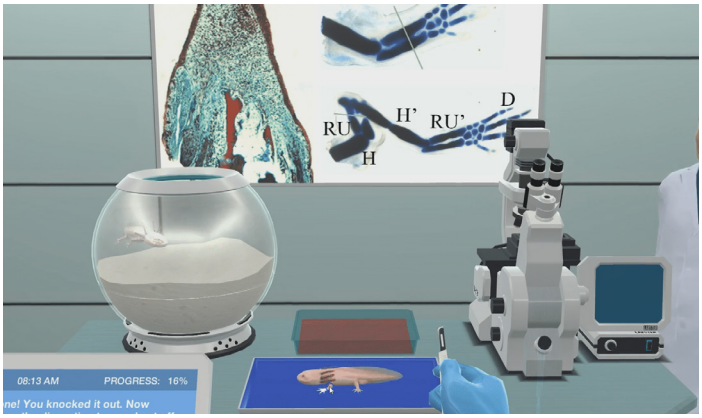
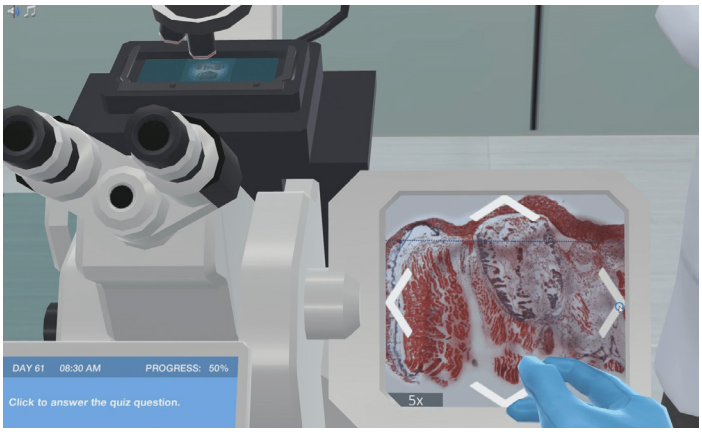
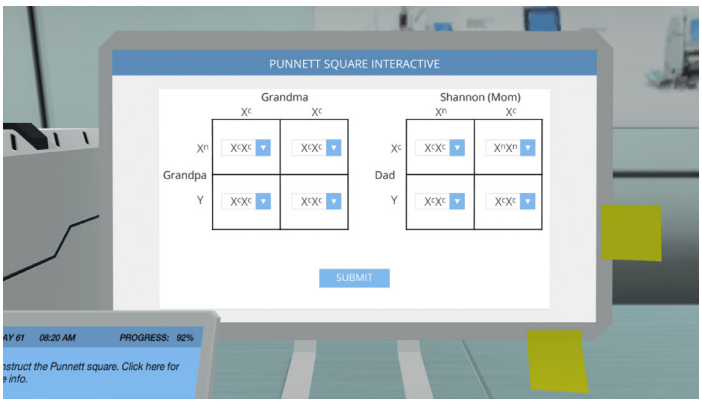
Labster Virtual Lab Simulations for Cellular and Molecular Biology







Labster is a world-leading provider of virtual lab simulations for higher education and high schools.

The simulations are designed to let students learn by doing in a virtual laboratory, solving real-case problems. Quiz questions test the students' knowledge, supporting an inquiry-based and deep-learning approach. The students will train real lab skills in a safe virtual environment where they can safely make mistakes, and learn at their own pace.

The most basic simulations are ideal as a self-study activity since the students will review essential concepts. The more advanced simulations are designed to support the course syllabus, reinforcing concepts and giving the students an innovative tool to deepen their learning.

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Cellular and Molecular Biology Simulations

Includes 39 simulations:

- Action Potential [Q2 '19]
- Animal Genetics
- Antibodies
- Cell Culture Basics
- Cell Culture Basics - Transfection
- Cellular Respiration
- Confocal Microscopy VR
- Cytogenetics
- Diabetes
- Electron Transport Chain (from PHS)
- Elisa
- Epithelial to Mesenchyme Transition
- FACS
- Fermentation
- Gene Expression Unit (from GEL)
- Gene Regulation
- Invertebrate Model System
- Mammalian Transient Protein Expression
- Medical Genetics
- Meiosis
- Mendelian Inheritance
- Microscopy
- Mitosis
- Molecular Cloning
- Monogenic Disorders
- Next Generation Sequencing
- Parkinson's Disease
- Pigment Extraction
- Plant Transcriptomics
- Pluripotent Stem Cell Culture
- Polymerase Chain Reaction
- Protein Synthesis
- Regeneration Biology
- RNA Extraction VR (from GEL)
- Signal Transduction
- Synthetic Biology
- Tissue Engineering
- Viral Gene Therapy
- Your Diet and Your DNA

Ready to learn more?

Bring the world of science into the classroom and enable students to bring learning home with Labster's virtual science lab content. No need for additional hardware or lab equipment; access these labs on Chromebooks or any other laptops, and spark creativity in students with this innovative and interactive way to explore science.

It's a million-dollar lab, one click away.

To learn more about how you can incorporate Labster virtual labs in your teaching, visit us at www.labster.com.

Learning objectives covered in Labster's cellular & molecular biology simulations

Action Potential

To be confirmed.

Animal Genetics

Learning objectives: At the end of this simulation you will be able to...

- Explain different hereditary traits and modes of inheritance
- Construct a pedigree analysis based on observed phenotypes
- Perform genome scanning to identify candidate genes for double muscling in cattle
- Develop a DNA test for double muscling in cattle

Antibodies

Learning objectives: At the end of this simulation you will be able to...

- Understand the structure and function of antibodies:
  - Different isotypes
  - Different parts of an antibody
- Understand the formation of antibody-antigen complex:
  - Types of interaction between antibody and antigen
- Understand the role of different blood types:
  - ABO and rhesus factor
  - Blood typing by using Eldon cards
  - Blood transfusions
  - Rhesus incompatibility and hemolytic disease of a newborn (HDN)

Cell Culture Basics

Learning objectives: At the end of this simulation you will be able to...

- Apply the aseptic technique and other good laboratory practices in a cell culture lab
- Describe the minimum requirements to have an adequate cell environment that supports cell growth
- Describe and perform the key steps when working with mammalian cells in vitro: thawing and plating; cell passaging; cell cryopreservation
- Correctly use a biosafety cabinet and an automated cell counter

Cell Culture Basics - Transfection

Learning objectives: At the end of this simulation you will be able to...

- Explain the advantages of using lipidbased transfection methods
- Design a transfection experiment:
  - Select the right transfection strategy
  - Correctly use controls
- Describe and perform the key steps for transfecting mammalian cells using Lipofectamine 3000:
  - Prepare cells to achieve highest transfection efficiency (number of passage, percentage of confluence)
  - Prepare reagents (storing, handling, complexation time, incubation time)
- Explain the molecular mechanism of lipidbased transfection
- Troubleshoot poor transfection efficiency outcomes

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Cellular Respiration

Learning objectives: At the end of this simulation you will be able to...

- Explain the structural changes of glucose and ATP during glycolysis
- Analyze blood glucose and lactic acid concentrations of athletes before and after exercise
- Determine electron carrier products of the Krebs cycle
- Understand the role of the electron transport chain in generating ATP
- Experiment on oxygen consumption in mice at various exercise intensities

Confocal Microscopy

Learning objectives: At the end of this simulation you will be able to...

- Describe the principles of confocal microscopy
- Use the basic functions of a confocal microscope
- Select the optimal settings to take confocal micrographs
- Acquire confocal images and create 3D renderings
- Describe the setup of a confocal microscope
- Discuss the advantages of confocal microscopy over conventional optical microscopy

Cytogenetics

Learning objectives: At the end of this simulation you will be able to...

- Define medical genetic counseling, especially in the case of prenatal diagnostics
- Describe and perform an Array-based Comparative Genome Hybridization (Array CGH)
- Explain a karyotype analysis

Diabetes

Learning objectives: At the end of this simulation you will be able to...

- Understand how Type II diabetes is diagnosed
- Understand the risk factors for Type II diabetes
- Understand the function of insulin in the body
- Understand how untreated diabetes affects organ function
- Regulate Type II diabetes
- Know how and when to measure blood sugar levels using a glucose meter
- Understand the effect of insulin and diabetes medication
- Prepare a syringe with insulin and know how to inject insulin
- Understand how a healthy diet and regular exercise help to regulate Type II diabetes

Electron Transport Chain

Learning objectives: At the end of this simulation you will be able to...

- Understand the importance and uses of photosynthesis
- Understand the photolysis of water and electron transport
- Understand properties of light and why pigments are colorful
- Develop a hypothesis and set up an experiment to test it
- Understand how to measure the redox potential of the electron transport chain

ELISA

Learning objectives: At the end of this simulation you will be able to...

- Explain the principle of different ELISA techniques
- Apply sandwich ELISA to quantify protein samples
- Analyze the standard curve of ELISA experiment
- Understand the function of reagents and equipment used in ELISA
- Describe the basic troubleshooting process of ELISA

Epithelial to Mesenchyme Transition

Learning objectives: At the end of this simulation you will be able to...

- Set up a protocol to get answers to a biological question related to the EMT process
- Acknowledge mistakes in the protocols and understand how to critically overcome them
- Properly prepare cells for the immunostaining procedure according to the localization of the target protein
- Select a suitable secondary antibody for an immunofluorescence experiment
- Analyze immunofluorescence results
- Describe the basics of CRISPR-Cas technique
- Design a guide RNA construct for knock-out strategies
- Evaluate CRISPR-Cas9 results

FACS

Learning objectives: At the end of this simulation you will be able to...

- Understand the basics of flow cytometry technique
- Understand the importance of each system that the technique relies on (fluidics, optics, and electronics)
- Use a cell sorter (start up, sorting, and shut down of the equipment)
- Understand how the equipment performs the measurements
- Interpret the results and understand the applications of the technique

Fermentation

Learning objectives: At the end of this simulation you will be able to...

- Understand cell growth, goals of fermentation and application to the real-world
- Understand the function and various parts of the bioreactor and auxiliary equipment
- Understand microbial growth kinetics with examples of batch and chemostat fermentations
- Understand how parameters such as pH, temperature, aeration, and agitation affects fermentation
- Perform virtual fermentations to identify optimal process conditions

Gene Expression Unit

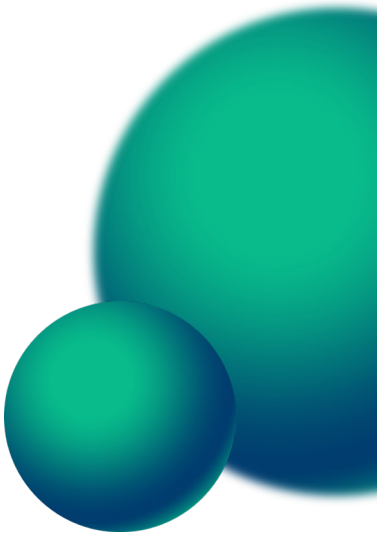
Learning objectives: At the end of this simulation you will be able to...

- Prepare samples for Next Generation Sequencing
- Understand the principles behind the Next Generation Sequencing technique
- Perform a qPCR experiment with the proper controls

Gene Regulation

Learning objectives: At the end of this simulation you will be able to...

- Explain how gene expression can be regulated
- Describe the different levels of gene regulation (mRNA and protein)
- Measure mRNA levels (RT-PCR), protein expression (Western blotting)



Invertebrate Model System

Learning objectives: At the end of this simulation you will be able to...

- Explain the importance of C. elegans as an invertebrate model system in medical research
- Perform a forward genetic screen
- Use sequencing data to discover the genes of interest

Mammalian Transient Protein Expression

Learning objectives: At the end of this simulation you will be able to...

- Explain the benefits of using mammaliancell based expression systems to produce recombinant proteins compared to other systems based on other hosts, such as E. coli
- Describe and perform the key steps for mammalian transient protein expression using the ExpiCHO protein expression kit:
  - Preparation of ExpiCHOS cells and transfection reagents
  - Transfection of cells
  - Addition of ExpiCHO Feeder and ExpiCHO Enhancer
- Select the cell culture conditions to maximize protein expression yield

Medical Genetics

Learning objectives: At the end of this simulation you will be able to...

- Understand Mendelian genetics and know how to perform linkage analysis
- Perform PCR and gel electrophoresis
- Understand the basics of breast cancer, tumor suppressor, oncogenes and BRCA1/2
- Understand the genetic event underlying breast cancer

Meiosis

Learning objectives: At the end of this simulation you will be able to...

- Understand assisted reproduction technology
- Understand the basic principle of meiosis
- Use the microscope to observe the phases of meiosis and understand their main characteristics
- Understand the main differences between mitosis and meiosis

Mendelian Inheritance

Learning objectives: At the end of this simulation you will be able to...

- Explain how traits are passed on from parents to their offspring and what causes variation between siblings
- Describe Mendel's Laws of Inheritance in color deficiency
- Compare and predict the phenotypes of offspring with given genotypes using Punnett squares
- Analyze dominant and recessive alleles, and how they play a part in an individual's biological make-up

Microscopy

Learning objectives: At the end of this simulation you will be able to...

- Understand different microscopy techniques and their limitations
- Identify various cell types and cellular structures
- Understand coeliac disease and intestinal inflammation
- Understand staining techniques

Mitosis

Learning objectives: At the end of this simulation you will be able to...

- Understand and visualize basic concepts about eukaryotic cells such as main cellular components and DNA packaging by immersive animations
- Understand the key characteristics of the cell cycle´s different stages: interphase (G1, S and G2) and mitosis
- Use different microscopy techniques to observe the phases of the mitosis and understand their main characteristics:
  - Prophase
  - Metaphase
  - Anaphase
  - Telophase
- Understand the cell cycle checkpoints and the molecules that control them (cyclins and cyclin-dependent kinases)
- Understand the main differences between mitosis and meiosis

Molecular Cloning

Learning objectives: At the end of this simulation you will be able to...

- Understand molecular cloning techniques: DNA extraction and preparation, ligation, transformation, plate streaking and antibiotic selection
- Understand inducible gene expression regulation
- Understand the use of GFP as a reporter gene
- Understand DNA damage and DNA repair system

Monogenic Disorders

Learning objectives: At the end of this simulation you will be able to...

- Understand the basic concepts of inheritance
- Build and interpret a pedigree based on family data
- Understand genetic risk assessment and counselling
- Understand the work of a genetics laboratory

Next Generation Sequencing

Learning objectives: At the end of this simulation you will be able to...

- Understand the different steps in sample preparation, cluster generation, sequencing and data processing
- Understand the characteristics of ancient DNA
- Understand that Single Nucleotide Polymorphism (SNP) can be tightly correlated to a specific physical feature

Parkinson's Disease

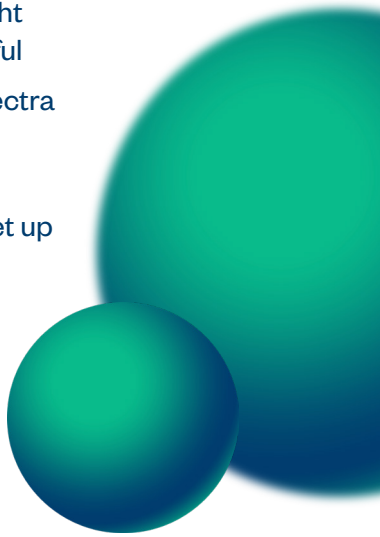
Learning objectives: At the end of this simulation you will be able to...

- Describe the role of alpha synuclein in Parkinson's disease
- Describe the different parts of a liquid chromatography equipment
- Interpret results from liquid chromatography experiments
- Describe the difference between Ion Exchange Chromatography and Size Exclusion Chromatography
- Evaluate the mode of action of Epigallocatechin gallate on Lewy body formation
- Describe the benefits of using Large Unilamellar vesicles as a cell membrane in vitro model

Pigment Extraction

Learning objectives: At the end of this simulation you will be able to...

- Understand the importance and uses of photosynthesis
- Understand properties of light and why pigments are colorful
- Analyze the absorbance spectra and chemical properties of pigments
- Develop a hypothesis and set up an experiment to test it



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Plant Transcriptomics

Learning objectives: At the end of this simulation you will be able to...

- Understand terpenoid and its benefit as an antimalarial drug
- Understand how Next Generation Sequencing technology can be used to screen candidate genes
- Use BLAST and phylogenetic analysis gene annotation

Pluripotent Stem Cell Culture

Learning objectives: At the end of this simulation you will be able to...

- Define the concept of pluripotent stem cell
- Describe the required combination of media and matrices that support cell health and pluripotency
- Describe and perform the critical steps for culturing PSCs:
  - Thawing and plating
  - Evaluating differentiated cells morphology and removing them from the culture
- Evaluating the pluripotency state of your PSCs using fluorescence microscopy

Polymerase Chain Reaction

Learning objectives: At the end of this simulation you will be able to...

- Explain the function of DNA polymerase in DNA replication and synthesis
- Perform a PCR experiment using DNA from a blood sample as the template
- Carry out a gel electrophoresis that separates DNA according to its size
- Interpret the unique signature of the human genome and the use of tandem repeated regions (TRR) in DNA profiling

Protein Synthesis

Learning objectives: At the end of this simulation you will be able to...

- Understand the translation process from mRNA to amino acid
- Understand the post-translational modification
- Understand the protein synthesis processing in the ribosome
- Understand the primary, secondary, tertiary and quaternary structures of protein
- Understand the basic principles of mass spectrometry (MALDI-TOF)

Regeneration Biology

Learning objectives: At the end of this simulation you will be able to...

- Understand that the ability to regenerate tissues varies throughout vertebrates
- Describe what a blastema is and the cell types that compose this structure
- Understand the concept of positional information in regenerative biology

RNA Extraction

Learning objectives: At the end of this simulation you will be able to...

- Understand how to extract the total RNA from a cell
- Separate mRNA molecules specifically from the rest of the RNA

Signal Transduction

Learning objectives: At the end of this simulation you will be able to...

- Explain the principles and importance of intracellular signal transduction
- Explain receptor tyrosine kinase (RTK) cell signaling
- Analyze dysregulated signal transduction in human cancer cells
- Understand the connection between angiogenesis and tumor growth
- Investigate the involvement of vascular endothelial growth factor receptor (VEGFR) signaling in human breast cancer

Synthetic Biology

Learning objectives: At the end of this simulation you will be able to...

- Engineer natural systems to perform specific functions
- Describe the fundamentals of the Gateway cloning technique and design your own biological circuit
- Explain and perform bacterial transformation, antibiotic selection and plasmid purification
- Explain and perform a restriction digest of your cloning product

Tissue Engineering

Learning objectives: At the end of this simulation you will be able to...

- Explain the basic principle of tissue engineering
- Describe the articular cartilage injuries and its treatment
- Define the types of crossllinking to synthesis hydrogels:
  - Ionic crosslinking
  - Michael addition crosslinking
  - Enzymatic crosslinking
  - Radical crosslinking
- Identify natural and synthetic polymers
- Analyze the synthesized hydrogels' mechanical properties using rheology.

Viral Gene Therapy

Learning objectives: At the end of this simulation you will be able to...

- Explain the use of gene therapy for the treatment of heart failure
- Explain the causes of heart failure
- Design a viralmediated gene therapy approach
- Define "therapeutic gene"
- Describe the anatomy and function of the heart from a healthy person vs. a heart failure patient
- Produce replicationdefective recombinant adenoassociated virus (rAAV)

Your Diet and Your DNA

Learning objectives: At the end of this simulation you will be able to...

- Describe nutrient compositions of healthy and unhealthy diets
- Explain how genomic instability may lead to the development of diseases such as cancer
- Summarize the impact of diet on genomic stability

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