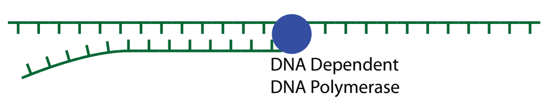
DNA and Gene Regulation

A Pictoral Guide to

Select Topics

to

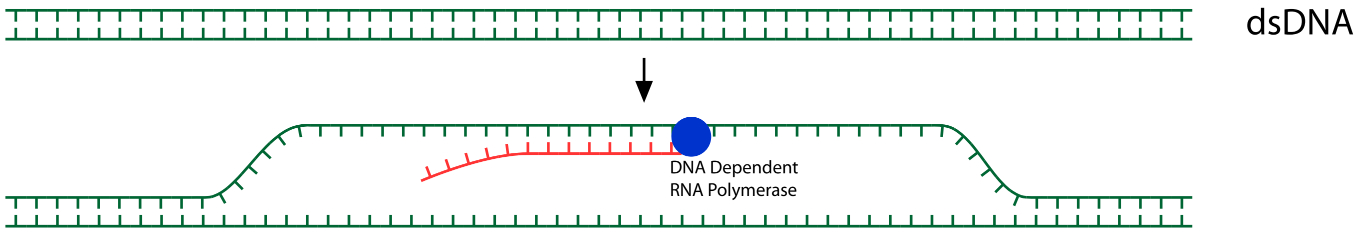
Accompany Lecture



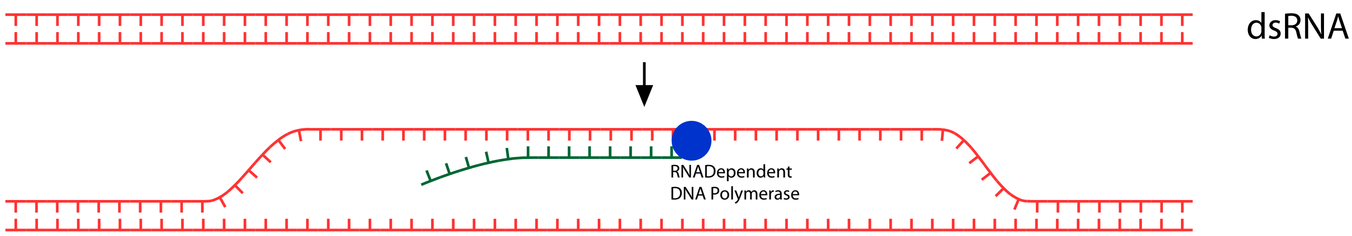
By Noel Ways

Polymerase Identification Handout

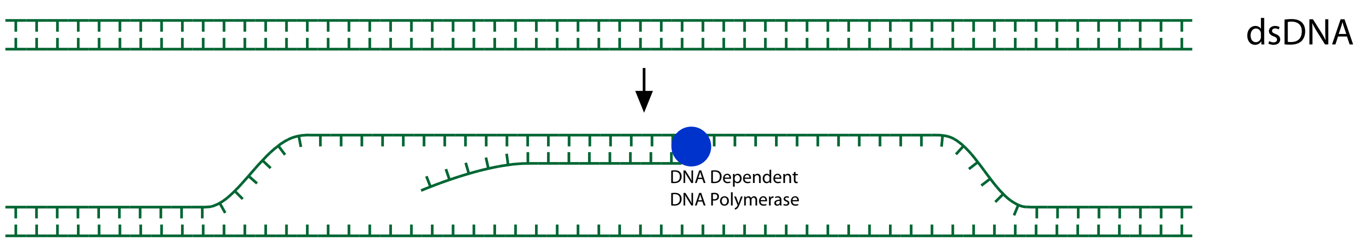
DNA Dependent RNA Polymerase - Used during *transcrpition* (ie, production of *"RNA transcript"*)



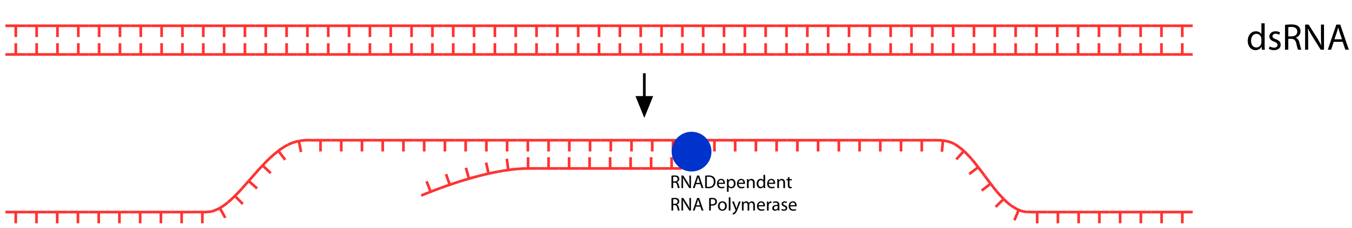
RNA Dependent DNA Polymerase - Important in the life cycle of *Retroviruses* (to be studied later). Also vital in Genetic Engineering. This polymerase sometimes gets the speical name, *"Reverse Transcrptase"* (Note, this process is the reverse of transcription noted above).



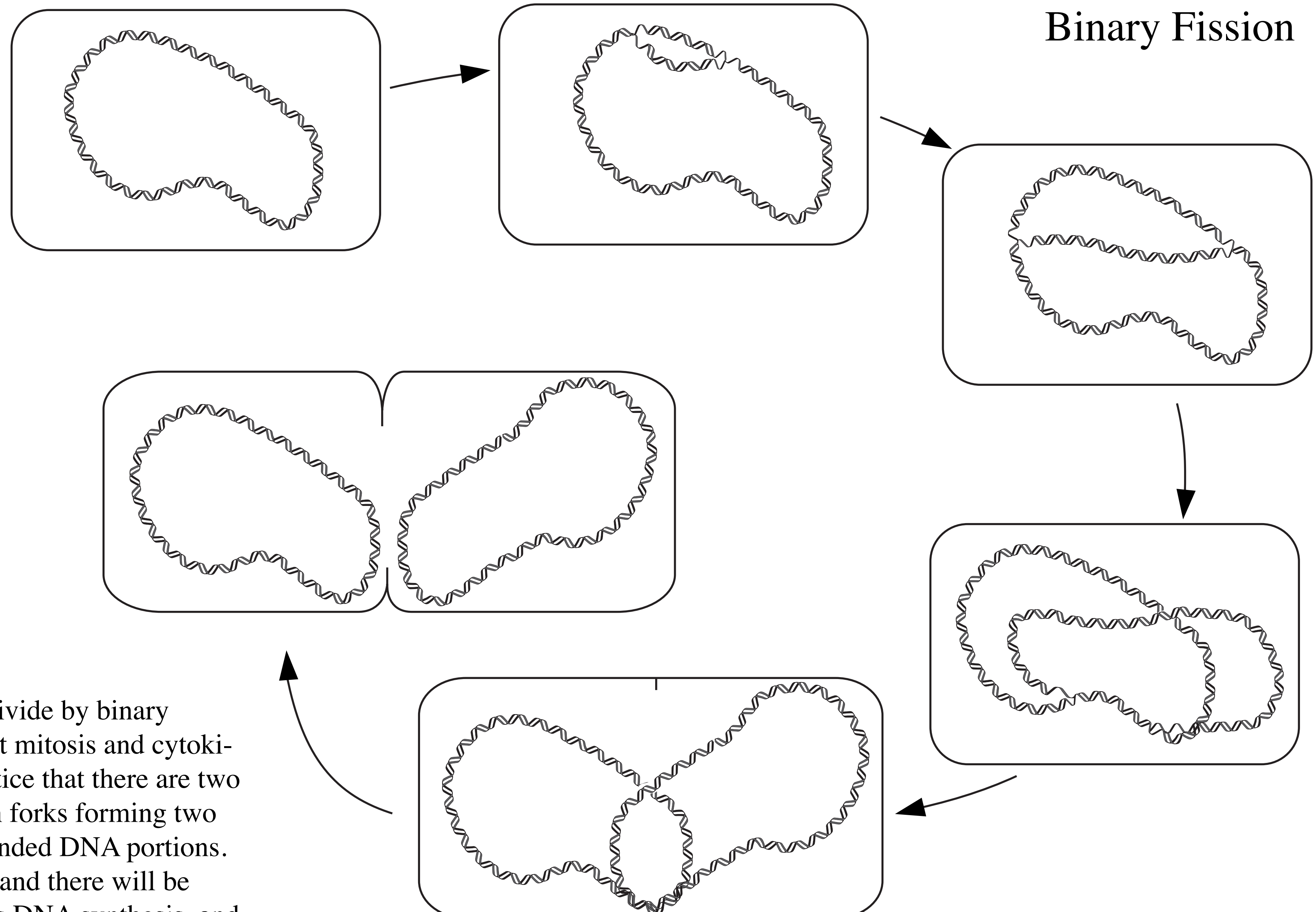
DNA Dependent DNA Polymerase - Used during DNA replication, as in *Binary Fission* of Prokaryotic Cells.



RNA Dependent RNA Polymerase - Important in the life cycle of many *RNA viruses* (to be studied later).



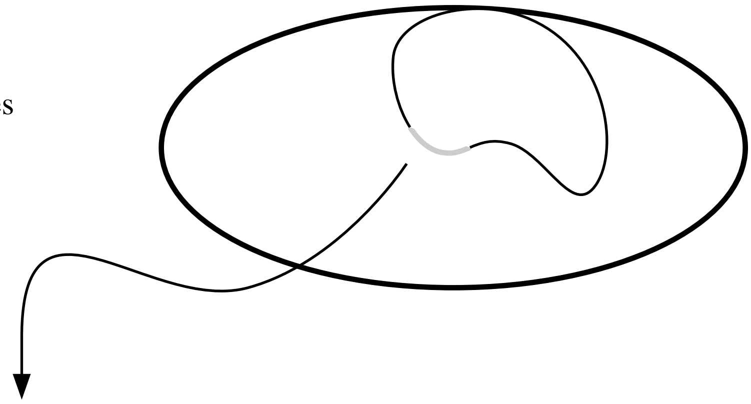
Binary Fission

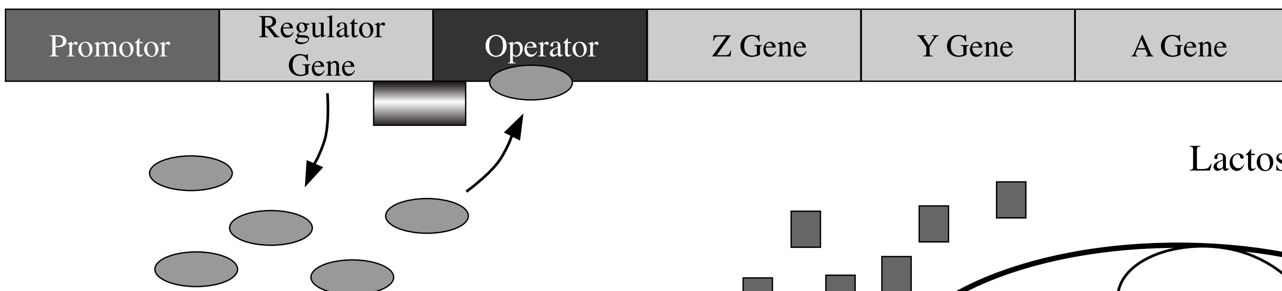


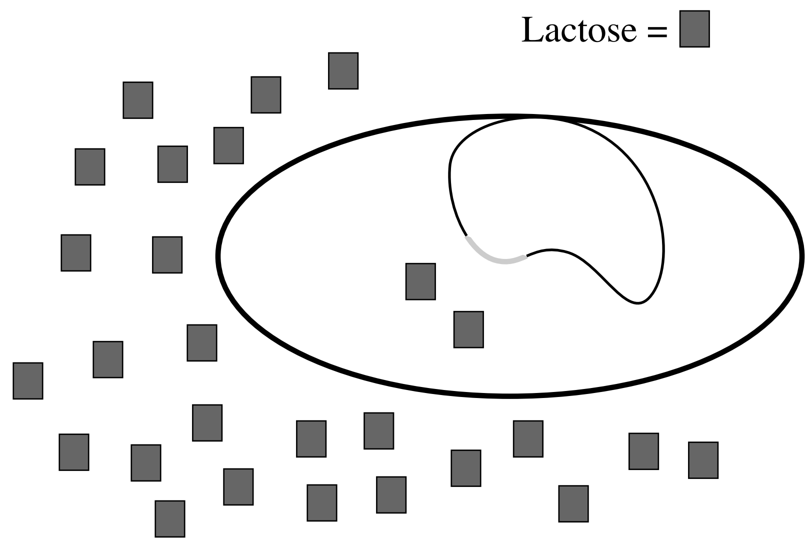
Bacteria divide by binary fission, not mitosis and cytokinesis. Notice that there are two replication forks forming two single stranded DNA portions. On one strand there will be continuous DNA synthesis, and on the other discontinuous DNA synthesis.

Gene Induction

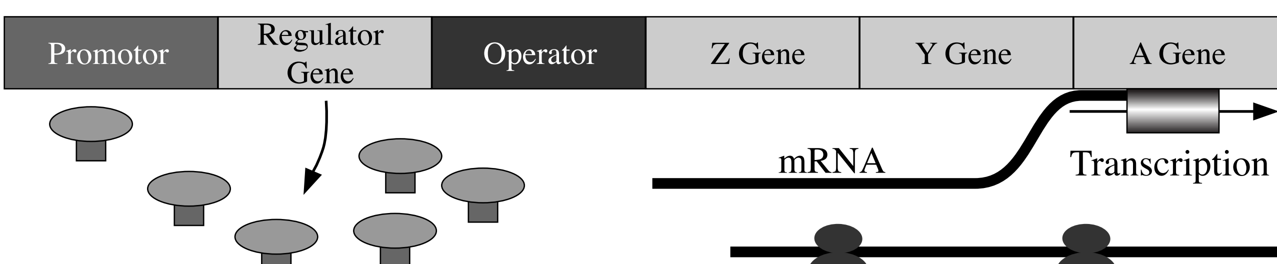
Transcription and translation of genes requires energy and resources. If the expression of the genes is needed only at certain times, then control of this process is in order. in this case the operon is designed for the digestion of lactose. If lactose is present, then genes should be expressed, thereby allowing the bacteria to utilize lactose as an energy source. If lactose is not present, the functional genes should not be expressed. In the absence of lactose the repressor molecules (made by the repressor gene) will bind to the operator (1), thereby not allowing the DNA dependent RNA polymerase to transcribe the functional genes. Hence, there will be no translation, and therefore no lactose digesting enzymes.

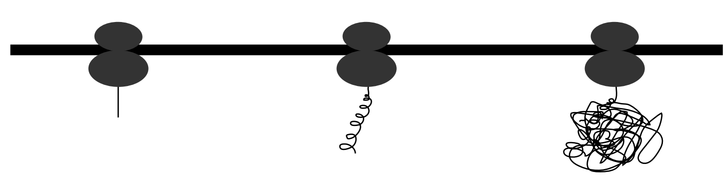






The presence of lactose (2), however will promote transcription and translation of the operon responsible for lactose digestion. Here, some lactose gets into the cell (3) and binds to the regulator molecules (4). By doing so, the regulator molecules an no longer attach to the operator. Now the DNA dependent RNA polymerase (5) is allowed to move beyond the operator and transcribe the functional genes.





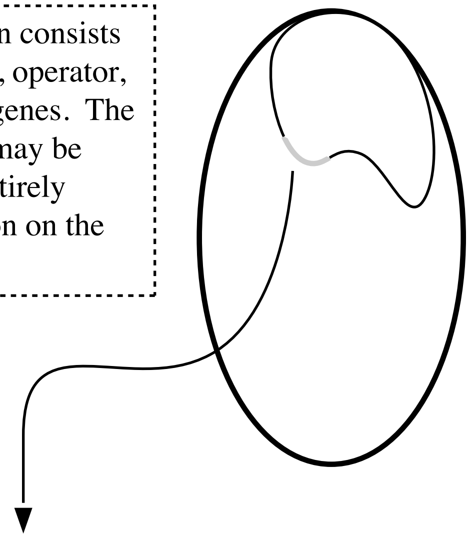
Once the genetic information relative to lactose digestion is transcribed into mRNA, the mRNA will then be translated by the ribosomes into the necessary enzymes to digest lactose. In this case, there is a permease, which makes the cell more permeable to the disaccharide; a prep enzyme (transactylase) necessary to prepare the sugar for digestion; and a digestive enzyme (galactosidase), which will break the sugar into the monosaccharide, glucose and galactose.

Note, should lactose become in short supply, for whatever reason, there will no longer be lactose available to bind to the repressor molecules. The repressor molecules will therefore spontaneously bind to the operator thereby halting transcription, and again saving the cell energy and resources.

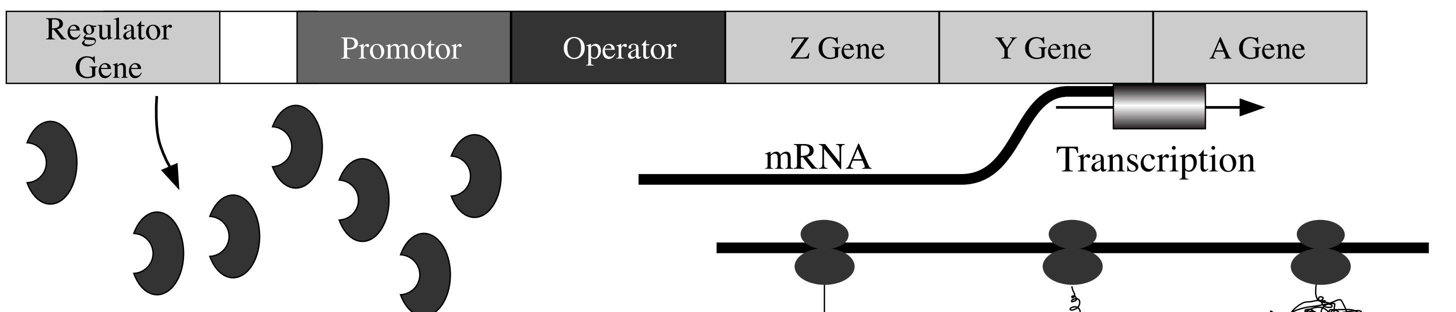
Gene Repression

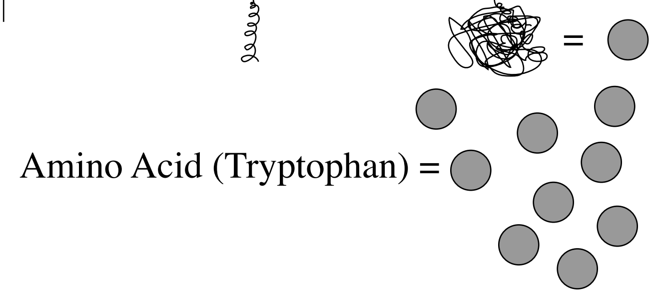
In this mode of gene regulation, the cell manufactures critical molecules essential for it's metabolism and survival. All such substances are only needed in particular concentrations. Once the need is met, the best strategy is to stop manufacturing the material until it is needed again. This saves energy and resources.

Note: the operon consists of the promotor, operator, and functional genes. The regulator gene may be located in an entirely different location on the chromosome.

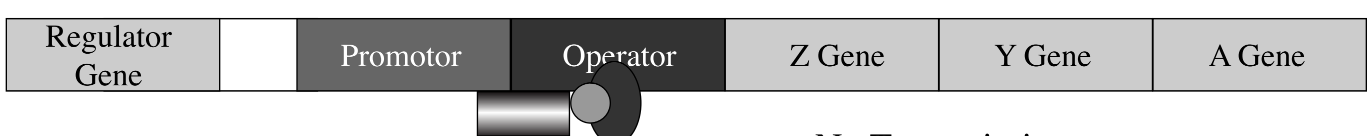


This is accomplished by producing regulator molecules that will become active only when a particular product is present (in this case, Tryptophan).

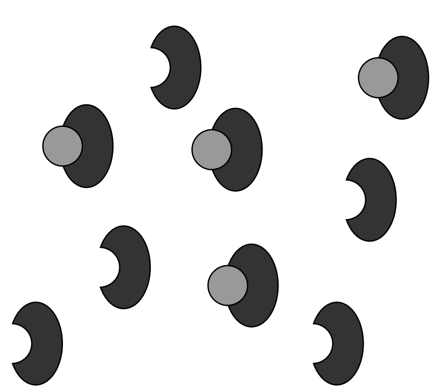




To accomplish this, both the critical molecules as well as the regulator molecules are made at the same time. However, once there is sufficient product to meet the metabolic needs of the cell, some of this product will bind to the repressors (regulator molecules) and activate them. An activated regulator molecule now binds to the operator and prevents the DNA dependent RNA polymerase for transcribing the DNA into mRNA. Now, energy and resources will not be wasted in producing molecules no longer needed.



No Transcription



Should the concentration of the essential molecules slip below a critical threshold, and there is no longer adequate concentrations to bind to the repressor molecules, the repressor molecules will be released from the operator and transcription will again proceed, until the concentration is again reestablished at necessary levels.