



PLTW Biomedical Science

Human Body Systems | Course Outline

Join a team of physical therapists and other medical professionals to diagnose and provide treatment and rehabilitation to patients at an outpatient center. Work as an intern in a research center and design a comprehensive laboratory investigation using a model organism. Keep clients safe and healthy on adventure trips in remote locations. Showcase a medical story or mystery at an interactive exhibit about the human body. Solve mini cases and medical challenges at the Quick Clinic!

Whether seeking a career in medicine or healthcare or just looking for the challenge of real-world problems, students in Human Body Systems will practice how to think creatively and critically to innovate in science, while gaining practical experience with clinical medicine and experimental design.

Human Body Systems (HBS) is a full-year high school course designed to follow Principles of Biomedical Science (PBS) in the PLTW Biomedical Science pathway. The HBS course provides foundational knowledge and skills in anatomy and physiology, clinical medicine, and laboratory research. The course engages students in how this content can be applied to real-world situations, cases, and problems. The HBS course includes interviews, challenges, and testimonials from biomedical professionals in a variety of settings—clinical, research, and public health.

Through both individual and collaborative team activities, projects, and problems, students tackle real-world challenges that biomedical professionals face in the field. Students work with the same tools and equipment used in hospitals and labs as they engage in relevant hands-on work. They explore BioDigital™ 3D interactive models, simulations, and assessments to visualize human anatomy and physiology. Students develop skill in technical documentation to represent and communicate experimental findings and solutions to problems, as well as skill in ethical reasoning and clinical empathy.

Following is a summary of the units of study in the proposed HBS course for the 2023–2024 academic year. Course content is aligned with NGSS, Common Core, National Consortium for Health Science Education, and other standards as appropriate. Activities, projects, and problems are provided to the teacher and students through an online delivery system, PLTW Courses.

The HBS course requires a rigorous pace and contains more material than a skilled teacher new to the course will be able to complete in their first experience. However, building enthusiasm for and a real understanding of the role, impact, and practice of biomedical scientists is a primary goal of the course.

HBS Unit Summary

| | |
|--------|------------------------|
| Unit 1 | Road to Rehabilitation |
| Unit 2 | Research Ready |
| Unit 3 | Adventure Awaits |
| Unit 4 | Patient Perspectives |

Unit 1: Road to Rehabilitation

In this unit, students join a dynamic team of biomedical professionals dedicated to helping patients with illness or injury progress through rehabilitation, getting them back to doing what they love. Students explore the human skeletal and muscular systems as they gain the knowledge and skills they need to design a solution for their assigned patient—involving physical rehabilitation, assistive devices, and overall strategies for physical and mental well-being. Throughout the unit, students gather medical evidence and information about their patient and use what they learn along the way to help them develop a comprehensive health and wellness plan for the patient.

Road to Rehabilitation

| | |
|------------|--------------------------------|
| Lesson 1.1 | Beginning with Bones (16 days) |
| Lesson 1.2 | Muscles and Motion (22 days) |
| Lesson 1.3 | Relief Within Reach (5 days) |

Lesson 1.1 Beginning with Bones

In Lesson 1.1, students meet five patients with medical conditions or injuries that need physical therapy or rehabilitative care. As they explore the medical history of the patient, students practice the language of anatomy, using directional and regional terms and terms for body cavities and planes, to reference the injury or condition. Students investigate tissues of the human body, focusing on the structure and function of bone. They will use their knowledge of the skeletal system to analyze a patient's fracture and explore biomechanical engineering solutions to repair this fracture.

Lesson 1.2 Muscles and Motion

In Lesson 1.2, students model the physiology of muscle contraction as they assist a patient suffering from chronic muscle cramps. They build muscles on a Maniken® skeletal model, demonstrating how the orientation of a muscle relates to the role the muscle plays in the body and how a patient's muscles are impacted in injury or illness. They use physiology sensors and probes to monitor muscle strength and design an experiment to test muscle fatigue. To help a patient with a knee injury, students measure and analyze range of motion of the joints, perform diagnostic tests on a dynamic knee model, and practice kinesiology taping techniques guided by an athletic trainer.

Lesson 1.3 Relief Within Reach

Now that students have studied the skeletal and muscular system, they are ready to design a comprehensive solution for their patient in the outpatient center. To create a personalized care and rehabilitation plan to give to the patient, their caregivers, and future healthcare providers, students analyze the patient's medical data available in a patient medical portal along with the data they have collected in the unit. Students consider and demonstrate the importance of empathy and respect in patient care as they design a plan to help the patient manage their condition, progress forward, and maintain the activities and lifestyle they love.

Unit 2: Research Ready

In this unit, students have accepted an internship at the Development and Aging Research Center at a local university. The researchers in this lab are especially interested in exploring how the brain and other parts of the nervous system change as a person ages and how the endocrine system controls how a person's body carries out various processes. The research findings of this lab will inform innovations, treatments, and strategies to improve the quality of life and longevity for people around the world.

Students explore the various labs at the research center through a virtual gaming environment. They gather advice from career professionals and design experiments and research projects. Students are tasked to acquire the knowledge and skills they will need to gain access to the main research laboratory, which is dedicated to solving problems that help unlock the mysteries of the communication network in the body—the nervous and endocrine systems.

Research Ready

| | |
|------------|--------------------------------|
| Lesson 2.1 | Getting Nervous (22 days) |
| Lesson 2.2 | Everything Endocrine (16 days) |
| Lesson 2.3 | Challenge Accepted (6 days) |

Lesson 2.1 Getting Nervous

Students begin their first day as interns at the Development and Aging Research Center. Over the course of the lesson, students tour the facility through a 3D gaming environment, dissect a sheep brain to visualize the connection between structure and function, complete a virtual lab to evaluate the impact of specific drugs on signaling of neurons, and use physiological sensors to compare reflex and reaction time. At the end of the lesson, students participate in a Lab Leads Challenge where they apply what they have learned to diagnose a patient and model how their condition is linked to the function of the nervous system.

Lesson 2.2 Everything Endocrine

In this lesson, students enter the Endocrinology Lab to research the role the endocrine system plays in the development of the human body. To examine feedback loops and how the endocrine system helps the body maintain homeostasis, students stimulate hormone action in a role-play game. This game uses blood sugar and insulin as the models for hormone regulation, which students map on a graphic organizer.

Students then work in the lab with a model organism, *C. elegans*, designing and running experiments to explore the impact of neurotransmitters and hormones on body function. Students explore scientific literature as they assist a colleague in preparing a poster presentation related to reproductive regulation. At the end of the lesson, they meet a new set of patients, analyze their conditions, and decide what laboratory testing each patient needs to help support a final diagnosis.

Lesson 2.3 Challenge Accepted

In the problem, students complete an open-ended research experiment with the model organism, *C. elegans*, to see how heavy metals affect the nervous and endocrine systems. They design an investigation of their choosing, run the experiment with their team, and analyze data to make conclusions.

Unit 3: Adventure Awaits

In this unit, students join a team of expedition leaders who escort adventure travelers through a series of activities and events in extreme or remote environments. They are tasked to ensure the health and wellness of their group—focusing on the cardiovascular, respiratory, and immune systems—as they identify and address health risks or challenges travelers may encounter in these environments.

They investigate pathogens native to an assigned environment and interventions to prevent and treat those pathogens. Students use what they have learned to work together to respond to an emergency medical incident that happens on an adventure trip, presented in an interactive simulation.

Adventure Awaits

| | |
|------------|--------------------------------------|
| Lesson 3.1 | Cardiopulmonary Connection (20 days) |
| Lesson 3.2 | Body Guards (12 days) |
| Lesson 3.3 | Adventure Medicine (5 days) |

Lesson 3.1 Cardiopulmonary Connection

Lesson 3.1 introduces students to their new role as adventure guides for an expedition company. Through the engaging lens of adventure medicine, students investigate the cardiovascular and respiratory systems. Students explore the movement of blood to our organs and tissues, build the heart and major blood vessels on their Maniken® model, perform cardiovascular measurements and calculations, and then learn how to record and interpret EKGs.

They investigate the connection between the cardiovascular and respiratory systems through a sheep pluck dissection, diagnose a fictional patient with respiratory issues, and use spirometry to measure lung volumes and flow rates. Finally, students apply all they've learned to analyze the cardiovascular and respiratory data of fictional clients and then make a recommendation as to whether they should be cleared for a climbing expedition.

Lesson 3.2 Body Guards

Students continue their work with the expedition company as they explore the systems, structures, and cells that function to protect the body from illness and injury. They investigate agents of disease and how the human body works to fight against invaders. They play a Roblox® game designed to teach them how the specific immune cells function in response to infection by viruses and bacteria. Students complete a plaque assay in the lab to evaluate the effectiveness of antiviral medicines. They dissect a cow eye to investigate conditions of the eye that can be an issue on adventure expeditions.

Lesson 3.3 Adventure Medicine

In the problem, students use an interactive to design an expedition, choosing the destinations and activities, and then prepare a guide to help keep travelers healthy on this journey. Their guide must address the impacts of their assigned environment on human physiology—specifically the cardiovascular, respiratory, and immune systems. They must identify and address health risks of the extreme environment, as well as the risks related to pathogens native to the chosen location.

Through an interactive experience, student teams are faced with an emergency on their trip. Using the guide they created, they work together to apply what they have learned to help their clients through the emergency and maintain the health and well-being of all adventurers on the expedition.

Unit 4: Patient Perspectives

In this unit, students are biomedical science advisors working on the development of an interactive exhibit. *Ins and Outs of the Body: Patient Perspectives* will combine art and storytelling into an immersive experience that spotlights the stories of real patients to investigate the structure and function of the urinary and digestive systems.

Patient Perspectives

| | |
|------------|--------------------------------|
| Lesson 4.1 | Keeping it Renal (19 days) |
| Lesson 4.2 | It Takes Guts (12 days) |
| Lesson 3.3 | Engage in the Exhibit (5 days) |

Lesson 4.1 Keeping it Renal

In Lesson 4.1, students hear from a kidney donor and a kidney recipient as they explore how the body filters the blood and processes liquid waste. They dissect both normal and abnormal kidneys to map filtration and determine impacts of cysts on overall kidney function. They build a 3D model nephron and complete a laboratory experiment to model kidney function. Students gain an appreciation for how changes in clinical algorithms and medical evaluation criteria highlight the push for equitable care to all patients. Students use gel electrophoresis to explore the genetics and inheritance of polycystic kidney disease. Finally, students complete simulated urinalysis, allowing them to see that clues in the urine may signal problems in other human body systems. They will tell the stories of these patients while creating a unique patient perspective asset for the exhibit.

Lesson 4.2 It Takes Guts

In this lesson, students experience the story of a young woman who has had a full digestive system transplant. As they follow her case and hear about her journey, students model the digestive system on their Maniken® model and explore microscopic images of digestive tissue. They investigate gut health - how microbes play a role in healthy digestion - and how diagnostic tests are used to detect disease. In the project, students complete laboratory tests to investigate how enzymes function in the breakdown of food and relate the results of these experiments to digestive conditions.

Lesson 4.3 Engage in the Exhibit

In the problem, student teams are challenged to design and storyboard an interactive element for the exhibit that allows visitors to apply their knowledge of biomedical science to investigate a medical story. They are tasked with providing a new patient perspective to showcase key science and using art and media to engage their audience.

Trademark Attribution PLTW, Project Lead The Way, and the PLTW logo are registered trademarks of Project Lead The Way, Inc. MANIKEN is a registered trademark of Zahourek Systems Inc. or affiliates in the US or other countries. Authorization for limited trademark use is licensed by Zahourek Systems Inc., a sole provider of ANATOMY IN CLAY Learning System. www.anatomyinclay.com. Roblox, the Roblox logo and Powering Imagination are among Roblox Corporation registered and unregistered trademarks in the U.S. and other countries.