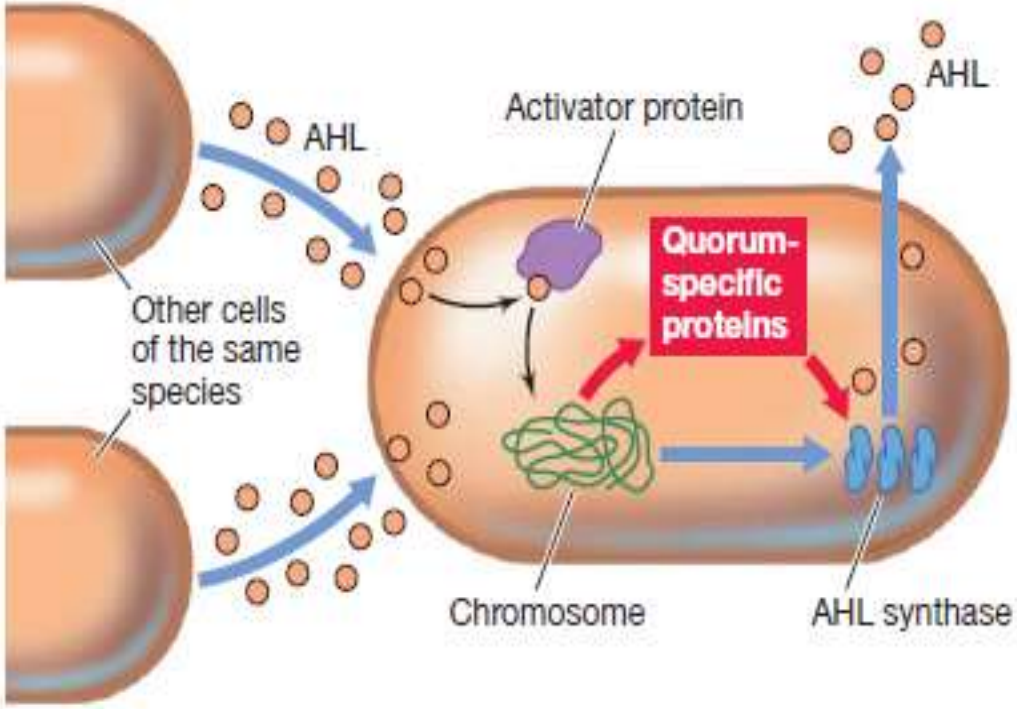

Environmental signal
Sensor kinase
ATP
ADP
Cytoplasmic membrane
P
P
Response regulator
P
P
Phosphatase activity
RNA polymerase
Transcription blocked
DNA
Promoter
Operator
Structural genes

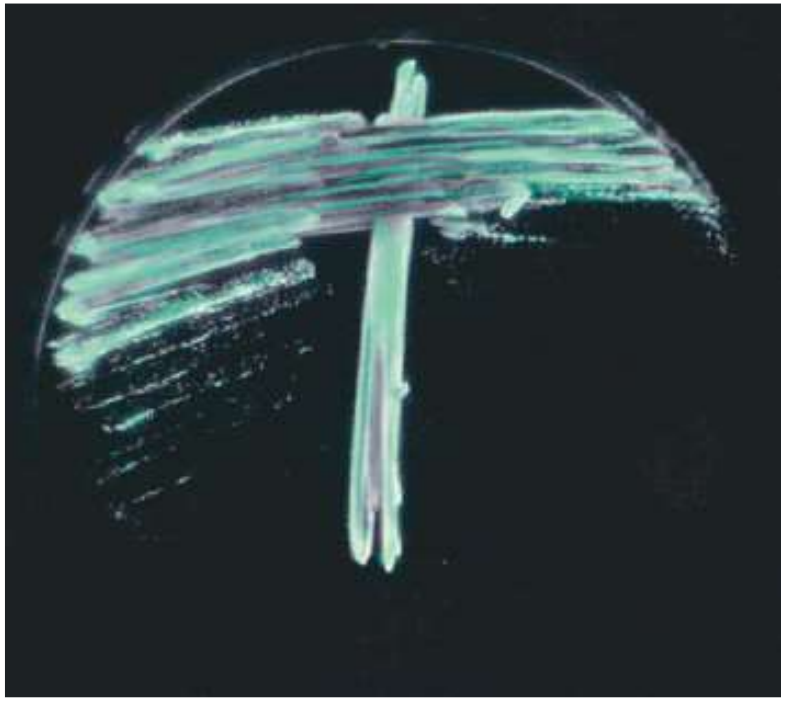

Repellents
MCPs
CheW
CheA
ATP
ADP
CheW
CheA
P
Cell wall
Flagellar motor
+CH3
–CH3
CheR
CheB
P
CheB
CheY
CheY
P
CheZ
Cytoplasm
Cytoplasmic membrane

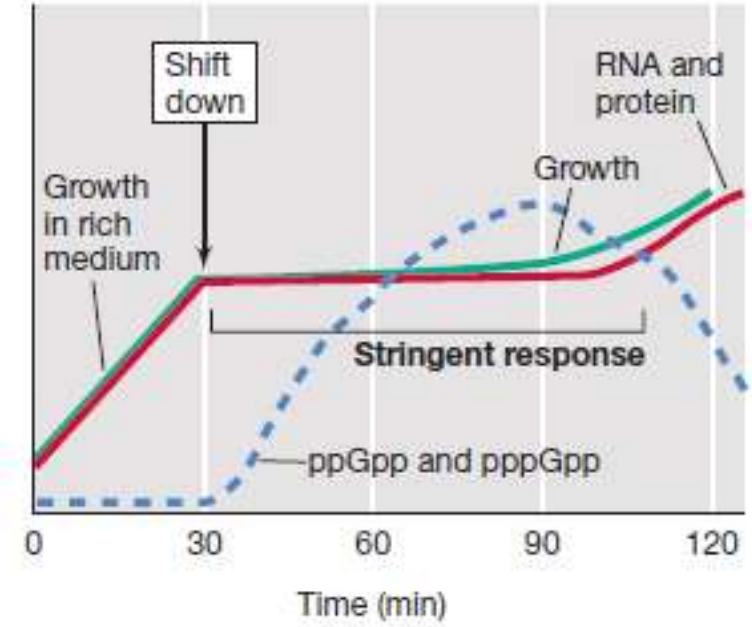


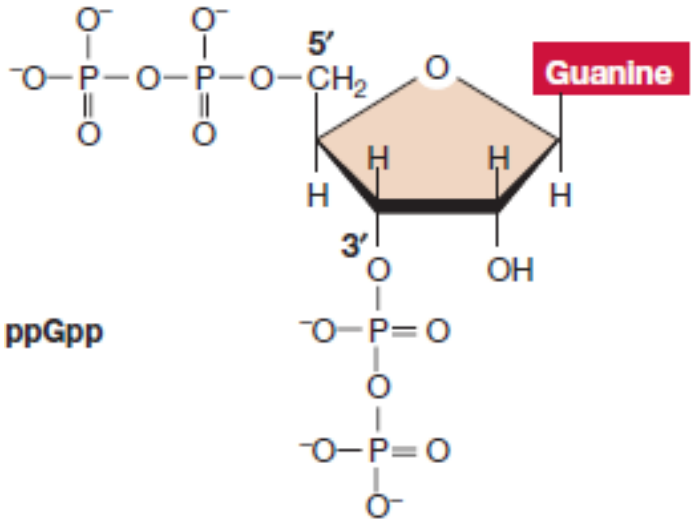
Acyl homoserine lactone (AHL)

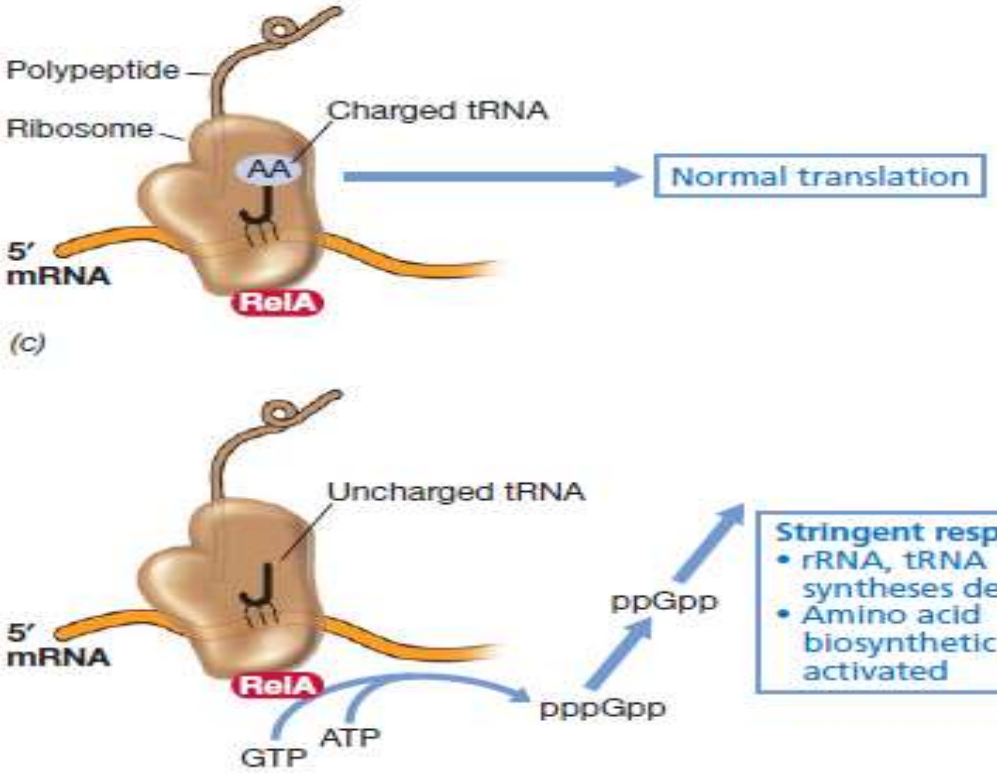
(a)

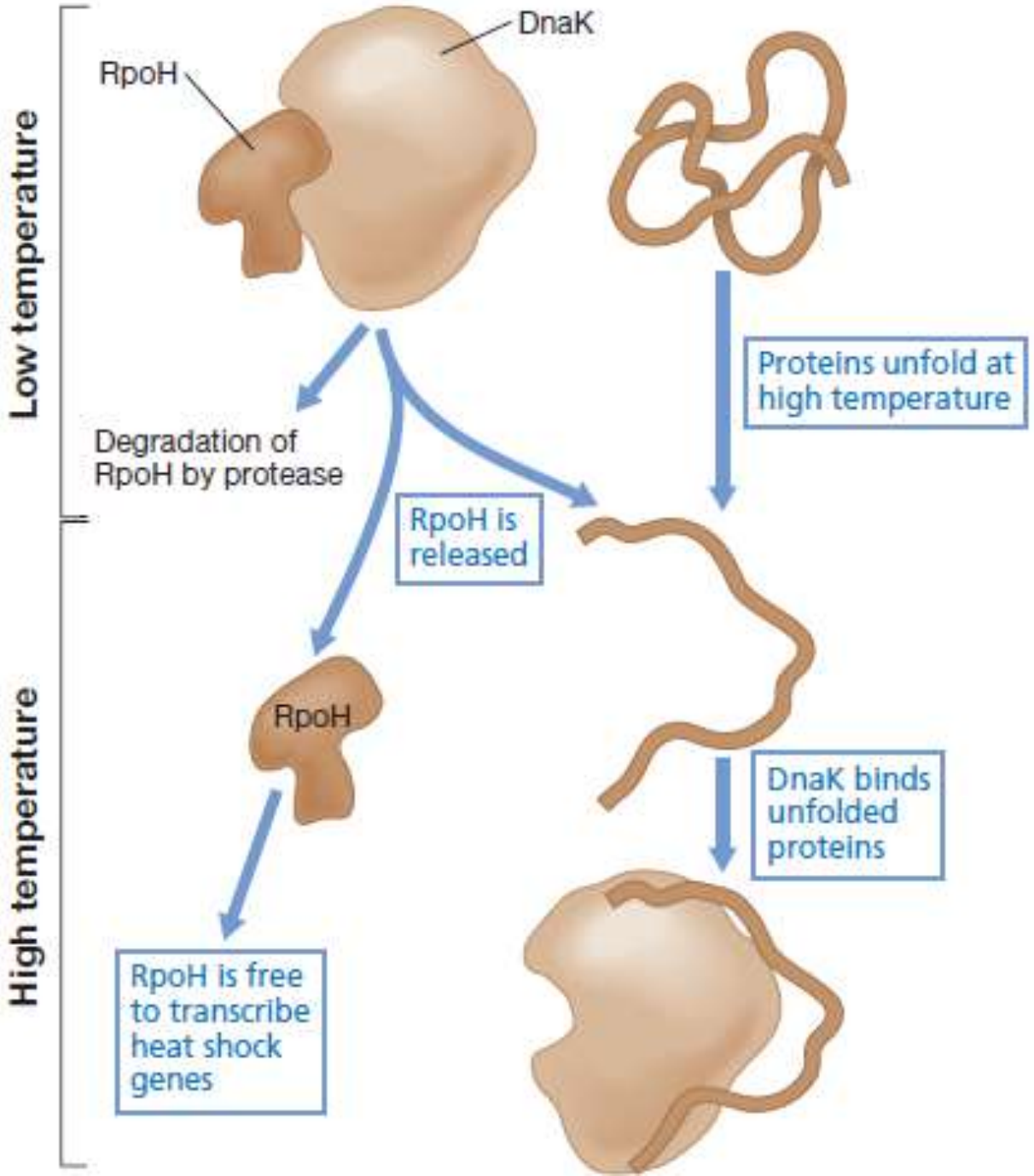


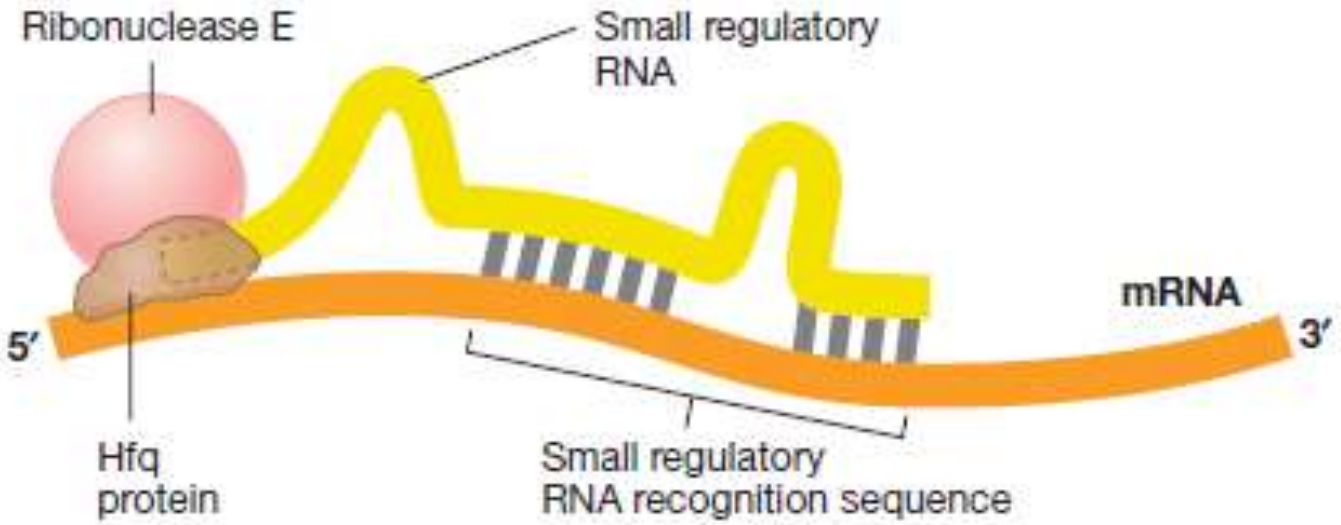


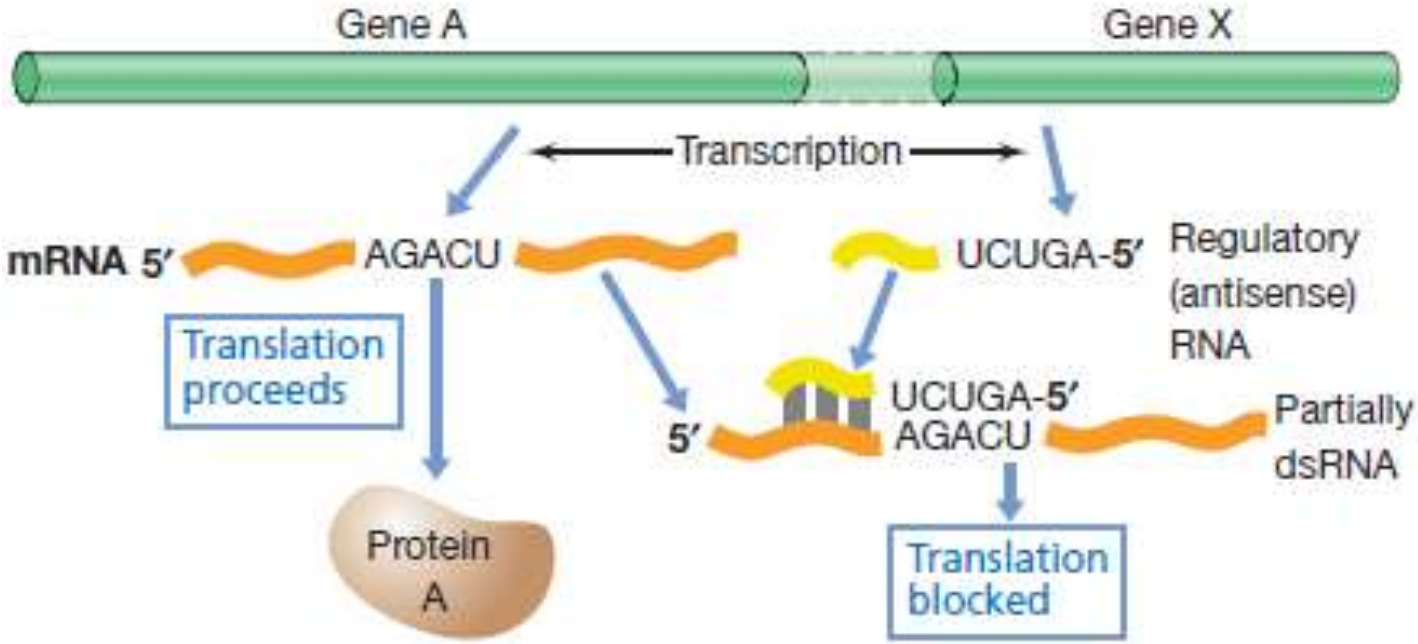

Shift down
RNA and protein
Growth
Growth in rich medium
Stringent response
ppGpp and pppGpp
0
30
60
90
120
Time (min)

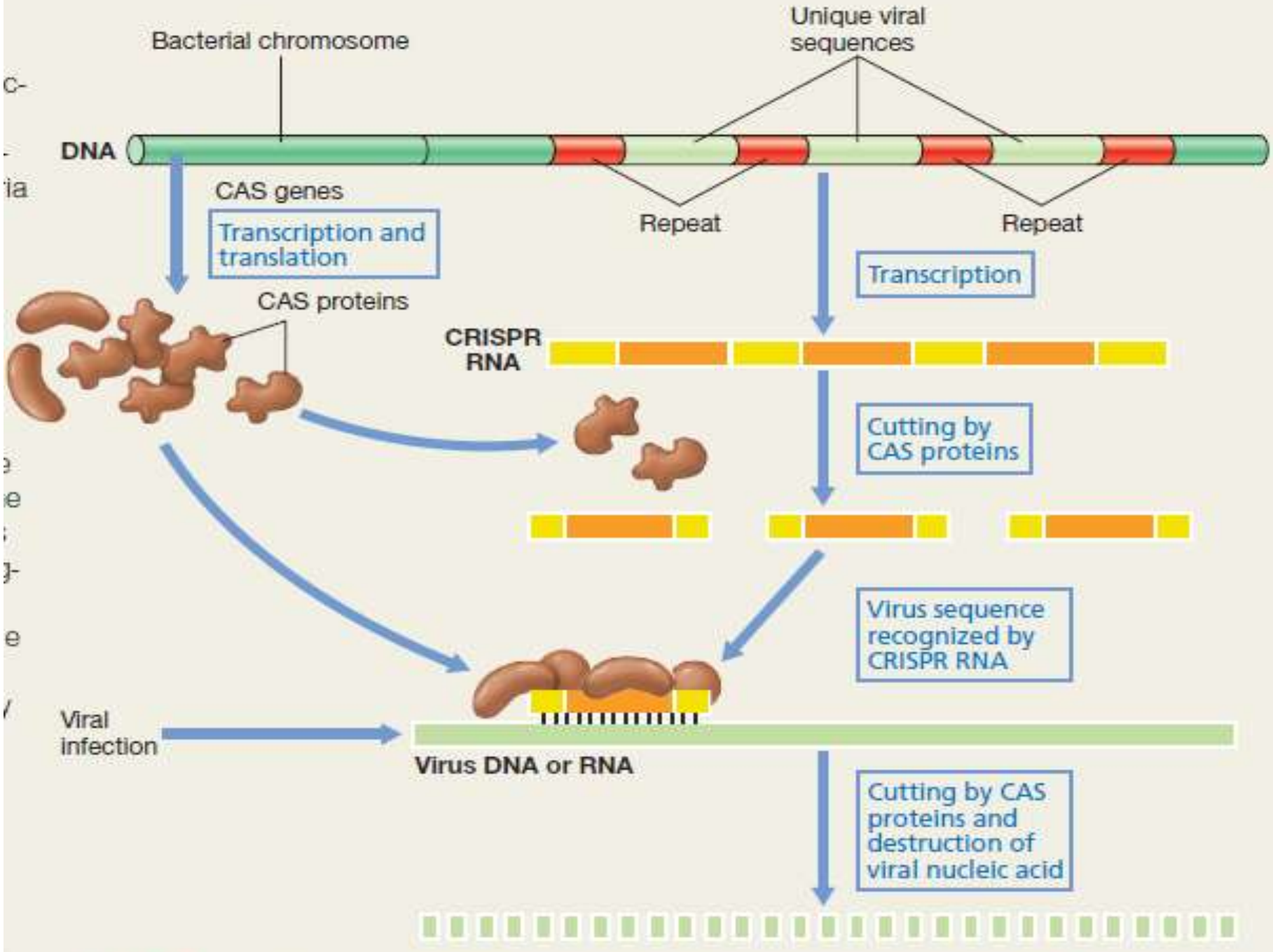

Guanine
ppGpp
5′
3′
OH

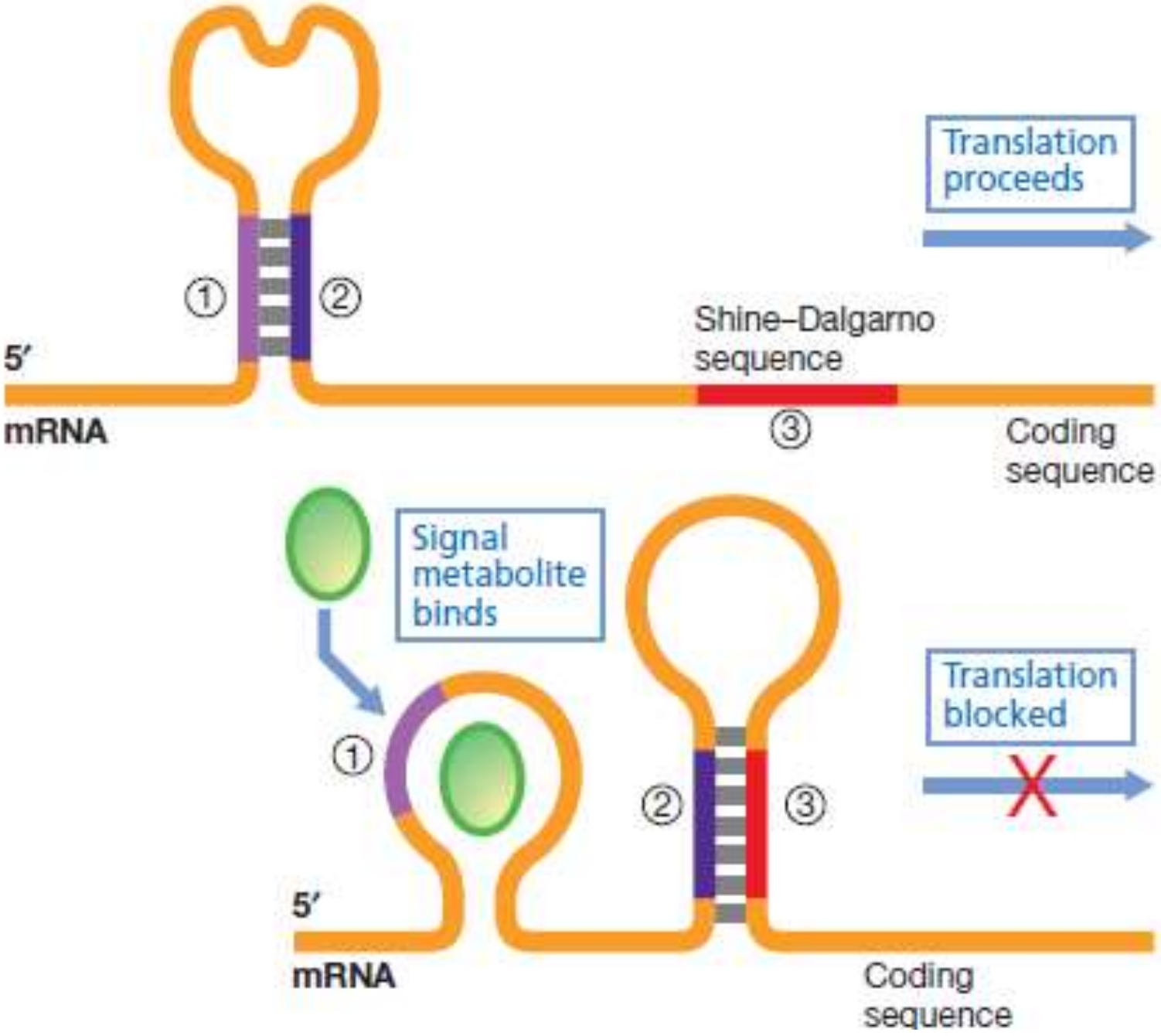

Polypeptide
Ribosome
Charged tRNA
AA
Normal translation
5′
mRNA
RelA
(c)
Uncharged tRNA
5′
mRNA
RelA
GTP
ATP
pppGpp
ppGpp
Stringent response
• rRNA, tRNA syntheses decreased;
• Amino acid biosynthetic operons activated


Low temperature
High temperature
RpoH
DnaK
Degradation of RpoH by protease
RpoH is released
Proteins unfold at high temperature
RpoH
RpoH is free to transcribe heat shock genes
DnaK binds unfolded proteins


Ribonuclease E
Small regulatory RNA
mRNA
5′
3′
Hfq protein
Small regulatory RNA recognition sequence


Gene A
Gene X
Transcription
mRNA 5′
AGACU
UCUGA-5′
Regulatory (antisense) RNA
Translation proceeds
5′
UCUGA-5′
AGACU
Partially dsRNA
Protein A
Translation blocked


Bacterial chromosome
Unique viral sequences
DNA
CAS genes
Repeat
Repeat
Transcription and translation
Transcription
CAS proteins
CRISPR RNA
Cutting by CAS proteins
Virus sequence recognized by CRISPR RNA
Viral infection
Virus DNA or RNA
Cutting by CAS proteins and destruction of viral nucleic acid


Translation proceeds
1
2
Shine–Dalgarno sequence
5′
mRNA
3
Coding sequence
Signal metabolite binds
Translation blocked
1
2
3
5′
mRNA
Coding sequence