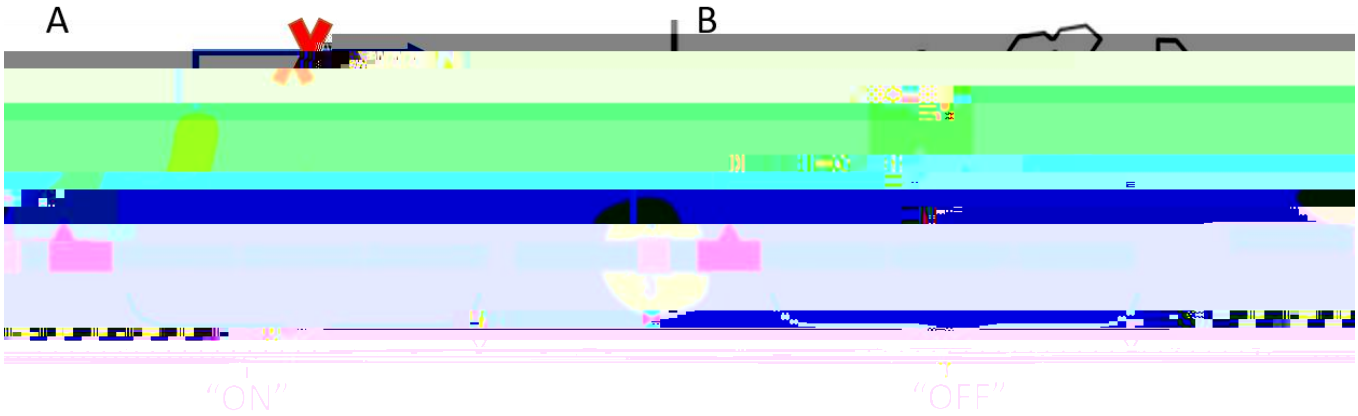
8. Genetic regulation of metabolism in bacteria

In the mid-20th century, French scientists Jacques Monod and Francois Jacob conducted a series of experiments on bacteria that linked metabolism with genes and their regulation. Their work is widely considered to be one of the foundations of molecular biology, and was acknowledged by the 1965 Nobel Prize in Physiology and Medicine.

Lactose is a discaccharide comprised of glucose and galactose

The scientists grew *Escherichia Coli* bacteria on media supplemented with different nutrient sources and noticed that when lactose was present in the media, *E. Coli* produced 200 times more enzyme lactase than in media without lactose (*to learn*).

This has led to a key idea that cells do not waste energy producing something, e.g. an enzyme, that they do not need, so there must be a regulation mechanism allowing bacteria to link lactose presence with the production of proteins needed for metabolising this sugar. Proteins are encoded by genes, so one of the most obvious ways to control protein production is at the DNA level. Below is a schematic depiction of the mechanism by which the lactase gene is regulated in order to only be active when lactose is present. *Complete the table by writing the correct number from the diagram next to each label.*



Number	Label
	Lactose – a disaccharide of glucose and galactose
	Repressor protein (LacI) – binds operator sequence and blocks transcription
	RNA polymerase – transcribes DNA into mRNA (that then gets translated into protein)
	Genes coding for proteins involved in metabolising lactose (3 numbers), including lactase (also known as beta-galactosidase)
	Operator – a DNA sequence before genes where a repressor binds
	Promoter – a DNA sequence before genes where RNA polymerase has to bind in order to initiate transcription

As you see, there are three distinct growth phases of bacteria. What do you think happens in each one?

To understand why lactose does not get consumed in the first 5 hours of growth, another layer of regulation has to be added to the model described above. See how both glucose and lactose presence can affect lactase production in this video explanation: http://highered.mheducation.com/olcweb/cgi/pluginpop.cgi?it=swf::535::535::/sites/dl/free/0072437316/120080/bio27.swf::Combination%20of%20Switches%20-%20the%20Lac%20Operon

Based on