Labster Virtual Lab Experiments: Basic Genetics

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Springer Spektrum

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Preface

Welcome to the "Basic Genetics" textbook, which is part of the "Labster Virtual Lab Experiments" series.

This book will help you to learn the fundamental concepts of basic genetics while applying your newly acquired knowledge in a virtual lab environment. In each chapter you will be introduced to one of five virtual lab simulations and the true-to-life missions that you will encounter when playing the simulations. Study the theory section presented in each chapter carefully and you will be fully prepared to master the challenging tasks awaiting you in the virtual lab!

Finally, you will find the learning objectives and techniques covered by the virtual lab simulation at the end of each chapter to easily align its content with your exam preparation.

About Labster

Labster is a company dedicated to developing virtual lab simulations that are designed to stimulate students' natural curiosity and highlight the connection between science and the real world. These simulations have been shown to improve learning outcomes among students, by making the learning experience more immersive and engaging. The content of this book was created by the Labster team members Dr. Sarah Stauffer, Dr. Aaron Gardner, Dr. Wilko Duprez, Dewi Ayu Kencana Ungu, Philip Wismer and Silvia Tjong.

About the Content of this Textbook

Genetics is the study of how living organisms pass on traits or characteristics to the next generation, and the mechanisms that control variations in these traits. The

study and manipulation of the genetic code is now a cornerstone of life science research and beyond; from identifying single DNA nucleotides, to reading an organism's entire genome to observing the spread of genes through a population.

Mendelian Inheritance
In the first chapter of this book, you will learn how Gregor Mendel kick-started genetic research in the late 19th-century by painstakingly investigating how specific traits were inherited across generations. Mendel's basic postulates are still widely used today, and in the Mendelian Inheritance simulation you will learn to apply two of them to a real-world situation. Can you help a color-blind patient understand if his children will also be affected?

Polymerase Chain Reaction
After learning how to apply Mendel's postulates you will learn about one of the most important techniques used in modern labs: the polymerase chain reaction (PCR). PCR is a widely used molecular biology technique whereby a single copy (or a small number) of a DNA fragment can be massively amplified for later analysis. PCR is widely used across disciplines but in the Polymerase Chain Reaction simulation you'll help investigators identify a murderer based on their DNA fingerprint.

Animal Genetics
Combining Mendelian inheritance with molecular biology techniques such as PCR is an incredibly powerful way of investigating population genetics, and identifying which genes are linked with specific traits. In the Animal Genetics simulation you will investigate a mutation on a cattle farm which leads to double-muscling. Can you identify in which gene the mutation resides and design a rapid test to detect it?

Gene Expression
While mutation is an important driver of genetic variation, there are many other mechanisms employed by our cell, giving rise to the huge variety of tissues contained in our bodies. It is estimated that our DNA contains approximately 20,000 genes. But not all genes are expressed equally; this variation gives rise to the different tissues of our body, determines variation between individuals and can even lead to the development of certain diseases or disorders. In the Gene Expression simulation, you will perform a cutting-edge next-generation sequencing (NGS) experiment to identify a candidate gene which may be linked with obesity.

Gene Regulation
Finally, you will combine all of your genetic knowledge and learn about how variation in gene expression is a tightly regulated process, with numerous factors increasing or decreasing expression in a highly complex fashion. While incredibly complicated, an understanding of this regulation can lead to some amazing discoveries, such as that described by Shinya Yamanaka whose study of stem cell biology won him the Nobel Prize for physiology in 2012. In the Gene Regulation simulation, you will replicate Yamanaka's groundbreaking work, generating induced pluripotent stem (iPS) cells, then attempt to differentiate these cells for transplantation.

At the end of your time in the virtual lab simulations, you should have a solid understanding of genetics; from its first discovery through to the cutting-edge science being performed today, and the techniques you will learn are fundamental to life science research and beyond.

How to Access the Virtual Simulations?

You can access the five virtual lab simulations included in this book at www.labster.com/springer.

If you have purchased a printed copy of this textbook, you will find a voucher code **on the last page**, which gives you free access to the five simulations for the duration of one semester (six months).

If you are using the e-book version, you can sign up and buy access to the simulations through the same link.

Please be aware that the six month period starts once you sign in for the first time.

If you have any questions about the use of the voucher, you can contact us at customerservice@springer.com.

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