

University of
North Dakota

Resource Guide for Developing Laboratories for Online Learning



UND Online
University of North Dakota

University of North Dakota Resource Guide for Developing Laboratories for Online Learning (updated 3/29/2020 by UND Online)

This document provides descriptions and contact links for two types of online laboratory resources.

The first type of resource are laboratory kits students would use in their homes to complete assignments as part of an online laboratory course (pages 2-3).

The second type of resource are computer simulations (some including virtual reality) that provide students a simulated laboratory experience directly in the online environment. This group includes commercial products as well as free or very low cost tools from non-profits (pages 4-6).

Laboratory Kits for Online Learning

Here are three good sources for science laboratory kits aimed at college courses

Carolina Biological Supply Company

[Carolina Distance Learning@ lab kits](#) are designed specifically for **college-level distance education**. They provide the same **rigor, relevance, and results** that traditional labs provide, giving your online students a successful lab experience wherever they are.

[Watch webinar about their labs](#)

[View labs](#)

Prepared starter kits are generally required and then can be customized kits in multiple ways depending on your needs. Areas that available kits cover are shown below:

- Allied Health
- Anatomy and Physiology
- Biology
- Chemistry
- Environmental Science
- Geology
- Microbiology
- Physics

Hands-On Labs

[Hands-On-Labs](#) has developed a meticulous content creation process to ensure that our lessons match — and even surpass — the sophistication of a face-to-face classroom. Our content team is led by Ph.D. scientists with teaching experience, who design our lessons to meet the latest pedagogical best practices. 700 lessons across the disciplines below

- Anatomy & Physiology
- Biology
- Chemistry
- Environmental Science
- Forensics
- Geology
- GOB Chemistry (non-major, allied health chemistry)
- Microbiology
- Physical Science
- Physics

eScience Labs

[EScience](#) collaborates with hundreds of higher education institutions to provide a traditional hands-on laboratory experience to students engaged in online and blended learning. Through a combination of hands-on science lab kits, virtual learning tools and customized digital curriculum, eScience Labs helps higher education institutions expand and strengthen science comprehension. Prepared and customized kits. Prepared standard kits are shown below:

- Allied Health
 - Pharmacy Technician
- Anatomy & Physiology
 - Anatomy and Physiology (3 versions, 8 labs, 11 labs, 18 labs)
- Biology
 - General Biology (3 versions)
 - Human Biology
 - Introductory Biology (4 versions)
 - Biology Slide Kit
- Chemistry
 - General Chemistry (3 versions)
 - Introductory Chemistry (4 versions)
 - General, Organic, and Biochemistry
- Earth Sciences
 - Physical Geology (2 versions)
 - Astronomy
 - Environmental Science
 - Rocks and Minerals Kit
 - Historical Geology
- Forensics
 - Forensic Science – crime scene collections and analysis
- Microbiology
 - Microbiology
- Physical Science
 - Physical Science
- Physics
 - General Physics (3 versions)
 - Introductory Physics (4 versions)

3D and Virtual Reality Laboratory Simulations

Non-Profit

LabXchange

[LabXchange](#) is an online community for learning, sharing, and collaboration. We curate and create world-class digital content, delivered on a free, online platform that lets you integrate your learning and research experiences. Here, you take control of your learning and solve real-world problems as a community. Participation will always be free. They offer a variety of tools including what they refer to as interactives (an image or a series of images and text that students advance by scrolling allowing them to control the pace of an animation) and simulations (a virtual experience that lets students practice engaging with lab equipment, techniques, and practices). Interactives and simulations exist in Biological Sciences, Chemistry, Physics, Global Health, and Health Science. Other resources available include: videos, narratives, pathways, images, assignments, documents, case studies, and textbooks.

Mechanics Lab (WebGL/HTML5 Version)

[Mechanics Lab](#) is a series of Physics simulations on many important areas of classical mechanics from GCSE and A level Physics. It is intended to be interactive and to require students to process results, perform calculations and solve problems. Mechanics Lab currently contains 13 different simulations: Gravity Lab, Vector addition, Moments, Projectiles, SHM: Free Oscillations, SHM: Driven oscillations and resonance, Two body orbits, 1D and 2D momentum, Friction ramp, Falling ball viscometer, Chaotic double pendulum, 3D pendulums, and Ideal Gas.

Merlot

The [Merlot](#) Project (Multimedia Education Resource for Learning and Online Teaching) provides access to curated online learning and support materials and content creation tools. This link will take you to a general search result for “virtual labs.” The next link will take you to a Merlot portal specifically constructed for virtual labs with tabs for: Biology, Chemistry, Physics, Earth/Environmental Science, Engineering, and Math. There are also additional resources such as case studies, vendors and authoring tools.

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OpenSim

[OpenSim](#) is a powerful and freely available tool for modeling and simulation of movement. Musculoskeletal modeling and dynamic simulation have recently emerged as powerful tools to uncover the biomechanical causes of movement abnormalities and to design improved treatments. Starting in 2006, we developed powerful, freely available software for simulating human movement, OpenSim. Users of this technology address fundamental issues in movement science and focus on critical areas of rehabilitation medicine, orthopaedics, Robotics, Ergonomics, Performance, and Designcs, and osteoarthritis. Projects using OpenSim can be found on [SimTK](#).

PhET

[PhET](#) - Our project originally focused on physics sims, and was hence named the *Ph*ysics *E*ducation *T*echnology project, or *PhET*. When we branched into chemistry, biology, mathematics, earth science and other areas, we decided to keep the name *PhET*, but to no longer describe it as an acronym. PhET provides free, interactive, research-based science and mathematics simulations. We extensively test and evaluate each simulation to ensure educational effectiveness. These tests include student interviews and observation of simulation use in classrooms. The simulations are written in Java, Flash or HTML5, and can be run online or downloaded to your computer. All simulations are open source (see our [source code](#)). Multiple [sponsors](#) support the PhET project, enabling these resources to be free to all students and teachers.

Commercial

Labster

[Labster](#) gives students access to a realistic lab experience that will let them perform experiments and practice their skills in a fun and risk-free learning environment. Some are desktop simulations and some are VR compatible. Labster provides some very good resources/whitepapers regarding using virtual labs. They include labs related to these disciplines: Biology, Chemistry, Engineering, Medicine, Physics, and additional course packages applicable to Food Science and Nutrition.

Hayden-McNeil Lab Solutions (Macmillan Learning)

[Hayden-McNeil Lab Solutions \(Macmillan Learning\)](#) offers realistic biology and chemistry lab simulations for an authentic experience that moves learning beyond the classroom. These lab simulations can be assigned as a hybrid solution to enhance in-lab learning, or as a complete lab replacement.

Chemistry (42 lab simulations)

Acids, Bases, and pH Buffers; Alka Seltzer Strength; Avogadro's Law; Boyle's Law; Characteristic Properties: Melting and Boiling Points; Charles Law; Chemical Enzymes; Chemical Kinetics; Chemical Reaction Types and Their Equations; Conservation of Mass; Decomposition of Malachite; Density: A Characteristic Property; Determination of Absolute Zero; Electrochemistry; Precipitation Titration of Cobalt Chloride; Empirical Formula of a Hydrate; Empirical Formula of Copper Oxide; Enthalpy Change for the Decomposition of Ammonium Chloride; Enthalpy Change of a Chemical Reaction; Flame Test; Identifying Unknown Substance from Characteristic Properties; Laboratory Skills; Molar Mass of Magnesium; Molar Volume of an Ideal Gas; Mole to Mole Relationship between Cu and Ag; Molecular Mass by Freezing Point Depression; pH Indicators; Precipitation Titration of Cobalt Chloride; Qualitative Analysis of Group I Cations; Quantitative Determination of Food Dyes in Powdered Drink Mixes; Sample Lab/Introduction to the Virtual Lab; Separating a Mixture of Compounds; Spectrophotometric Analysis of Copper; Standardization of an NaOH Solution; Stoichiometry by Loss of CO₂; Stoichiometry of a Gas-Forming Reaction; Stoichiometry of an Acid-Base Reaction; The Apparent Molecular Weight of Air; The Temperature Dependence of Salt Solubility; Titration of Strong and Weak Acids; Titration Tutorial; Volume of Air as a Function of Temperature;

Biology (27 lab simulations)

Acids, Bases, & pH Buffers; Antibiotic Sensitivity; Bacteria; Basic Microscopy; Biological Molecules; Biology PCR; Cell Structure and Function; Cellular Respiration; Diffusion and Osmosis; DNA; Earthworm; Ecology; Enzymes; Evolution; Expanded Diffusion and Osmosis; Fungi; Genetics; Introduction to the Virtual Lab; Mammalian Tissues; Mitosis and Meiosis; PCR of 16s rRNA Gene; Photosynthesis; Plant Reproduction; Plant Structure and Function; Protists; Quantitative Analysis of Enzyme Activity; Scientific Method;

PraxiLabs

[PraxiLabs](#) provide students with an immersive and interactive 3D simulation of a realistic lab. They provide various study aids in different formats and assessments as well. There are visual aids, multimedia, and immediate feedback from the student's cgi "lab partner." Their simulated (desktop and mobile platforms) labs cover the following disciplines: Biology (Molecular, Proteomics, Immunology, & Tissue Culture), Chemistry (General, Analytical, & Organic), Physics (Heat and Thermodynamic, Properties of Matter, Mechanics, Waves (Geometrical Optics, Oscillation, & Sound), and Electricity.

SimTutor

[SimTutor](#) offers simulation learning tools and solutions for every organization (e.g., medical, construction, logistics, aviation, utilities, franchises). They offer a DIY authoring tool, SIMTICS, ready made simulation training modules, and start-to-finish novel solutions. SIMTICS is currently focused on medical simulations, but the DIY tool should be broadly applicable to many disciplines. I believe UND's School of Medicine and Health Sciences uses SIMTIC.

Lab4U

[Lab4U](#) provides ready-made experiments using sensors built into a smartphone or tablet. They currently have a Lab4Physics module and a Lab4Chemistry module, with a Lab4Biology module expect this year (2020).

The Journal of Visualized Experiments (JoVE)

[JoVE \(Journal of Visualized Experiments\)](#) is a peer-reviewed scientific journal that publishes experimental methods in video format. It has over 9,500 videos demonstrating experiments from laboratories at top research institutions. Educators and students use our innovative video collections in the JoVE Science Education Library to better teach and learn key concepts and fundamental techniques at the undergraduate course level. These simple, easy-to-understand video demonstrations cover a wide range of STEM subjects including Biology, Chemistry, Environmental Science, Psychology, Clinical Medicine and Engineering. Available without a subscription until June 15 2020.