

Course **Syllabus**

What you will learn in this course



Biotechnician 1b: Advancements in Biotechnology

You've scratched the genetic surface of a biotechnician's world, but now, we're going to dive deeper into mankind's future. In this course, you'll explore essential topics that structure the reality of biotechnology such as the role genetics and epigenetics play in influencing human traits, the creation and purpose of recombinant DNA, and how the human immune response can be tweaked to fight disease. You'll also explore GMO's and biofuels and how an idea becomes reality in the biotech industry. Let's continue learning about how you can change the world in a role as a biotechnician.

Unit 1: Genetics and Beyond: Epigenetics

Since much of what we are is due to our DNA, it is important to understand how our cells receive and translate their instructions. Not all cells develop in the same way, and each person's cells are unique, even if their DNA came from the same set of parents. So what influence do our

parent's genes have on our development? Are there other things that can influence how our cells express themselves? Why is it important for scientists to understand this important process? The answers to these questions can be found by looking more closely into genetic inheritance and another type of inheritance called epigenetics.

What will you learn in this unit?

1. Recognize recessive and dominant Mendelian inheritance patterns
2. Understand how gene expression in germ cells, stem cells, and somatic cells is controlled
3. Determine the difference between genetics and the genome vs. epigenetics and the epigenome
4. Cite examples of epigenetic inheritance

UNIT 1 Assignments	
Assignment	Type
Unit 1 Critical Thinking Questions	Homework
Unit 1 Activity 1	Homework
Unit 1 Activity 2	Homework
Unit 1 Activity 3	Homework
Unit 1 Discussion 1	Discussion
Unit 1 Discussion 2	Discussion
Unit 1 Quiz	Quiz

Unit 2: Stem Cells: Hope for the Future

What are stem cells? Did you know they are life-giving opportunities for hundreds of thousands of grateful bone marrow transplant recipients who suffer from cancers of the blood such as leukemia and lymphoma? Stem cells may one day be able to treat degenerative diseases such as spinal cord injuries, type I diabetes, and heart disease. Let's consider not only the science behind stem cells but also the ways scientists are using them to treat disease.

What will you learn in this unit?

1. Understand the difference between an embryonic stem cell and a somatic stem cell, as well as the significance of iPS cells
2. List the uses of stem cells, such as in bone marrow transplant
3. Explain applications of research involving regenerative medicine
4. Connect how cloning Dolly the sheep led to the development of iPS cells
5. Evaluate the many ethical issues surrounding stem cell technology

UNIT 2 Assignments	
Assignment	Type
Unit 2 Critical Thinking Questions	Homework
Unit 2 Activity 1	Homework
Unit 2 Activity 2	Homework
Unit 2 Activity 3	Homework
Unit 2 Discussion 1	Discussion
Unit 2 Discussion 2	Discussion
Unit 2 Quiz	Quiz

Unit 3: Genetic Engineering: The Dawn of CRISPR

Since the discovery of DNA, scientists have continually investigated how it works and can be manipulated. This has led to the age of genetic engineering, which is already improving the lives of millions through advances in agriculture, the environment, and medicine. Many feel that the discovery of CRISPR could be our next quantum leap forward in medicine. This powerful, precise, and efficient gene-editing tool first looks for a mistake in a cell's DNA and then cuts it out and replaces it with a new DNA sequence! Scientists are excited to apply this new technology to treat genetic diseases like sickle cell anemia and others. We'll consider the exciting discoveries in genetic engineering that brought us to today, how they work, and what they promise for the future.

What will you learn in this unit?

1. Track some of the historic discoveries that have led to our current advances in genetic engineering
2. Explain the process of creating a recombinant DNA and gene expressing it in a model organism
3. Understand the mechanisms involved in the gene search/edit proteins of zinc finger nucleases, TALENS, and CRISPR-Cas9
4. List current applications of CRISPR technology
5. Acknowledge the ethical issues involved in gene-editing technologies

UNIT 3 Assignments	
Assignment	Type
Unit 3 Critical Thinking Questions	Homework
Unit 3 Activity 1	Homework
Unit 3 Activity 2	Homework
Unit 3 Activity 3	Homework
Unit 3 Discussion 1	Discussion
Unit 3 Discussion 2	Discussion
Unit 3 Quiz	Quiz

Unit 4: Immunology: Our Great Defender

Microscopic organisms make us sick and can even kill us, but evolution has not left us defenseless. All organisms, from bacteria to humans, possess some sort of immune system that recognizes invading pathogens and rallies a force to destroy them. We can prime our immune system and jumpstart this process through vaccination. We can even engineer specific immune cells called CAR T cells to seek out and destroy cancer cells. Biotechnology even harnessed the power of antibodies for routine clinical tests such as ELISA and Western Blotting. Let's dive into this world of immunology and learn about the vigilant army of cells that are programmed and ready to protect us.

What will you learn in this unit?

1. Define a pathogen and distinguish the difference between a bacterium and a virus
2. Compare primitive immune systems like RNAi and CRISPR with human adaptive and innate immune systems
3. Outline the mechanism of action of a traditional vaccine and compare this process to the novel COVID mRNA vaccine
4. Explain what CAR T cells are and why they act like a magic bullet directed towards cancer cells
5. Discuss the versatility of antibodies in the laboratory and how they are used in the ELISA or Western Blotting procedures

UNIT 4 Assignments	
Assignment	Type
Unit 4 Critical Thinking Questions	Homework
Unit 4 Activity 1	Homework
Unit 4 Activity 2	Homework
Unit 4 Activity 3	Homework
Unit 4 Discussion 1	Discussion
Unit 4 Discussion 2	Discussion
Unit 4 Quiz	Quiz

Biotechnician 1b Midterm Exam

- Review information acquired and mastered from this course up to this point.
- Take a course exam based on material from the **first** half of the course (Note: You will be able to open this exam only one time.)

MIDTERM Assignments	
Assignment	Type
Midterm Exam	Exam

Midterm Discussion

Discussion

Unit 5: Model Organisms

How do scientists determine which gene to turn off to prevent cancer cells from growing or figure out how to activate immune cells to respond to a virus? Instead of using themselves as guinea pigs, scientists begin by experimenting with model organisms. Here, we will consider how model organisms are related to humans, which ones are generally used in the lab, and some of the important discoveries that have come from their use. We'll also consider some of the ethical issues that arise from experimenting on non-humans and how scientists balance these issues with the greater good.

What will you learn in this unit?

1. Gain an appreciation for the evolutionary relationship between different model organisms and where they fit on the phylogenetic tree of life
2. List advances like gene expression and the process of recombinant DNA technology due to experiments on *E. coli*
3. Compare the use of simple eucaryotes in biotechnology, recognizing their advantages and disadvantages
4. Understand the ethical concern with the use of vertebrates as model organisms
5. Describe applications that scientists use with the plant *Arabidopsis thaliana*

UNIT 5 Assignments

Assignment	Type
Unit 5 Critical Thinking Questions	Homework
Unit 5 Activity 1	Homework
Unit 5 Activity 2	Homework
Unit 5 Activity 3	Homework
Unit 5 Discussion 1	Discussion
Unit 5 Discussion 2	Discussion
Unit 5 Quiz	Quiz

Unit 6: Biotechnology in Agriculture and the Environment

What do the issues of world hunger, the oil spill from the Deepwater Horizon rig, and our growing carbon footprint all have in common? The solutions to these problems are being made possible by biotechnology! We will consider which biotechnologies are being used to accomplish these tasks, as well as learn more about some of the ethical issues that may arise in their use. We will also discuss the important work of organizations such as the US Food and Drug Administration, the US Environmental Protection Agency, and the US Department of Agriculture to provide oversight. Let's learn more about genetic engineering uses in agriculture and the environment to see how these advances are affecting us now and will continue to do so in the future.

What will you learn in this unit?

1. Explain how agriculture has benefited from genetically engineered crops and the regulations that oversee their use
2. Outline the steps in making a GMO or transgenic plant and understand the contribution CRISPR has made to the process
3. Recognize the use of biotechnology in environmental applications such as the cleanup of oil spills and contaminated land as well as production of biofuels
4. Discuss the controversial issues surrounding the use of GMOs in agriculture and environmental science and be knowledgeable about the ongoing debate

UNIT 6 Assignments	
Assignment	Type
Unit 6 Critical Thinking Questions	Homework
Unit 6 Activity 1	Homework
Unit 6 Activity 2	Homework
Unit 6 Activity 3	Homework
Unit 6 Discussion 1	Discussion
Unit 6 Discussion 2	Discussion
Unit 6 Quiz	Quiz

Unit 7: Starting Your Job in the Industry

A biotech manufacturing facility is a vibrant exciting microcosm of the outside world and one of the most exciting places you can be fortunate enough to work! So what goes on in a biotechnology company? Let's learn about the different departments you may one day get a chance to work in, and how they contribute to create, develop, and manufacture lifesaving medications. We will also consider how the government oversees these companies and works alongside their employees to make sure the final products are safe for consumers.

What will you learn in this unit?

1. Discuss the day-to-day responsibilities of a biotechnician at the workplace including ethical behavior, safety requirements, and use of GLPs
2. Describe how research & development identifies, experiments with, and tests a potential drug
3. List the stages of bioprocessing of a recombinant DNA product using the production of Genentech's recombinant human insulin as a model
4. Explain the vital tasks performed by quality control to provide a safe product for consumers
5. Appreciate the role that quality assurance departments play in making sure all procedures and products follow FDA regulations

UNIT 7 Assignments	
Assignment	Type
Unit 7 Critical Thinking Questions	Homework
Unit 7 Activity 1	Homework
Unit 7 Activity 2	Homework
Unit 7 Activity 3	Homework
Unit 7 Discussion 1	Discussion
Unit 7 Discussion 2	Discussion
Unit 7 Quiz	Quiz

Unit 8: Scientific Communication in Biotechnology

A life-changing discovery is made after hours of painstaking effort in the laboratory... CRISPR technology has the potential to cure genetic diseases! How do we effectively communicate this

information in a way that is credible, believable, honest, and in a format that both the expert and layman can appreciate? Effective communication is key. If scientific research is successfully communicated, it has the potential to raise the public's awareness of exciting scientific topics as well as create a sense of wonder about the world around us. Researchers must therefore have strengths with both written and verbal communication skills. Avenues of communication include publication in trusted peer-reviewed journals, presentations at local and national meetings, and high-quality education in the classroom.

What will you learn in this unit?

1. Recognize the components of authentic science and describe the steps that must be taken in communicating credible discoveries
2. Explain the importance of peer review in determining the credibility of a scientific discovery
3. Understand how written journal articles, verbal presentations, and social media communicate scientific research and the values of each
4. Learn how to read a journal article and dissect the components of a journal article
5. Analyze an article and organize a journal club presentation

UNIT 8 Assignments	
Assignment	Type
Unit 8 Critical Thinking Questions	Homework
Unit 8 Activity 1	Homework
Unit 8 Activity 2	Homework
Unit 8 Activity 3	Homework
Unit 8 Discussion 1	Discussion
Unit 8 Discussion 2	Discussion
Unit 8 Quiz	Quiz

Biotechnician 1b Final Exam

- Review information acquired and mastered from this course up to this point.
- Take a course exam based on material from the **second** half of the course (Note: You will be able to open this exam only one time.)

FINAL Assignments	
Assignment	Type
Final Exam	Exam
Final Exam Discussion	Discussion

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