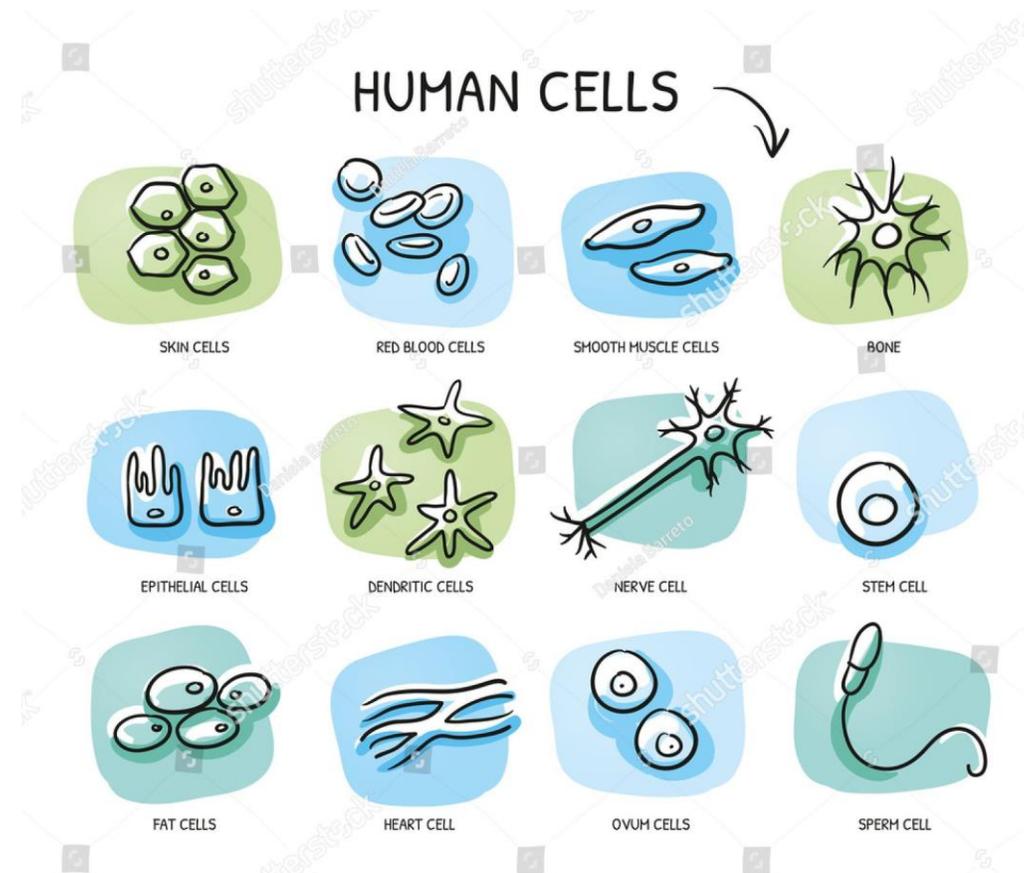


Gene Regulation

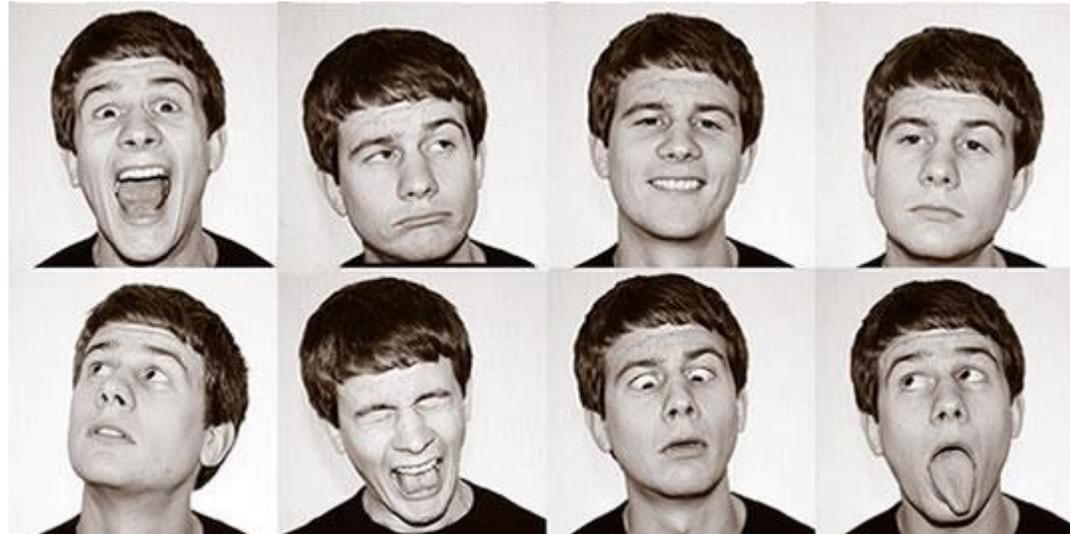
How different cells act like different cells

How does the same set of genes direct the activities of 220 human cell types?



Gene Regulation

The process of controlling which genes in a cell's DNA are expressed (used to make a functional product such as a protein).



When a gene is **expressed**, it is “turned on” (protein will be produced)

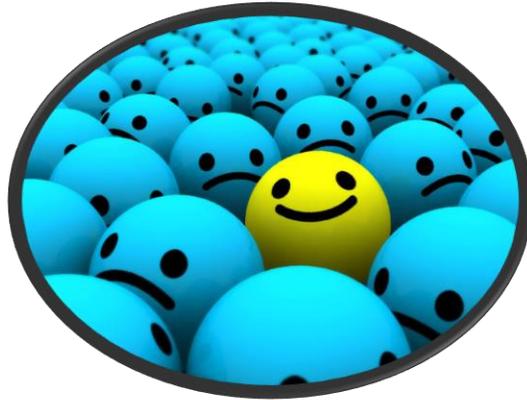


When a gene is **repressed**, it is “turned off” (protein will not be produced)



All the cells in a multicellular organism contain the same DNA.

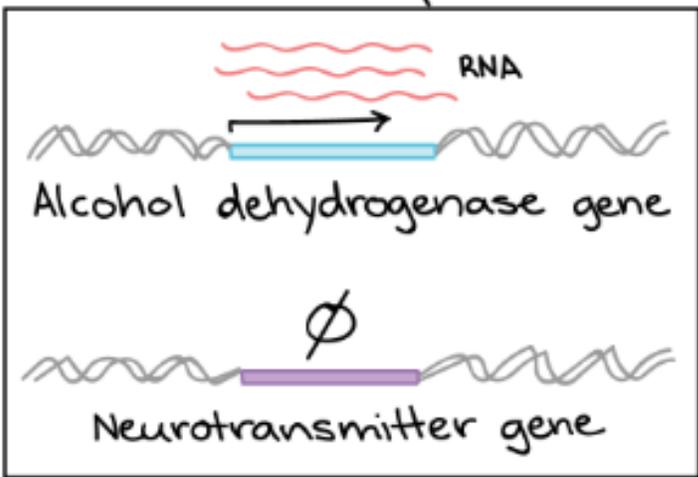
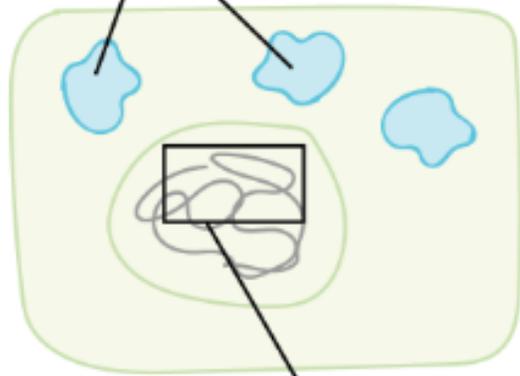
However, different cells may express very different sets of genes.



How, then, does this make different types of cells different?

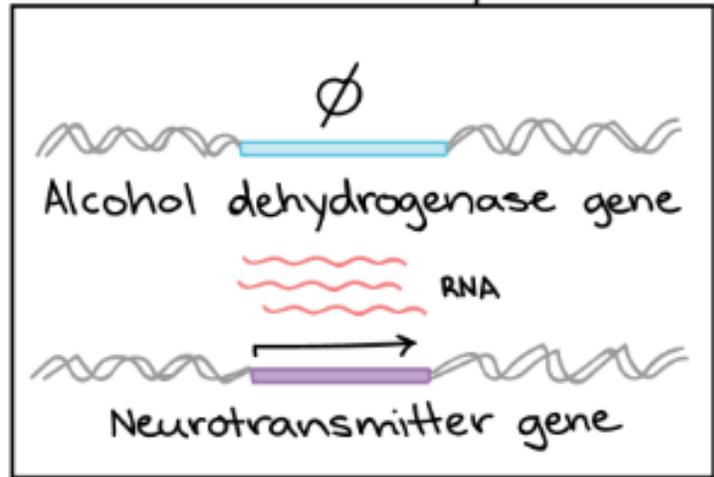
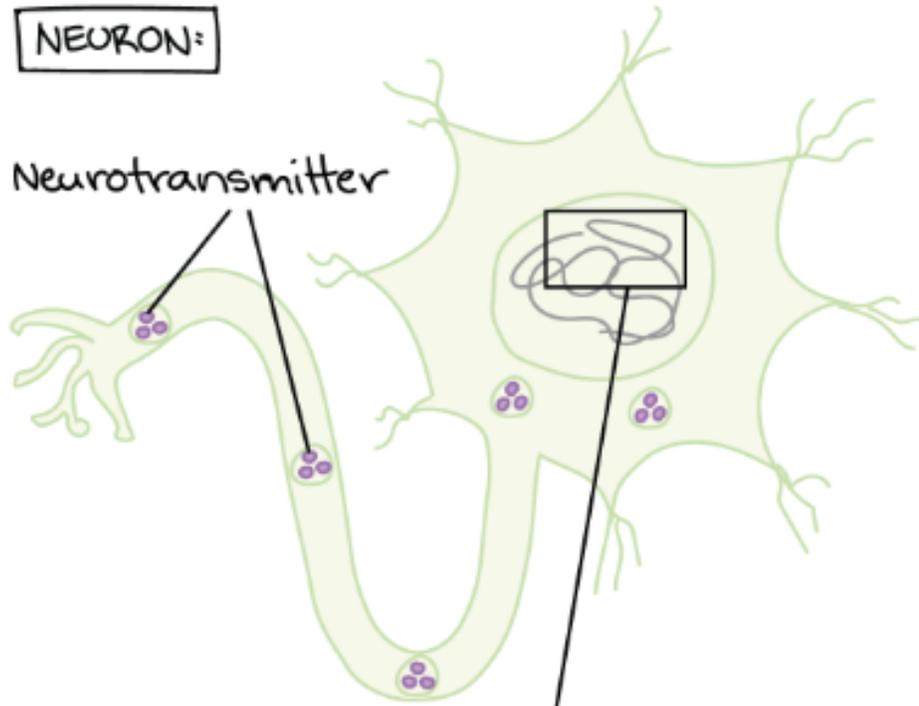
LIVER CELL:

Alcohol dehydrogenase

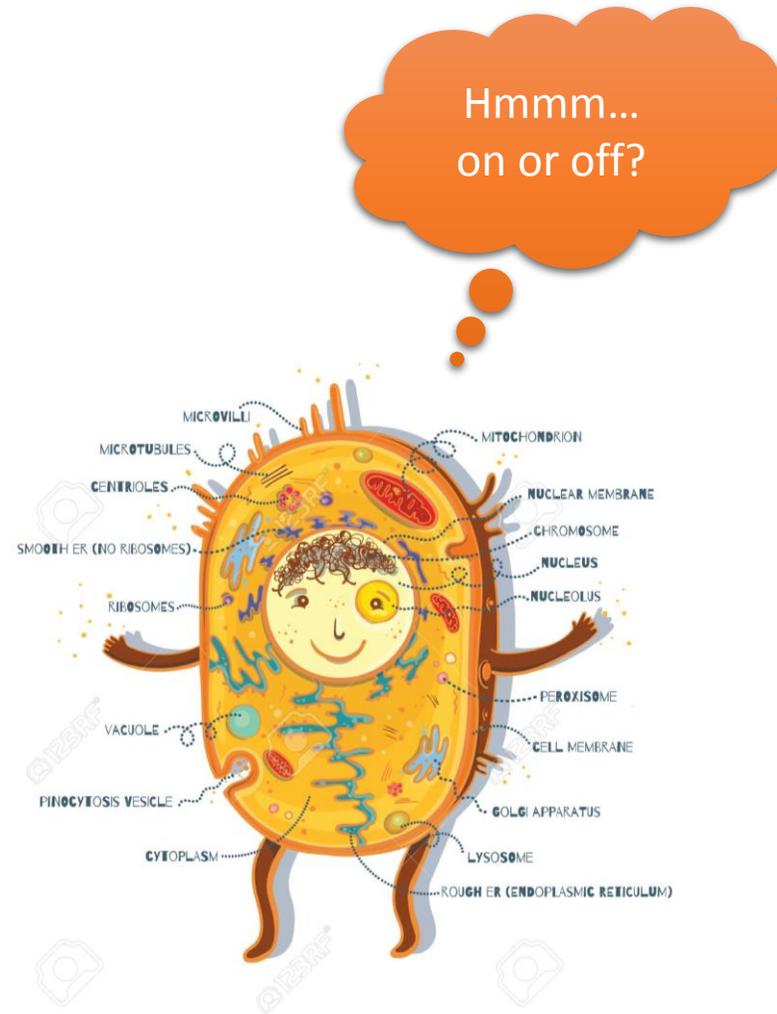


NEURON:

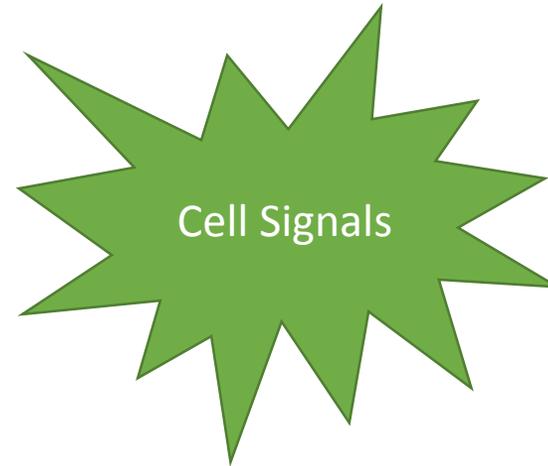
Neurotransmitter



How do cells "decide" which genes to turn on?

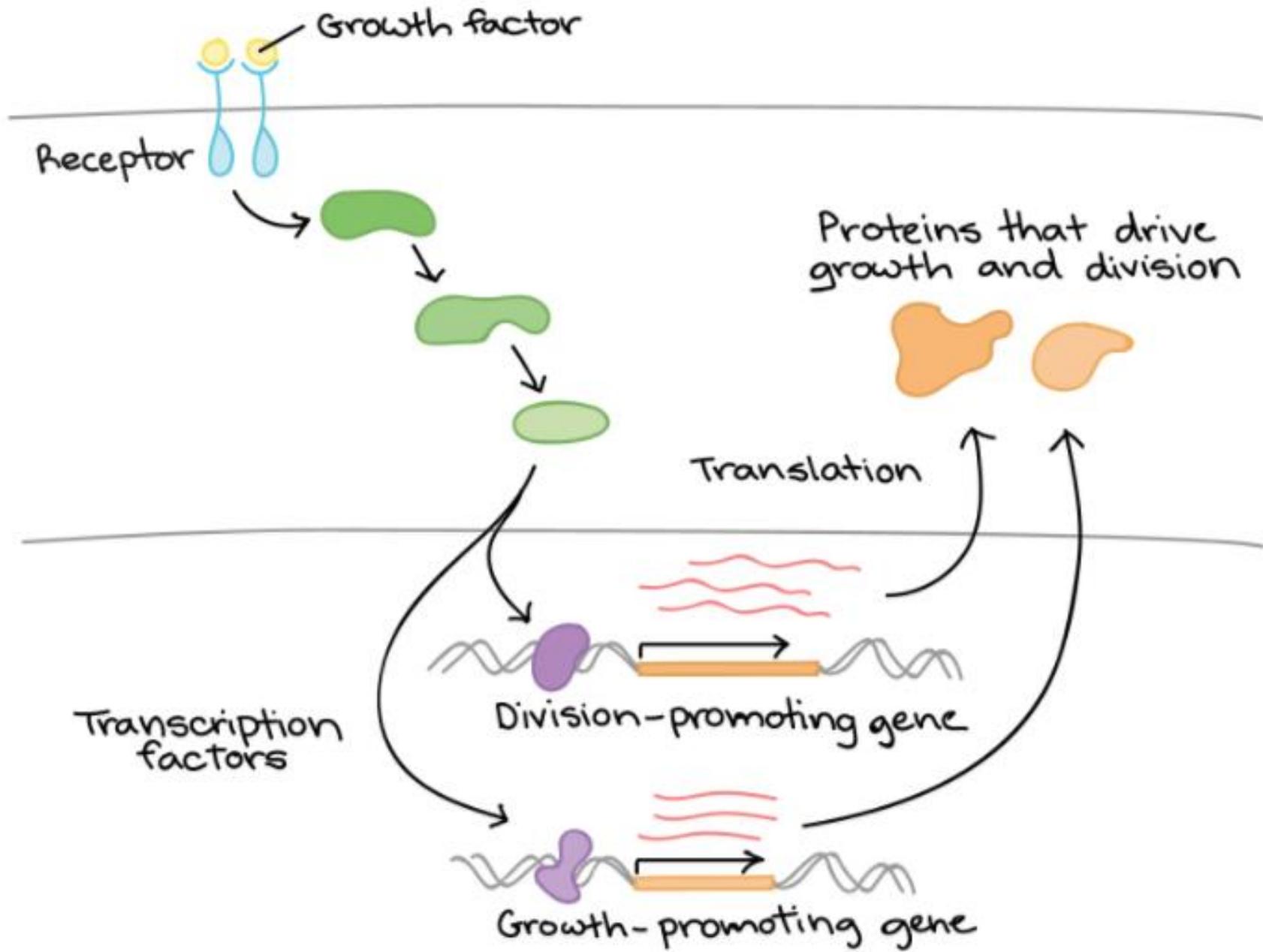


A cell's gene expression pattern is determined by information from both inside and outside the cell.



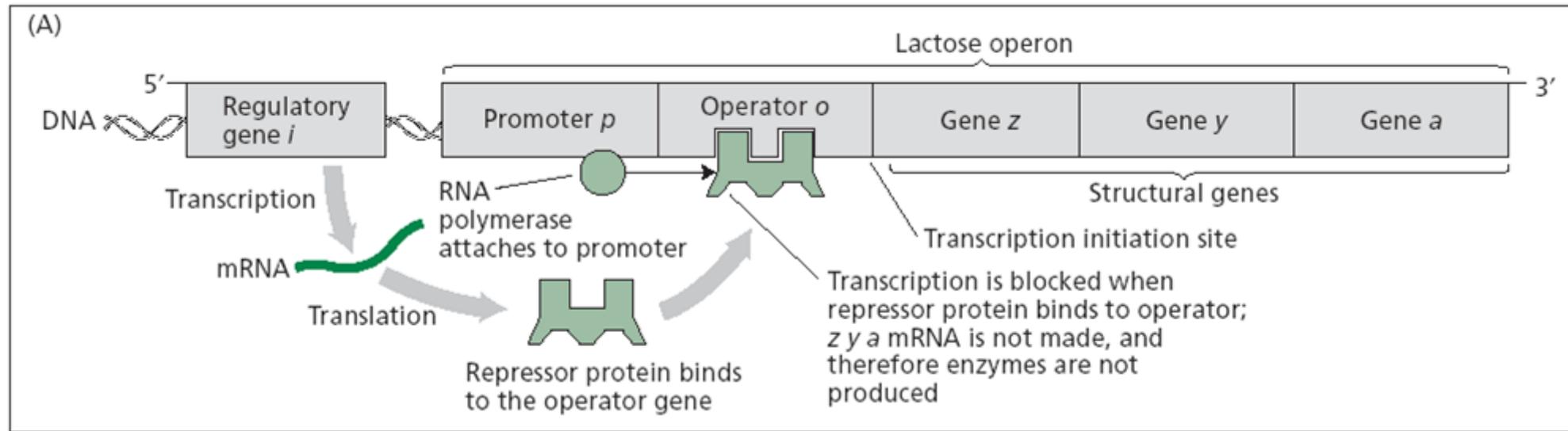
From inside the cell (ex: inherited proteins, whether its DNA is damaged, how much ATP it has).

From outside the cell (ex: chemical signals from other cells, mechanical signals from the extracellular matrix, and nutrient levels).



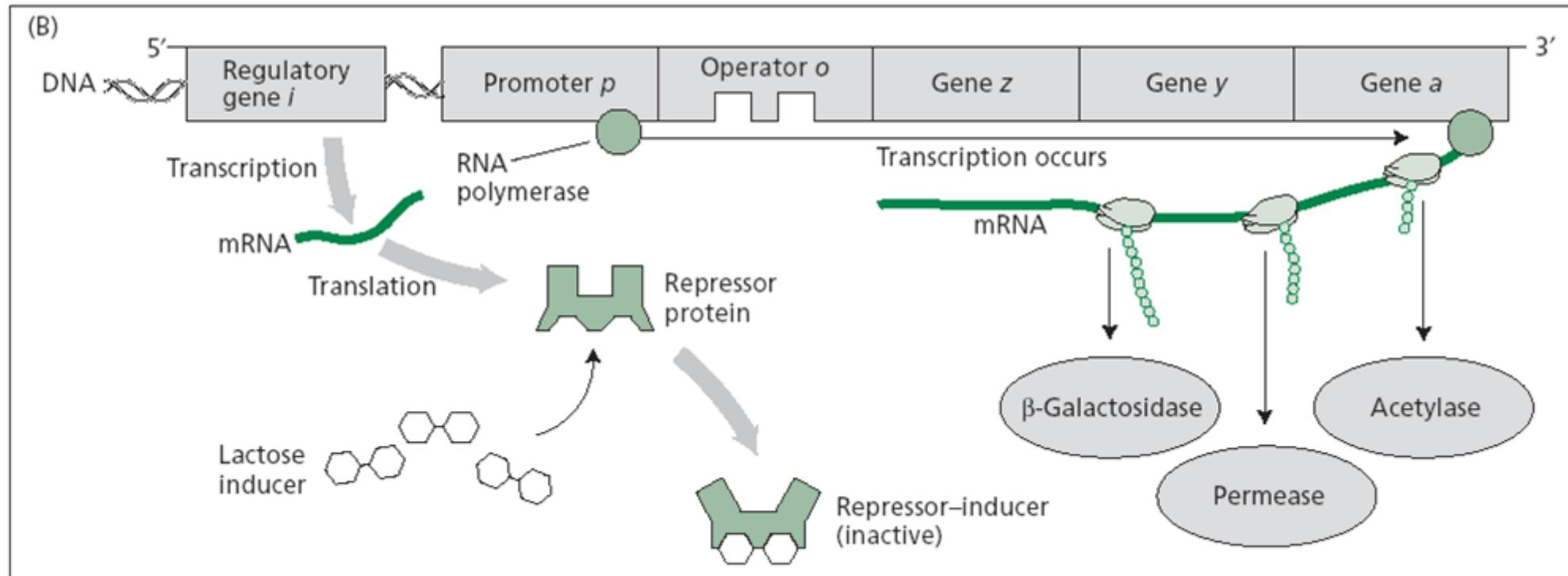
the lac operon

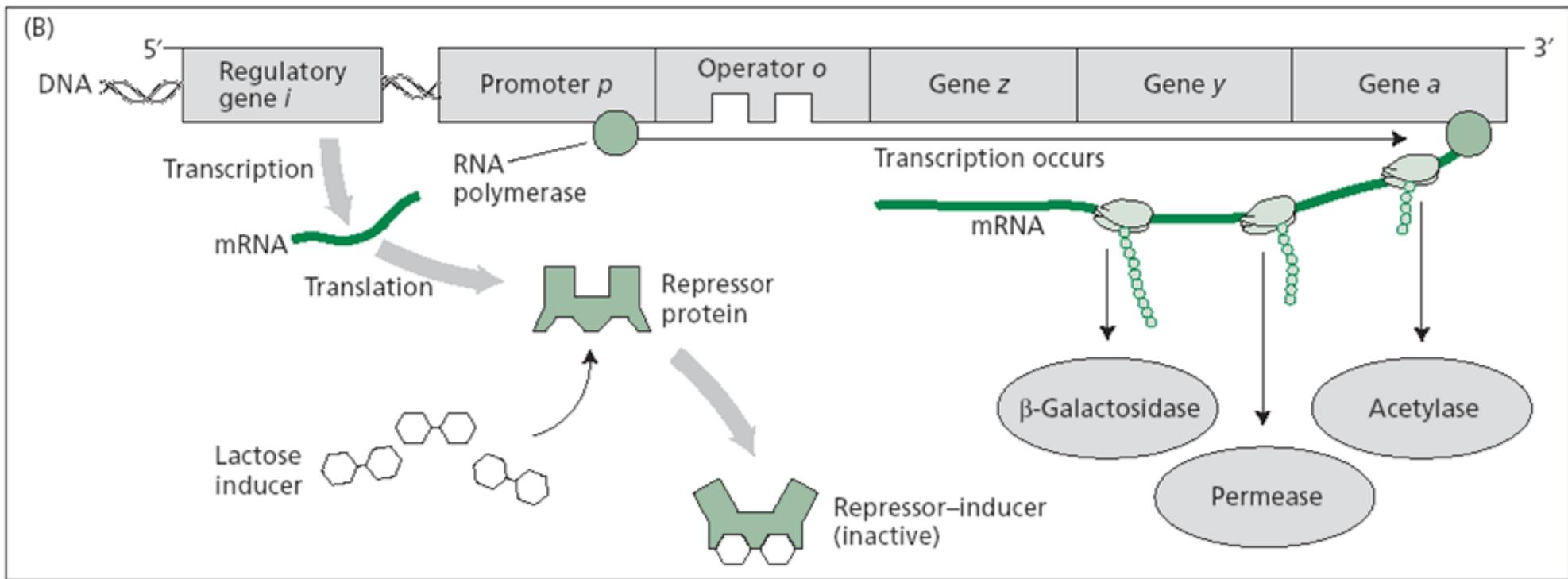
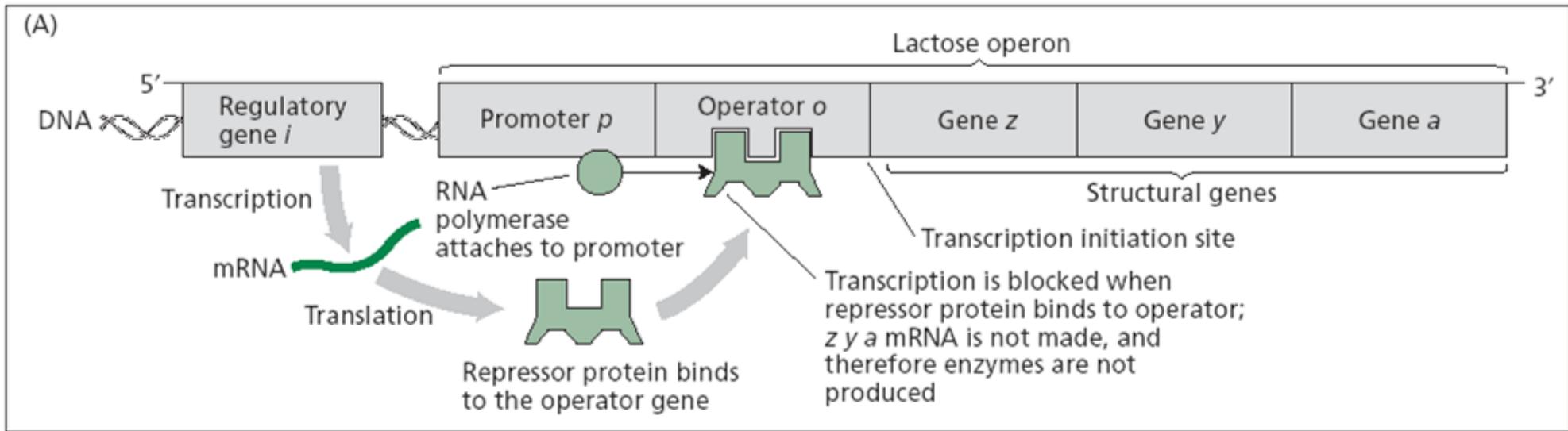
gene regulation in prokaryotic *E. coli* bacteria



No lactose present, so no need to produce proteins that break down lactose

Lactose is present, so cell needs to produce proteins that break down lactose





Eukaryotic gene expression involves many steps, and almost all of them can be regulated.

Chromatin accessibility. The structure of chromatin (DNA and its organizing proteins) can be regulated. More open or “relaxed” chromatin makes a gene more available for transcription.

Transcription. Sets of transcription factor proteins bind to specific DNA sequences in or near a gene and promote or repress its transcription into an mRNA.

RNA stability. The lifetime of an mRNA molecule in the cytoplasm affects how many proteins can be made from it. Small regulatory RNAs called miRNA scan bind to target mRNAs and cause them to be chopped up.

Translation. Translation of an mRNA may be increased or inhibited by regulators. For instance, miRNAs sometimes block translation of their target mRNAs (rather than causing them to be chopped up).

Protein activity. Proteins can undergo a variety of modifications, such as being chopped up or tagged with chemical groups. These modifications can be regulated and may affect the activity or behavior of the protein.

