

# *Gene Machine - The Lac Operon*

**Talk to a Teacher**

**<http://spoken-tutorial.org>**

**National Mission on Education through ICT**

**<http://sakshat.ac.in>**

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# Learning Objectives



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- ▶ **Demonstrate Gene Machine - The Lac Operon, PhET Simulation**



# Pre-requisites



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- ▶ **Learner should be familiar with topics in high school Biology**



# System Requirement



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- ▶ **Ubuntu Linux OS v 14.04**



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- ▶ **Java v 1.7.0**





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- ▶ **Ubuntu Linux OS v 14.04**
- ▶ **Java v 1.7.0**
- ▶ **Firefox Web Browser v 53.02.2**



# Learning Goals



# Learning Goals

- ▶ **Lactose regulation**



# Learning Goals

- ▶ Lactose regulation
- ▶ Genes involved in Lactose regulation



# Learning Goals

- ▶ Lactose regulation
- ▶ Genes involved in Lactose regulation
- ▶ Factors affecting **LacZ** gene regulation



# About Lac Operon



# About Lac Operon

- ▶ The **Lac Operon** is a set of genes responsible for regulating lactose metabolism in *E.coli* bacteria



# Components of Lac Operon





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**An operon is made up of 3 basic DNA components:**



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**An operon is made up of 3 basic DNA components:**

- ▶ **Promoter:** Initiates transcription



# Components of Lac Operon

An operon is made up of 3 basic DNA components:

- ▶ **Promoter:** Initiates transcription
- ▶ **Operator:** Segment of DNA where repressor binds



# Components of Lac Operon

An operon is made up of 3 basic DNA components:

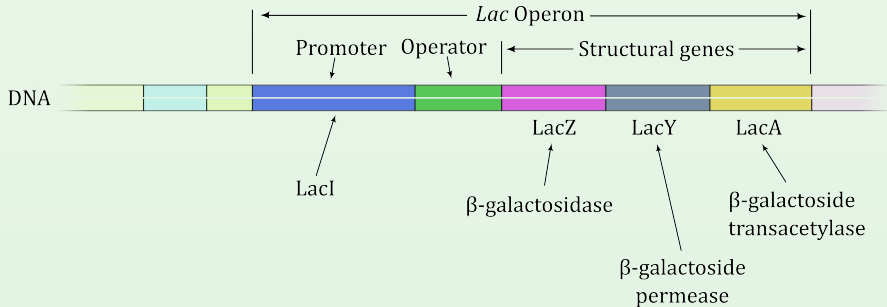
- ▶ **Promoter:** Initiates transcription
- ▶ **Operator:** Segment of DNA where repressor binds
- ▶ **Structural gene:** A gene which codes for protein



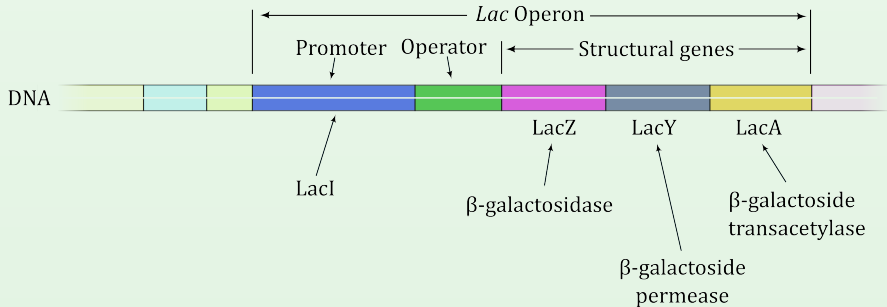
# Structural Gene



# Structural Gene



# Structural Gene



# PhET Simulation-Link





# PhET Simulation-Link

<https://phet.colorado.edu>



# LacI Protein



# LacI Protein

- ▶ **LacI** is a Lac repressor protein



# LacI Protein

- ▶ **LacI** is a Lac repressor protein
- ▶ It binds to the Lac operator region of the Operon



# LacZ Protein



# LacZ Protein

- ▶ **LacZ** is  $\beta$  – *galactosidase* enzyme



# LacZ Protein

- ▶ **LacZ** is  $\beta$  – *galactosidase* enzyme
- ▶ It cleaves lactose into glucose and galactose



# LacY Protein

- ▶ **LacY** is  $\beta$  – *galactoside permease* enzyme





# LacY Protein

- ▶ **LacY** is  $\beta$  – *galactoside permease* enzyme
- ▶ It enables transport of lactose into the cell



# Factors affecting LacZ gene regulation



# Factors affecting LacZ gene regulation

- ▶ **The lac repressor acts as a lactose sensor**



# Factors affecting LacZ gene regulation

- ▶ The lac repressor acts as a lactose sensor
- ▶ It blocks transcription of the Lac Operon when there is no lactose present in the cell



# Factors affecting LacZ gene regulation



# Factors affecting LacZ gene regulation

- ▶ **When lactose is present, the lac repressor loses its ability to bind DNA**



# Factors affecting LacZ gene regulation

- ▶ When lactose is present, the lac repressor loses its ability to bind DNA
- ▶ It floats off the operator, clearing the way for RNA polymerase to transcribe the Operon



# Summary





# Summary

- ▶ How to use Gene Machine-The Lac Operon, PhET simulation



# Summary



# Summary

- ▶ Lactose regulation
- ▶ Genes involved in lactose regulation
- ▶ Factors affecting **LacZ** gene regulation



# Assignment



# Assignment

1. Remove some of the components of Operon (Operator, Promoter and Genes)
2. Run the simulation
3. Observe the results and give explanation



# About the Spoken Tutorial Project

- ▶ Watch the video available at [http://spoken-tutorial.org/What\\_is\\_a\\_Spoken\\_Tutorial](http://spoken-tutorial.org/What_is_a_Spoken_Tutorial)
- ▶ It summarises the Spoken Tutorial project



# About the Spoken Tutorial Project

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- ▶ It summarises the Spoken Tutorial project
- ▶ If you do not have good bandwidth, you can download and watch it



# Spoken Tutorial Workshops

## The Spoken Tutorial Project Team

- ▶ Conducts workshops using spoken tutorials
- ▶ Gives certificates to those who pass an online test
- ▶ For more details, please write to [contact@spoken-tutorial.org](mailto:contact@spoken-tutorial.org)





# Forum for specific questions

- ▶ Do you have questions in **THIS Spoken Tutorial?**
- ▶ Please visit  
<http://forums.spoken-tutorial.org>
- ▶ Choose the minute and second where you have the question
- ▶ Explain your question briefly
- ▶ Someone from our team will answer them



# Acknowledgements

- ▶ This project is partially funded by  
**Pandit Madan Mohan Malaviya  
National Mission on Teachers and  
Teaching**



# Acknowledgements

- ▶ Spoken Tutorial Project is a part of the Talk to a Teacher project
- ▶ It is supported by the National Mission on Education through ICT, MHRD, Government of India
- ▶ More information on this Mission is available at

<http://spoken-tutorial.org/NMEICT-Intro>

