Transcript and Related Materials

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Notes

Structure and regulation of trp operon- Part II

The trp operon is also controlled by a mechanism called as attenuation. This is the second level of control. There is a region in the 5' leader sequence of mRNA which is called as the attenuator region. This contains a small open reading frame (ORF). Attenuation in the trp operon means that the transcription termination is controlled by the rate of translation of the attenuator ORF. High levels of tryptophan tRNA will attenuate or terminate transcription whereas low levels of tryptophan tRNA allows the trp operon to be transcribed. This is accomplished by changes in the secondary structure of the attenuated RNA which in turn is determined by the position of the ribosome on the mRNA.

Attenuation of trp operon - Regulation at the level of translation:

Charles Yanofsky found that the trp operon has a very unique regulatory site between the operator and the first structural gene trp E. This region is a non coding region made up of 102 nucleotides and is called as the leader region. It codes for 14 amino acids. The mRNA which is formed from this leader region has an initiation codon at the 5' end and a stop codon at the

3’ end. Two tryptophan codons are present in position 10 and 11. The leader can be divided into four distinct regions denoted as 1,2,3 and 4.

In stable conditions when the concentration of tryptophan is in requisite amounts region 1 pairs with 2 and region 3 pairs with 4. The termination loop is formed when region 3 pairs with 4, this is a region having a high GC content. Due to formation of the loop the process is immediately terminated.

When the concentration of tryptophan is low the concentration of trp tRNA is also low. As a result during the process of translation when the ribosome reaches codon position 10 or 11 it stops due to non availability of trp tRNA. Since the ribosome stops in region 1 it cannot pair with region 2 and therefore region 2 now pairs with region 3. Hence the termination loop is not formed, as a result transcription of region 4 and the subsequent structural genes takes place in an uninterrupted manner. Termination or attenuation occurs only if the region 3 base pairs with region 4. Beyond the region 4 there is a sequence of 8 uracil residues which are present just before the structural gene trp E. Hence that part of the leader RNA comprising of region 3 ,4 and 8 uracil residues is called as the attenuator. The hairpin loop of the attenuator region behaves as a transcription terminator signal and leads to the detachment of the RNA polymerase as well as growing mRNA from the DNA molecule.

Repression decreases transcription of trp operon 70 fold, attenuation slows it down another 8 to 10 fold. Together the decrease is around 600 fold.