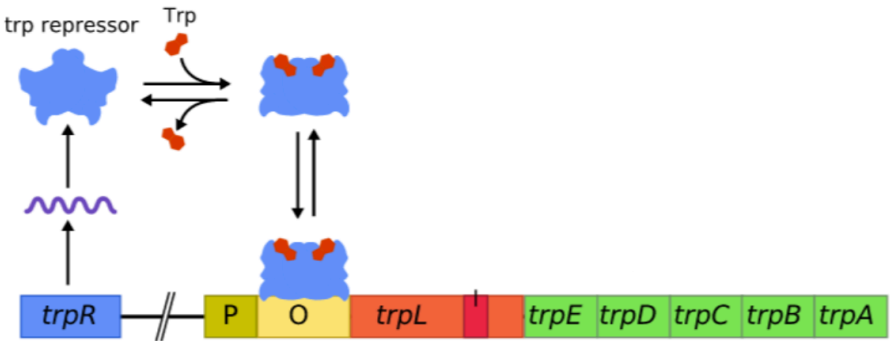
CONCEPT: TRYPTOPHAN OPERON AND ATTENUATION

- The **Trp operon** encodes genes that synthesize and process the amino acid tryptophan
  - □ The *trp* operon is regulated by tryptophan in _____- ways: a repressor and attenuation
    - Cytoplasmic tryptophan acts as a **corepressor** when regulating the *trp* operon
      - Tryptophan binds to a repressor, which then binds to the operator and represses transcription

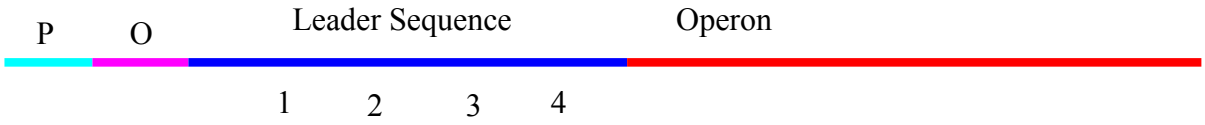
EXAMPLE:



Attenuation

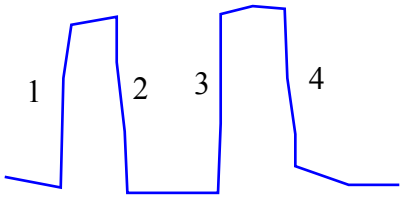
- **Attenuation** describes the process that uses $tRNA^{trp}$ levels to _____ the *trp* operon
  - □ When tryptophan levels are high, attenuation turns off the *trp* operon
  - □ The *trp* operon has a **leader sequence** of 100+ nucleotides prior to the start site but after the promoter
    - The leader sequence can form different types of secondary structures by combining 4 small sequences
    - These sequences are called regions 1, 2, 3, and 4
  - □ A **terminator** structure forms when 1 and 2 form a loop and 3 and 4 form a loop
    - Terminates transcription
  - □ An **anti-terminator** structure forms when 2 and 3 form a loop
    - Allows transcription to continue

EXAMPLE:



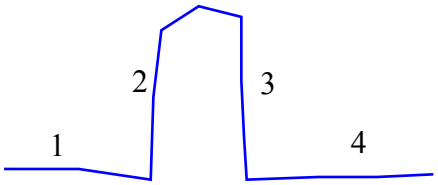
Terminator

Stops Transcription



Anti-Terminator

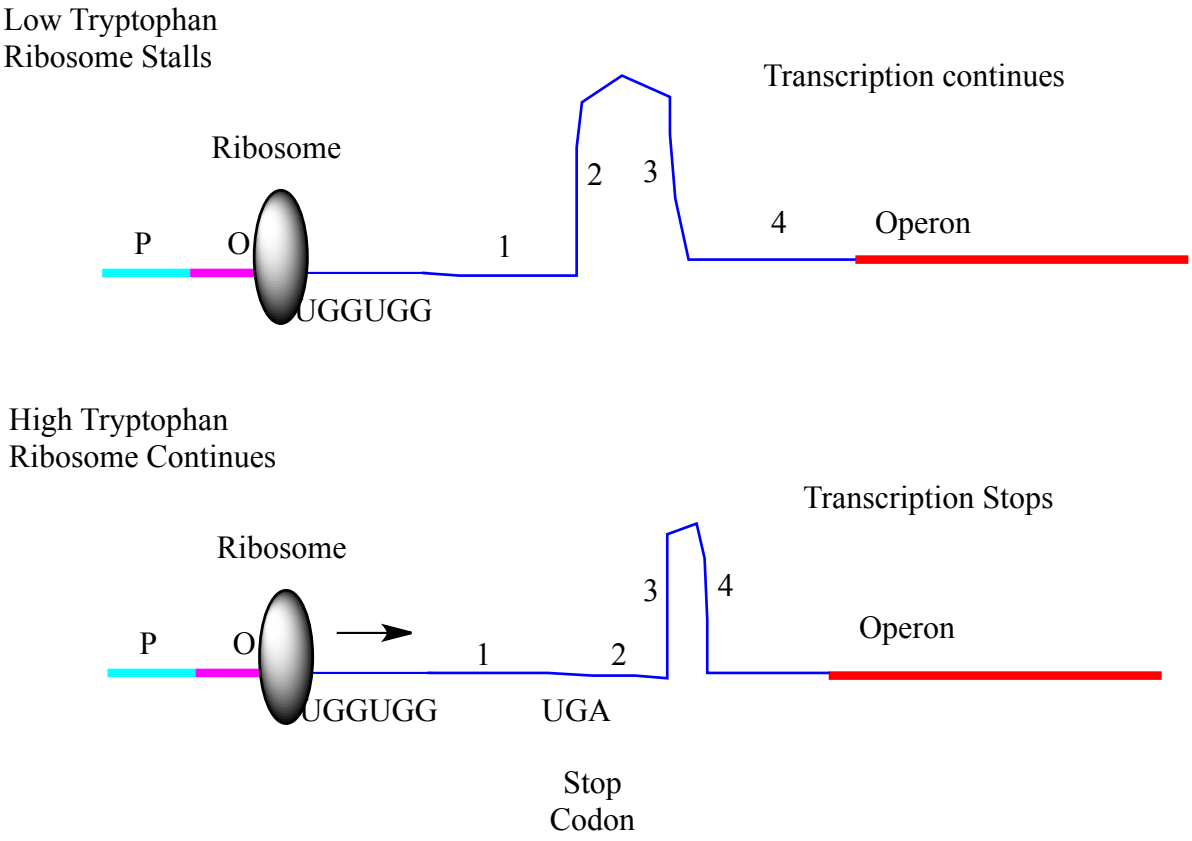
Allows Transcription



□ The leader sequence can also be used to control translation because it contains many tryptophan _____

- If tryptophan levels are **low**, there will be very little $tRNA^{trp}$ and therefore translation stalls
  - When translation stalls, 2 and 3 forms a loop forming an anti-termination sequence
    - Anti-termination sequence promotes transcription
- If tryptophan levels are **high**, there will be enough $tRNA^{trp}$ and translation continues
  - Translation continues until it reaches a stop codon at the end of region 1
  - Then region 3 forms a loop with 4 and acts as a termination sequence – stopping transcription

EXAMPLE:

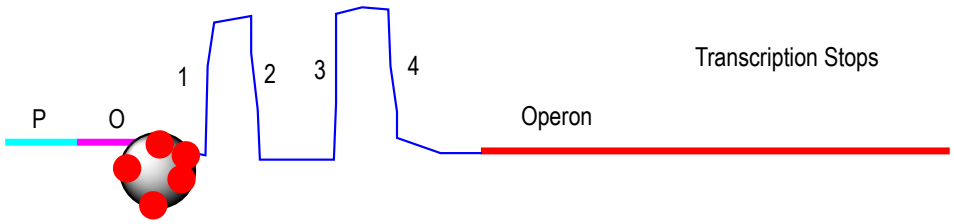

Low Tryptophan
Ribosome Stalls
Transcription continues
Ribosome
2
3
4
Operon
P
O
1
UGGUGG
High Tryptophan
Ribosome Continues
Transcription Stops
Ribosome
3
4
Operon
P
O
1
2
UGGUGG
UGA
Stop
Codon

TRAP Regulation of *trp* Operon

- Occasionally, other organisms have evolved _____ ways of regulating the *trp* operon
  - □ *B. subtilis* uses the **Trp RNA-Binding Attenuation Protein (TRAP)**
    - TRAP binds to multiple tryptophan molecules
      - When tryptophan concentration is high TRAP is saturated, and binds to the leader sequence
        - This forms the terminator configuration and prevents transcription
    - A second protein **anti-TRAP** binds to TRAP when tryptophan is low
      - This allows fort he formation of the anti-terminator configuration and promotes transcription
    - The TRAP/anti-TRAP regulatory method is sensitivite to a wide variety of tryptophan concentrations

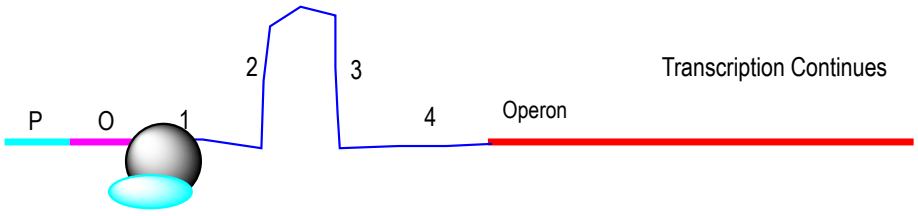
EXAMPLE:

Tryptophan Concentration: High



TRAP w/ Tryptophan

Tryptophan Concentration: Low



TRAP/anti-TRAP

PRACTICE:

1. Tryptophan regulates the *trp* operon by doing what?
    a. Activating the operon and synthesizing more tryptophan
    b. Activating the operon and breaking down tryptophan
    c. Repressing the operon and inhibiting further tryptophan synthesis
    d. Repressing the operon and inhibiting breakdown of tryptophan

2. Attenuation uses what molecule to regulate the *trp* operon?
    a. All tRNAs
    b. Tryptophan
    c. Lactose
    d. $tRNA^{trp}$

3. What is the name of the sequence responsible for regulating the *trp* operon through attenuation?
    a. Leader sequence
    b. Regulator sequence
    c. Terminator sequence
    d. Anti-terminator sequence

4. If tryptophan levels are low, attenuation does what to the *trp* operon?
    a. Translation stalls, forming anti-termination sequence which promotes transcription
    b. Translation is activated and promotes tryptophan creation
    c. Transcription is inhibited
    d. A termination structure is formed blocking translation