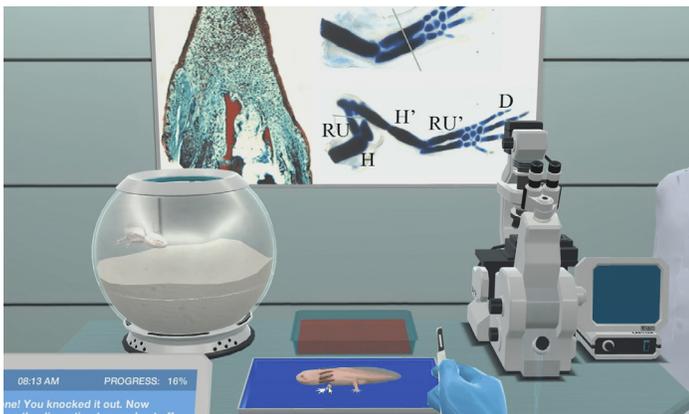


# Labster Virtual Lab Simulations for Advanced Placement Biology

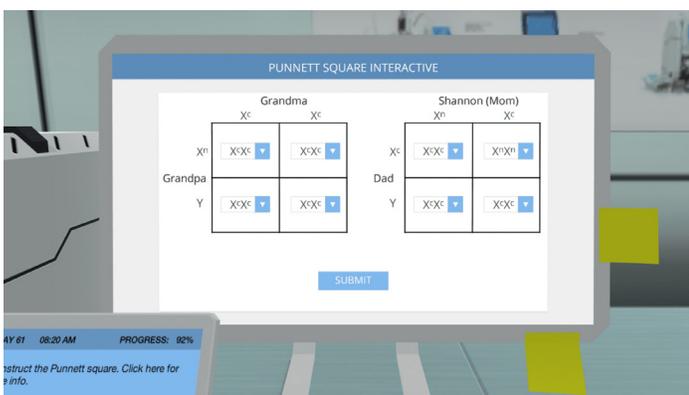


Labster is a world-leading provider of virtual lab simulations for higher education and high schools.

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.



# Advanced Placement Biology Simulations

## Includes 49 simulations:

- Action Potential [Q2 '19]
- Animal Genetics
- Antibodies
- Bacterial Growth Curves
- Bacterial Isolation
- Behavioral Thermoregulation
- Carbohydrates
- Cardio-respiratory Physiology [Q2 '19]
- Cardiovascular Exercise [Q2 '19]
- Cellular Respiration
- Competition
- Cytogenetics
- Diabetes
- Ecological Niches
- Ecosystem Dynamics
- Electron Transport Chain (from PHS)
- Embryology
- Endocrinology: Control of Reproduction [Q2 '19]
- Enzyme Kinetics
- Evolution
- Experimental Design
- Fermentation
- Food Web Simulation
- Gene Expression Unit (from GEL)
- Gene Regulation
- Intestinal transport [Q2 '19]
- Introductory Polymerase Chain Reaction
- Lab Safety
- Medical Genetics
- Meiosis
- Mendelian Inheritance
- Microscopy
- Mitosis
- Molecular Cloning
- Monogenic Disorders
- Next Generation Sequencing
- Osmoregulation/renal function [Q2 '19]
- Pasteurization and Sterilization
- Pigment Extraction
- Pipetting
- Polymerase Chain Reaction
- Protein Denaturation
- Protein Synthesis
- RNA Extraction VR (from GEL)
- Sensory physiology [Q2 '19]
- Signal Transduction
- Skeletal muscle function [Q2 '19]
- Smooth muscle regulation lab
- 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](http://www.labster.com).

# Learning objectives covered in Labster's advanced placement 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)

## Bacterial Growth Curves

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

- Use given data to plot a growth curve on a semi-logarithmic scale
- Recognize the different phases of bacterial growth (lag, exponential, stationary, decline)
- Learn how the growth rate can be calculated from a growth curve

## Bacterial Isolation

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

- Understand the importance of bacterial growth for the investigation of pathological microorganisms
- Work under aseptic techniques
- Understand the concept of a single colony
- Perform plate-streaking techniques
- Use selective media for isolation purposes

## Behavioral Thermoregulation

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

- Explain changes in microclimate over small spatial scales and predict how this would influence the energy and water budgets of an organism
- Identify ways that an organism can regulate its body temperature in a given environment and discuss the costs and benefits of each strategy
- Predict and analyze the thermoregulatory behavior of an animal in a natural environment

## Carbohydrates

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

- Understand the molecular structure of sugars and polysaccharides
- Understand digestion and appreciate the complexity of the human body
- Experiment with different foods and measure their impact on the blood sugar levels

## Cardio-respiratory physiology

*To be confirmed.*

## Cardiovascular Exercise

*To be confirmed.*

## 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

## Competition

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

- Identify competition between species and quantify the strength of competition between two species
- Establish evidence of competition in an agricultural environment

## Cytogenetics

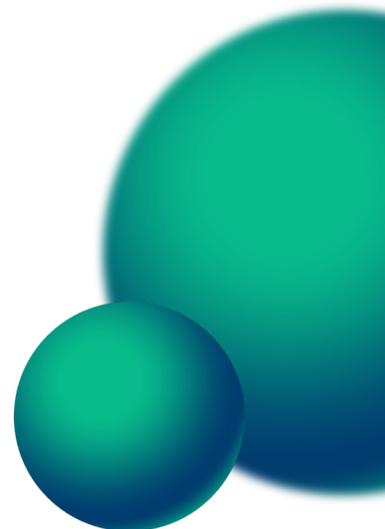
*Learning objectives: At the end of this simulation you will be able to...*

- 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



## Ecological Niches

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

- Quantify a species realized niche
- Set up an experiment to compare the effect of simple variables on a species niche
- Experimentally determine a species fundamental niche
- Visualize niches using an n-dimensional hypervolume
- Measure the extent to which acclimation expands a species' niche
- Determine how trade-offs affect the boundaries of a niche

## Ecosystem dynamics

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

- Understand how the respiratory and cardiovascular system responds during exercise.
- Understand how cardiac output and blood pressure can be measured.
- Understand how heart rate, stroke volume, cardiac output and total peripheral resistance change with exercise.
- Interpret data to assess possible cardiovascular problems during exercise

## 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

## Embryology

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

- Understand the advantages and disadvantages of the mouse and chicken models
- Understand the different developmental stages and compare them between organisms
- Understand the molecular pathway responsible for forming forelimbs or hindlimbs

## Endocrinology: control of reproduction

*To be confirmed.*

## Enzyme Kinetics

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

- Understand the experimental design of enzyme kinetics
- Understand the Michaelis-Menten model of enzyme kinetics
- Analyze spectrophotometer data and calculate  $K_m$  and  $V_{max}$
- Understand that kinetics of an enzyme can be modified by genetic mutations
- Understand inhibition kinetics by using several types of inhibitors

## Evolution

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

- Understand how populations evolve by adapting to their environment
- Understand the basic mechanisms of evolution
- Understand evolution as the foundation of biology and show evidence for it
- Use DNA sequencing and phylogenetic trees to identify an unknown creature
- Deal with common misconceptions about the theory of evolution



## Experimental Design

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

- Explain and apply the scientific method
- Design an experiment and test a hypothesis
- Correctly use experimental controls

## 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

## Food Web Simulation

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

- Understand food webs
- Explain the differences between different trophic cascades
- Calculate the amount of energy needed for maintenance

## 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)

## Intestinal transport

*To be confirmed.*

## Introductory Polymerase Chain Reaction

*To be confirmed.*

## Lab Safety

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

- Use the correct clothing to work in the lab
- Describe the do's and don'ts in a laboratory
- Correctly use the lab safety equipment
- React in an emergency situation

## 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

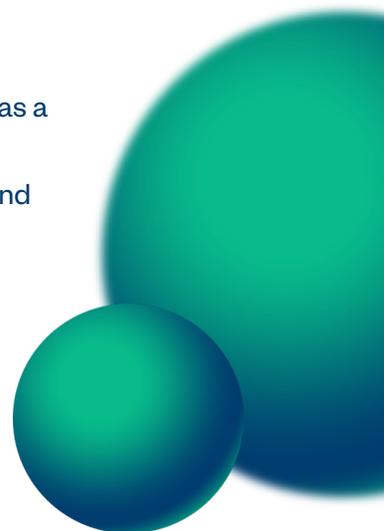
*Learning objectives: At the end of this simulation you will be able to...*

- 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

## Osmoregulation/renal function

*To be confirmed.*

## Pasteurization and Sterilization

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

- Understand the concept of food spoilage and shelf life
- Understand the principle of pasteurization and sterilization
- Analyze the parameters of High-Temperature-Time-Treatment (HTST) pasteurization
- Perform canning as a method of sterilization
- Understand how plastic and metal can be used as materials for packaging

## 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

## Pipetting

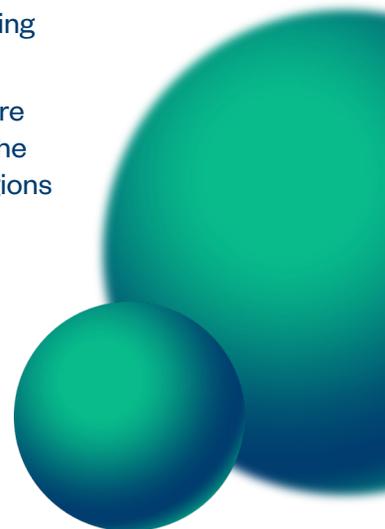
*Learning objectives: At the end of this simulation you will be able to...*

- Select the correct micropipette for its purpose
- Use the two stops of the pipette
- Explain pipetting techniques
- Perform a serial dilution
- Quantify the protein content in a sample with a Bradford assay

## 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 Denaturation

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

- Understand what protein denaturation is
- Understand how interactions between side groups influence the protein structure
- Understand the chemical causes of protein denaturation
- Understand the physical causes of protein denaturation
- Remember the steps involved in protein denaturation
- Understand the results of protein denaturation and how food texture changes as a result of it (coagulation)
- Understand how biotechnology is used in daily life

## 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)

## 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

## Sensory physiology

*To be confirmed.*

## Signal Transduction

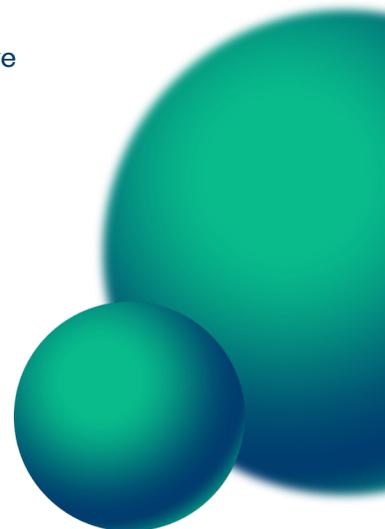
*Learning objectives: At the end of this simulation you will be able to...*

- 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

## Skeletal Muscle Function

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

- Explain length tension relationships of a skeletal muscle
- Understand how twitch and tetanus, the force-frequency relationship and the response to fatigue differs for two specific muscles
- Measure physiological properties of isolated EDL and soleus muscles
- Quantify the proportion of fibers found in both muscles
- Understand where the above muscles are found



## Smooth Muscle Regulation

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

- Understand smooth muscle characteristics
- Understand the autonomous nervous system (sympathetic and parasympathetic) control of smooth muscle
- Understand which neurotransmitters and receptors are involved in smooth muscle contraction
- Use the equipment and to interpret the results from the performed experiments

## 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

