

RESOURCE LIST

FOR NON-ANIMAL LEARNING METHODS IN SCIENCE EDUCATION



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Summer 2009

PREPARED BY PEOPLE FOR THE ETHICAL TREATMENT OF ANIMALS

Non-animal Learning Tools for Science Education

A Resource Guide

Prepared by People for the Ethical Treatment of Animals
July 2009

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Computer-Based Replacements for Anatomy Dissections

Frog Anatomy

Digital Frog's DigitalFrog 2.5 provides an interactive virtual frog dissection and seamlessly links the dissection to an anatomy and physiology section, with a comparative anatomy feature. Digital Frog has also undertaken an in-depth evaluation of the ways its programs meet the educational needs of K-12 students in the U.S. (Digital Frog International, "DFI Software and Curriculum Standards," digitalfrog.com/resources/curriculum.html). Evaluations for eight states are provided, including California, New Mexico, Oklahoma, Missouri, Florida, Illinois, Michigan, and Texas. In addition, the independent California Learning Resource Network (CLRN) has evaluated Digital Frog's software tools and found that they meet the state of California's educational objectives (see CLRN's Web site at clrn.org/search/search.cfm?search=1&publisherid=425). For more information on Digital Frog's products, visit digitalfrog.com/products/frog.html.

BioLab's Frog Dissection allows students to observe and dissect external features as well as the digestive, mouth, respiratory, reproductive, and skeletal systems. The program also includes "mini-labs" such as the Breathing Rate Mini Lab, Heart Rate Mini Lab, and Muscle Contraction Mini Lab. (biolabsoftware.com/bls/frog.html)

Froguts supplies lessons that are systems-based and integrate anatomy, physiology, and ecology through interactive and engaging simulations. Interactive virtual tools include microscopes and scalpels, and randomized quizzes help test students' knowledge. (froguts.com)

Tangent Scientific's DryLab Plus Frog explores the circulatory, digestive, muscular, nervous, respiratory, skeletal, and urogenital systems of the frog through interactive dissections, full-motion video, comprehensive text and narration, quizzes, sound, music, and full-color photographs. (tangentscientific.com/pdf/5404.pdf)

Neotek's Frog Dissection Laboratory covers all major systems in micro-surgically prepared dissections, including the skeletal, musculature, nervous, digestive, circulatory, respiratory, and reproductive systems. The new version also includes a worm dissection as a bonus. (neotek.com/Educational_Titles.htm#FrogLab)

Tactus Tech's V-Frog simulates nearly every manipulation of specimen tissue—each dissection is different, reflecting students' individual work. The software is designed for grades 7 through 12 as well as advanced-placement biology students. Using a mouse and PC, students can "pick up" a scalpel, cut open V-Frog's skin, and explore the internal organs. V-Frog's true real-time interaction and three-dimensional navigation accommodate discovery as well as procedures that are not possible with a physical frog specimen. (tactustech.com)

A number of free, online frog dissection programs are also available, including the following:

- **Virtual Frog Dissection Kit** (itg.lbl.gov/frog/)
- **Comparative Anatomy: Rat and Frog** (umanitoba.ca/faculties/science/biological_sciences/lab17/biolab17_1.html)

- ***Frog and Dogfish Shark: Nervous Systems***
(umanitoba.ca/faculties/science/biological_sciences/lab18/biolab18_1.html)

Fetal Pig Anatomy

Tangent Scientific's DryLab Plus Fetal Pig incorporates live, interactive dissections, full-motion video, text and narration, quizzes, sound, music, and full-color photographs. (tangentscientific.com/pdf/5403.pdf)

BioLab's BioLab Pig gives students the ability to perform informative dissections and introduces the concepts of physiology alongside anatomy. The software includes the digestive, respiratory, urogenital, endocrine, and skeletal systems. Also included are Carbon Dioxide and Heart Rate Recovery mini-labs. (biolabsoftware.com/bls/pig.html)

Free online fetal pig dissection programs include the following:

- ***Virtual Pig Dissection*** (whitman.edu/biology/vpd)
- ***Fetal Pig Dissection*** (esu7.org/%7elweb/Lakeview/science/fetal.html)
- ***University of Central Oklahoma Fetal Pig Dissection***
(biology.uco.edu/AnimalBiology/pigweb/Pig.html)

Cat Anatomy

Neotek's Cat Dissection Laboratory presents every “major system (Skeletal, Musculature, Nervous, Digestive, Circulatory, Reproductive, Respiratory and more) ... in 80 brilliant dissections, each micro-surgically prepared” (neotek.com/)

ITG's CatLab is available online and in CD-ROM format, and it includes more than 300 laboratory-quality images. The developers state that CatLab is “excellent for medical, dental, physical and occupational therapy students.” (itgworld.com/catlabonline/index.html)

BioLab's Cat Dissection is exciting teacher-developed learning software that allows students to perform informative dissections and introduces the concepts of physiology alongside anatomy. Students expand their knowledge with interactive experimentation, eye-opening illustrations, and enlightening discussions about how form relates to function. (biolabsoftware.com/bls/cat.html)

ScienceWorks' CatWorks: Cat Dissection Simulation is a deluxe version of the program that includes real-life schematics, a glossary with pronunciations, online quizzes, lab practicals, and in-depth histology. (scienceclass.com/catworks)

Cat dissection programs are also available for free online; they include the following:

- ***Anatomically Correct: The Online Cat Dissection***
(library.thinkquest.org/15401/?tqskip1=1&tqtime=0530)
- ***Virtual Cat Dissection*** (bio.bd.psu.edu/cat/index.htm)
- ***Virtual Cat: Video Dissection*** (tutorials.maconstate.edu/CATDISSECTION/default.htm)
- ***Cat Neuroscience Laboratories*** (cal.vet.upenn.edu/neuro/N_Index.html)

Human Anatomy

Touch of Life Technology's VH Dissector is a human anatomy program “based on the National Library of Medicine’s Visible Human Project and was developed by the team of scientists at the University of Colorado that acquired the specimens and images that comprise the Visible Human DataSets™.” (toltech.net/products/vh_dissector/index.htm).

Neotek's Human Anatomy Lab includes 400 separate dissections of real human anatomy with thousands of anatomical structures, including arteries, veins, muscles, nerves, bones, and radiographs. The program also provides a quiz mode that allows instructors to give lab practical-type exams. Neotek also offers programs specific to the human skeletal system, the human heart, and the human upper limb. (neotek.com/Educational_Titles.htm#AnatomyLab)

Primal Pictures' 3-D Human Anatomy Software is derived from genuine medical scan data that has been interpreted by a team of primal anatomists and then translated into three-dimensional images by an expert team of graphics specialists. The anatomy visuals are accompanied by three dimensional animations that demonstrate function, biomechanics, and surgical procedures. The software has been widely adopted in education and is currently used for patient, practitioner, and student education in more than 20 countries. (primalpictures.com/).

Think Anatomy provides links to online resources, programs, and demos that teach human anatomy. (thinkanatomy.com/)

Bassett Collection of Stereoscopic Images of Human Anatomy is a free, online collection of detailed line drawings based on the photographs of Ruth Ogren, Harriet O’Neill, and Lorene Segal. A total of 1,547 photographic images and accompanying drawings have been compiled into a 24-volume Stereoscopic Atlas of Human Anatomy, completed in 1962; the images in this collection are derived from the Atlas project. (lane.stanford.edu/bassett/index.html)

Visible Body Interactive Anatomy Simulation is a complete, fully interactive, three-dimensional human-anatomy model with detailed models of all body systems and dynamic search capability. The program is Web-browser based and includes a free online demo. (visiblebody.com)

Brown & Herbranson Imaging's eHuman is an integrated, research-grade anatomy imaging library for consumer and professional use. eHuman integrates stereographic photography, micro-CT and synchrotron scan data, whole-body CT datasets, x-ray imaging, and world-class dissection studies. Development is ongoing, in collaboration with Stanford University, the Smithsonian, the Max Planck Institute, and other leading public and private entities around the world. (ehuman.com)

Dissection Packages

Tangent Scientific's DryLab Plus Suite series offers interactive virtual dissection software for six animals: a frog, a fetal pig, a rat, an earthworm, a perch, and a crayfish. These programs include full-motion videos, high-quality photographs, interactive anatomy modules,

and online interactive tests and meet the National Science Education Standards for middle schools and high schools. (tangentscientific.com/pdf/7200.pdf)

BioLab's Virtual Lab Series Package includes BioLab Fly, BioLab Frog, BioLab Invertebrates, BioLab Cat, BioLab Fish, and BioLab Pig. In addition to virtual labs, each CD-ROM contains supplemental teaching materials (in Adobe PDF format) such as crossword puzzles, student worksheets, tests, quizzes, etc. Instructors can monitor student progress with an electronic student-activity log.

(<http://www.carolina.com/product/virtual+lab+series+package+carolina%26%23153-+biolab%26reg-.do?keyword=virtual+lab+series&sortby=bestMatches>)

Neotek's DryLab Dissection Package contains the CatLab, FrogLab, Cellular Structure, DryLab Fetal Pig, DryLab Crayfish, DryLab Perch, DryLab Rat, DryLab Frog, and DryLab Worm in a money-saving set. (neotek.com/Educational_Titles.htm#DissectionPackage)

DissectionWorks Deluxe offers virtual dissections of a frog, a fetal pig, an earthworm, a crayfish, or a perch. The programs are intended for middle school- and high school-level students. Each program contains detailed schematics of the major body systems, information on organ function and structure, and review questions. (scienceclass.com/dissect/)

Pearson Higher Education's Practice Anatomy Lab 2.0 (PAL) is a virtual anatomy practice tool that provides students with the most widely used lab specimens including the human cadaver, cat, fetal pig, anatomical models, and histology slides.

(aw-bc.com/myaandp/learnMore.html#pal)

Other Virtual Dissection Resources

Several online invertebrate virtual dissection resources are available for free, including the following:

- **Crayfish Dissection** (aa.psu.edu/biology/crayfish/default.htm)
- **Crayfish Review** (biog-101-104.bio.cornell.edu/BioG101_104/tutorials/animals/crayfish.html)
- **Earthworm Review** (biog-101-104.bio.cornell.edu/BioG101_104/tutorials/animals/earthworm.html)
- **Starfish Dissection Tutorial** (library.thinkquest.org/13008/index.htm?tqskip1=1)
- **Cockroach Dissection** (everest.ento.vt.edu/~carroll/insect_video_dissection.html)
- **Squid Review** (biog-101-104.bio.cornell.edu/BioG101_104/tutorials/animals/squid.html)

The available free, online rat and mouse virtual-dissection resources include the following:

- **Rat Dissection Video and Computer Simulation** (ltsn-01.ac.uk/resources/features/rats/)
- **Comparative Anatomy: Rat and Frog**
(umanitoba.ca/faculties/science/biological_sciences/lab17/biolab17_1.html)
- **Rat Dissection: Muscular and Digestive systems**
(umanitoba.ca/faculties/science/biological_sciences/lab15/biolab15_1.html)
- **Rat Dissection: Respiratory, Circulatory and Urogenital Systems**
(umanitoba.ca/faculties/science/biological_sciences/lab16/biolab16_1.html)

- **Mouse Dissection** (geocities.com/virtualbiology/necropsy.html)
- **Mouse Brain Atlas** (hms.harvard.edu/research/brain)

Free, online sheep's brain virtual-dissection resources include the following:

- **Sheep Brain Dissection Guide** (academic.uofs.edu/department/psych/sheep/)
- **Sheep Brain Dissection: The Anatomy of Memory** (exploratorium.edu/memory/braindissection)
- **Atlas of the Sheep Brain** (msu.edu/user/brains/sheepatlas/)
- **Comparative Mammalian Brain Collections** (brainmuseum.org)
- **Veterinary Gross Anatomy Online Lab** (cal.vet.upenn.edu/projects/neurology/lab2/lab2.htm)

Several virtual dissection resources that do not fit into the categories above are also available, including the following:

- **MorphologyNet: Interactive, 3D Visualizations of Animal Anatomy** (morphologynet.org)
- **Cow's Eye Dissection** (exploratorium.edu/learning_studio/cow_eye/)
- **Sheep Heart Anatomy** (zerobio.com/videos/sheep_heart_anatomy.html)
- **Salmon Dissection** (library.thinkquest.org/05aug/00548/Dissection.htm)

Simulator- and Model-Based Replacements for Anatomy Dissections

Human Simulators and Models

Zahourek Systems' Anatomy in Clay Learning System is a system that allows student to build nonhardening clay onto specially designed, durable scale models of skeletons. All model lines are hand-cast in polyurethane and hand-finished, providing a standing skeleton designed with unique insights into the vertebrate skeleton and vary scale for easy comparison between lines of models of animals. Both student and professional models are available. (anatomyinclay.com/student-human-skeletons.html)

Denoyer Geppert's Functioning Pumping Heart is a fully functional schematic replica that portrays a frontally sectioned human heart showing all four chambers, valves, and major vessels of the cardiovascular system. The liquid-filled working model provides positive visual evidence of the double-pump nature of the heart, the isolation of the pulmonary and systemic circulatory systems, and the directional flow of the blood stream. (denoyer.com/products.asp?Cat=15&heading=2&title=Human%20Anatomy%20Models&category=15&cattitle=Heart)

Denoyer Geppert's Cardiovascular System is an economically priced heart replica that shows the ventricles, atria, veins, and aorta in precise detail. The front heart wall is detachable to reveal its inner valves and chambers. (denoyer.com/details.asp?item=W%20A380&heading=2&title=Human%20Anatomy%20Models&category=15&cattitle=Heart&subcategory=&subcattitle=)

Denoyer Geppert's Budget Two-Part Brain With Arteries is divided into hemispheres along the median sagittal plane. This life-size replica depicts the left and right cerebrum, cerebellum, brain stem, medulla, and blood vessels.

(denoyer.com/products.asp?Cat=16&heading=2&title=Human%20Anatomy%20Models&category=16&cattitle=Brain)

Denoyer Geppert's Student Edition Brain Set is cast from nonbreakable vinyl and incorporates simplified numbering and a budget-stretching monochrome painting scheme. Component parts are locked together with pins and will stay together during pass-around until pulled apart. Fifty principal features of the cerebral lobes, cerebellum, brain stem, and ventricles are number-coded for identification in the accompanying three-page key—perfect for introductory study.

(denoyer.com/products.asp?Cat=16&heading=2&title=Human%20Anatomy%20Models&category=16&cattitle=Brain)

Simulab's TraumaMan System is an anatomical human body form designed for students to practice several advanced surgical procedures, including cricothyroidotomy, chest-tube insertion, pericardiocentesis, diagnostic peritoneal lavage, and intravenous cutdown. The TraumaMan System consists of a simulated human-tissue structure made from an elastomeric composition designed specifically for surgical dissection. (simulab.com/home-traumaman-system)

Laerdal's SimMan is a portable and advanced patient simulator for team training. The simulator has realistic anatomy and clinical functionality. SimMan provides simulation-based education to challenge and test students' clinical and decisionmaking skills during realistic patient-care scenarios. (laerdal.com/document.asp?docid=33199898)

Laerdal's SimNewB is an interactive simulator designed by Laerdal with the American Academy of Pediatrics to meet the training requirements of the Neonatal Resuscitation Program (NRP) course. With realistic newborn traits and lifelike clinical feedback, SimNewB is ideal for training in the specific needs of neonates. SimNewB features six preset patient states, ranging from a vigorous to a compromised newborn. (<http://www.laerdal.com/document.asp?docid=31600070>)

Ingmar Medical's RespiTrainer is a respiratory skill trainer that provides immediate performance feedback on delivered ventilation to help ensure proper technique. The RespiTrainer includes an adjustable test lung that simulates different patient models and disease states, and it can be used with a variety of manikin heads (including infant) according to training needs. It is suited for EMS and respiratory-care training and education. (ingmarmed.com/respitainer_family.htm)

The Gordon Center for Research in Medical Education's "Harvey" Cardiology Patient Simulator is a full-size manikin that realistically simulates nearly any cardiac disease by varying blood pressure, pulses, heart sounds, murmurs, and breath sounds. "Harvey" also has the ability to provide an oral history. (crme.med.miami.edu/harvey_changes.html)

Flinders Meditech's Cricoid Pressure Trainer 1500 (CPT 1500) is designed for practicing the application of cricoid pressure, intubation, ventilation, suction, and CPR techniques. The neck region contains lifelike anatomy of the human throat. Sensors located in the throat

provide feedback on the amount of pressure applied, the direction of the pressure, and the duration of the pressure on the cricoid cartilage. (flindersmeditech.com/2.1.1.1%20CPT-1500.html)

Simulab's Knot Tying Board has a multipurpose platform for skill development that can be used on its own or with Simulab's laparoscopic trainers. The board includes parallel knotting tubes that simulate a realistic tissue response as well as two suture pads that simulate different skin thicknesses. (simulab.com/product/surgery/suturing/knot-tying-board)

Limbs & Things' Knot Tying Trainer is a comprehensive trainer for teaching all surgical knot-tying techniques, including one-handed reef knot technique, instrument tie, surgeon's knot, and slip knot. It also features a unique magnetic system to represent tissue strength. (limbsandthings.com/global/products.php?id=195)

Cardionics' Student Auscultation Manikin (SAM) provides a means for the instructor to teach cardiac and pulmonary auscultation to students at any level. The students can be taught as a group using the optional SimulScope or Classroom Infrared Emitter. There are three SAM models: SAM Complete, SAM Senior, and SAM Junior. (cardionics.com/heartandbreathsounds/manikins/SAM/)

Simulab's Torso Trainer provides a realistic laparoscopic experience by concealing the procedure from direct view. It accommodates most task and procedure models. The replaceable pneumoperitoneum is shown as an insulated abdomen. Additional replaceable pneumoperitoneum are sold separately. (simulab.com/product/surgery/laparoscopic/torso-trainer#tabs-product-info-1)

Laerdal's Pediatric Intubation Trainer is an anatomically accurate reproduction of a pediatric torso designed for teaching the differences in pediatric and adult anatomy for airway-management procedures. It allows sizing and insertion of various airway adjuncts: oropharyngeal and nasopharyngeal airway insertion, endotracheal tube insertion and securing, bag-valve-mask ventilation, tracheal suctioning, manually generated carotid pulse, and closed-chest compressions. (laerdal.com/document.asp?docid=14979235)

Animal Simulators and Models

Neo/Sci's Frog Lab: Lab Investigation allows students to study the anatomy and physiology of a frog by molding their own "frogs" using the included easy-to-prepare materials. Ready to dissect in just 15 minutes, the resulting "specimens" look and feel like the real thing. Students then dissect and explore the 11-piece plastic skeletal and organ system—complete with lungs, heart, and other organs. (neosci.com/catalog.asp?sid=72104169&showID=625&content=cn_showitem)

Denoyer-Geppert's The Great American Bullfrog is vinyl plastic replica of a sexually mature female bullfrog (*Rana catesbeiana*). Twice the size of a real frog, this replica includes 10 organ systems. This model offers internal nares, vomerine teeth, eustachian tube, and the nictitating membrane of the eye as well as a detachable heart, which is divided into anterior and posterior halves. Heart chambers and blood vessels throughout the body are color-coded to augment understanding of the circulation of the blood. More than 175 hand-numbered features are identified in the accompanying key, which also illustrates the male reproductive

system.

denoyer.com/products.asp?Cat=31&heading=3&title=Biology%20Models&category=31&attitle=Bullfrog)

Ward's Natural Science's Frog Activity Model provides dorsal and ventral dissections of a bullfrog (*Rana catesbiana*) and clearly shows the internal organs and musculature, while the inset shows details of the heart. The model includes an activity guide containing lesson plans, copy masters for student activities, and an overhead transparency.

wardsci.com/product.asp_Q_pn_E_IG0013676_A_name_E_Frog+Activity+Model)

Ward's Natural Science's Frog Models provide meticulous detail and incredible realism of *Rana catesbiana*—even the structures of the inner mouth are shown. Cast from actual specimens, the models feature more than 50 details from the digestive, circulatory, musculature, and reproductive systems and are colorfully yet subtly painted to show all major structures realistically. Each model is made from a unique material for flexibility and durability and comes with a key identifying 45 structures.

wardsci.com/product.asp_Q_pn_E_IG0013677_A_name_E_Frog+Models)

Ward's Natural Science's Fetal Pig Activity Model has raised-relief dorsal and ventral dissections side by side to show the viscera and nervous system in detail; the brain is also exposed. The ventral dissection is of a male pig and the dorsal is of a female pig, showing the kidney and ovary. Between the two, a third diagram details the circulatory system. The model comes with an activity binder containing lesson plans, copy masters for student activities, and an overhead transparency.

wardsci.com/product.asp_Q_pn_E_IG0013680_A_name_E_Fetal+Pig+Activity+Model)

Ward's Natural Science's Fetal Pig Model is cast from an actual specimen and includes all the intricate structural detail usually seen on a real dissected animal. It features all the internal organs as well as the major arteries and veins found in the body cavity, head, and neck. In addition, the heart, lungs, stomach, liver, and intestines are removable as a single unit so that students can study the deeper organs and vasculature. One kidney is sectioned to show renal circulation. Made of a unique material that is flexible and durable, the model has the look and feel of a real specimen and is hand-painted to match real dissection specimens. The model comes with a key identifying more than 100 structures.

wardsci.com/product.asp_Q_pn_E_IG0013681_A_name_E_Fetal+Pig+Model)

Ward's Natural Science's Rat Model is a highly detailed model patterned on an actual dissected rat. Made from unbreakable material and hand-painted for accuracy, the durable life-size model features a number of detailed structures, including a fetus in a partially dissected uterus and a sectioned kidney. It includes a key identifying more than 50 structures.

wardsci.com/product.asp_Q_pn_E_IG0013679_A_name_E_Rat+Model)

Ward's Natural Science's Earthworm Activity Model is a basic model that is clearly presented on an inexpensive plaque. The model features a medial section of the anterior as well as a cross section to illustrate all important earthworm characteristics: clitellum, complete segmentation, anus, and all internal systems such as longitudinal muscles and the intestine. The model comes with an activity binder containing lesson plans, copy masters for student activities, and an overhead transparency.

wardsci.com/product.asp_Q_pn_E_IG0007201_A_name_E_Earthworm+Activity+Model)

Ward's Natural Science's SOMSO® Earthworm Model is colorfully illustrated and enlarged to 25 times the size of a real earthworm. The comprehensive model can be taken apart for an even closer view of earthworm structure. It features a sectioned and dissected anterior to the clitellum to clearly show the septa, coelom, nephridia, aortic arches (or “hearts”), and even the setae. The intestine is removable for a better view of the stomach, and the reproductive organs are removable to show the sperm ducts. The three-part model is mounted on a stand and can be removed for closer study. It also includes a study guide identifying 41 structures. (wardsci.com/product.asp?QpnEIG0007202_AnameEEarthworm+Model+%28SOMSO%26reg%3B%29)

American Educational Products' Zoology Models introduce students to anatomy with seven dissection models shown in raised relief: a clam, a crayfish, an earthworm, a fetal pig, a frog, a grasshopper, and a perch. Each markable model is constructed of durable vinyl and shows internal structures in graphic detail. All models are 18 inches high by 24 inches wide; they are also available separately. The models are accompanied by a three-ring notebook, which includes background information for instructors as well as basic understandings, learning activities, a glossary, color transparencies, a blackline master, and a key to model structures for students. (amep.com/cat_science.asp?cid=4)

Rescue Critters' "Baxter" Big Dog Skeleton is mounted on a stand and has a removable head and tail. “Baxter” is more than twice the size of the popular CHD14 Canine Skeleton Model. Dimensions are 49 inches by 23 inches. (rescuecritters.com/p26.html)

Rescue Critters' "Bosley" Big Cat Skeleton is mounted to the base; the head and tail are removable. Dimensions are 27 inches by 12 inches. (rescuecritters.com/p26.html)

Sawbones' Average-Size Feline Skeleton is mounted on a base and features a removable tail and skull; the jaw is on springs. (sawbones.com/products/product.aspx?1787)

Sawbones' Large-Size Feline Skeleton features a removable tail and skull with the jaw on springs. It is mounted on base and measures 69 cm by 30 cm. (sawbones.com/products/product.aspx?1788)

Rescue Critters' Canine 4-Stage Knee is a set of four life-size models showing degenerative joint disease (osteoarthritis). A disease-free (normal) knee also includes additional important structures, including ligaments, tendons, and patella. The progressive degeneration of the articular surfaces and the development of osteophytes (bone spurs) are demonstrated in the three other models. (rescuecritters.com/p26.html)

Rescue Critters' Canine Heartworm Model has a cut-away view of an average-size dog heart with improved decoration of arteries, fat, and three sections of heartworm parasites. (rescuecritters.com/p26.html)

Sawbones' Feline Jaw opens, closes, and separates for closer study. Healthy teeth are on the right side, while diseased and damaged teeth are on the left. The model includes eight pathologies: a fractured canine tooth, periodontal disease, tartar accumulation, plaque, gingivitis, worn incisors, a retained deciduous tooth, and a missing premolar. (sawbones.com/products/product.aspx?1790)

Computer-Based Learning Methods for Physiology Experiments

General

cLabs' Virtual Physiology Series consists of five interactive simulation CD-ROMs: SimNerv, SimMuscle, SimVessel, SimHeart, and SimPatch. The series covers the entire field of nerve-muscle physiology and simulates all the classic experiments conducted by medical, dental, veterinary, biology, and chemistry students. (clabs.de/virtphys.htm)

Benjamin Cummings' PhysioEx 8.0: This software set includes 79 lab activities, covering topics such as cell transport, skeletal muscle contraction, irritability and conductivity of neurons, hormones and metabolism, cardiovascular dynamics, respiratory processes, digestion, glomerular filtration, acid/base balance, serological testing, and more. (pearsonhighered.com/educator/academic/product/0,3110,0321548574,00.html)

Anesoft's Hemodynamics Simulator 2002 is a computer program designed to help students review hemodynamic monitoring, cardiovascular physiology, and vasoactive infusions. Twenty self-directed lessons allow students to explore non-invasive vs. direct arterial blood pressure measurements, monitor central venous pressures, insert a pulmonary artery catheter, and learn to interpret the pressure waveforms in a variety of clinical scenarios. (anesoft.com/products/hs.asp)

Sheffield Biosciences offers multiple software programs that provide virtual physiology experiments, including blood physiology, blood coagulation, nerve physiology, muscle physiology, frog heart, exercise physiology, intestinal absorption, cellular respiration, guinea pig ileum, Langendorff heart, intestinal motility, Finkleman preparation, and rat blood pressure. (sheffbp.co.uk)

The Physiology Education Research Consortium (PERC) offers several software programs designed for physiology students. The following individual programs are also available as a set (physiologyeducation.org):

- ***Simulations in Physiology: The Renal System*** allows comparison of data from up to five experiments: glomerular capillary dynamics, proximal tubular reabsorption, the distal nephron, the total nephron, and acid-base balance.
- ***ABASE: A Program for Teaching Acid-Base Regulation*** is designed to help students to integrate their knowledge of the components of acid-base regulation by requiring them to make predictions about the effects of disturbances on five important variables. The program consists of four tutorial lessons and seven problems (only available for Macintosh computers).
- ***Cardiovascular Physiology Part I: Pressure/Flow Relations*** is a tutorial exercise that uses a single circuit, parallel organ system circulatory model without reflexes to explore students' knowledge of and ability to evaluate and/or calculate pressures, flows, and resistances in static and dynamic states. Postural changes are used as stimuli.
- ***Cardiovascular Physiology Part II: Reflex*** is a tutorial that explores basic hemodynamics using a set of problems related to a single circuit, parallel organ system

circulation. The reflex responds to postural changes, and hemorrhage and exercise are explored.

- **CIRCSIM: A Teaching Exercise on Blood Pressure Regulation** is a simulated experiment based on a model of the baroreceptor reflex loop. Users are required to make predictions about the effects of each of eight experiments on seven CV parameters before obtaining the actual results. Prediction errors then serve as triggers for discussion of the physiology involved.
- **GASP: A Teaching Exercise on Chemical Control of Ventilation** is a simulated experiment based on a model of the chemical control of the respiratory system. Users are required to make predictions about the effects of each of 11 experiments on 11 parameters before obtaining the actual results. Prediction errors serve as triggers for corrective discussion.

Thieme Medical Publishers offers a number of physiology simulations. According to the company, “The Virtual Physiology series consists of 5 interactive simulation CD-ROMs: SimNerv, SimMuscle, SimVessel, SimHeart, and SimPatch. The series covers the entire field of nerve-muscle physiology and simulates all of the classic experiments conducted by medical, dental, veterinary, zoology, and science students” and is “an ideal alternative to animal-based experiments.” (thieme.com)

iWorx offers a full range of advanced hardware and software tools for physiology teaching and research. The human physiology teaching kits include everything needed to conduct a comprehensive lab course, with 22 experiments and 76 exercises in cardiovascular, respiratory, and neuromuscular physiology. In addition, the LabsOnLine and LabsOnCD are a complete physiology laboratory operated from students’ Web browsers. The 31 exercises cover a variety of basic concepts in cardiovascular, neuromuscular, and respiratory physiology. (iworx.com)

Biosoft offers several different physiology simulation programs, including the following:

- **CardioLab** simulates chart recorder outputs of experiments on anesthetized (normal or reserpinized) animals and pithed animals. The simulated heart rate and blood pressure traces appear on screen and can be printed. CardioLab can also mimic stimulation of vagal and sympathetic cardiac nerves. “Overdoses” with agonists or blockers will “kill” the preparation. Responses are subject to biological variation and are influenced by cardiac compensatory reflexes, if appropriate. Tachyphylaxis is seen with relevant agonists. (biosoft.com/w/cardiolab.htm)
- **Isolated Guinea-Pig Ileum Simulator** accurately simulates laboratory experiments that investigate the effects of drugs on the *in vitro* guinea pig ileum. It is possible to mimic experiments to identify an unknown compound. Random elements are incorporated to simulate the inherent biological variability in the response to the same dose of agonist. (biosoft.com/w/ileum.htm)
- **NeuroSim** is a computer program intended for use in teaching neurophysiology, primarily at the undergraduate and beginning graduate level. It contains several modules, each of which simulates a particular aspect of neural function. NeuroSim has an intuitive interface so that students can concentrate on the underlying science. The programs have been designed for maximum flexibility and configurability so that each simulation can be used at a range of levels—from simple illustrations of phenomena suitable for junior

courses through to advanced data-handling and analysis. NeuroSim won an important prize for Technology in Learning. (biosoft.com/w/neurosim.htm)

Oakleaf Systems offers a variety of individual physiology software programs and software suites; titles include Physiological Data Simulation, Human Physiology Data Simulation, Stress Physiology Data Simulation, Endocrinology Data Simulation, Physiology Suite of Data Simulations, Animal Physiology Data Simulation, and the AJP-2000 Physiology Data Simulation. (oakleafsystems.net/Physiol.html)

The Modeling Workshop offers a variety of freeware physiology models that cover a range of organs, body systems, and physiological effects. (physiology.umc.edu/themodelingworkshop/)

Sciatic Nerve and Gastrocnemius Muscle Experiments

Biopac Systems' Finger Twitch self-experimentation kit: This kit allows students to safely and non-invasively record the force generated from the twitch of a finger and measure the stimulus frequency required to induce fatigue. (biopac.com/Education.asp?Cid=399&Level=3)

cLabs' SimMuscle: This software features a variety of simulated experiments on the prepared leg muscle of a frog, including single twitch as a function of stimulation intensity, superimposition of double stimuli, tetanic contractions, resting-tension curve, curve of isometric/isotonic maximum values, force-shortening velocity relationship, and fatigue. (clabs.de/muscle.htm)

Sheffield Biosciences' Muscle Physiology: This software simulates experiments on the frog sciatic nerve-gastrocnemius muscle preparation. Students can perform a number of experiments to illustrate the physiological properties of skeletal muscle and neuromuscular transmission. (sheffbp.co.uk/products/muscphys.htm)

Benjamin Cummings' PhysioEx 8.0: See description above. (pearsonhighered.com/educator/academic/product/0,3110,0321548574,00.html)

The Modeling Workshop's Skeletal Muscle model: This model covers circulation, vascular conductance, metabolism, effluent blood, heat, nerves, and function. (physiology.umc.edu/themodelingworkshop/Integrative%20Model/Organs/Skeletal%20Muscle/Skeletal%20Muscle.HTML)

Biopac Systems' Nerve Conduction self-experimentation kit: This kit allows students to safely and non-invasively record a charge from the stimulus electrodes to recording electrodes; observe the threshold, maximal and supra-maximal response levels; and determine nerve conduction velocity along the ulnar nerve. (biopac.com/Education.asp?Cid=395&Level=3)

cLabs' Neuron: This computer program uses animations and simulations to demonstrate the interrelations between ion channel dynamics and membrane currents and voltages. The program consists of four parts: membrane properties, ion channels, voltage-clamp experiments, and compound action potentials. (clabs.de/startpage_e.htm)

cLabs' SimMuscle: This software features a variety of simulated experiments on the prepared leg muscle of a frog, including single twitch as a function of stimulation intensity, superimposition of double stimuli, tetanic contractions, resting-tension curve, curve of isometric maximum values, curve of isotonic maximum values, force-shortening velocity relationship, and fatigue. (clabs.de/muscle.htm)

cLabs' SimNerv: This program uses digital video sequences to show the dissection and preparation of the nerve. It includes a virtual lab, complete with the equipment necessary to study the fundamentals of nerve stimulation: stimulator, oscilloscope, recording chamber, and two “frog” sciatic nerves. The position of stimulating and recording electrodes can be changed easily, and nerve ligations can be set and removed using a thread. (clabs.de/nerv.htm)

Sheffield Biosciences' Nerve Physiology: This program simulates a number of simple experiments that can be performed on the frog sciatic nerve preparation to illustrate the important properties of nerves. It provides an inexpensive, practical alternative to the use of live animals in teaching. (sheffbp.co.uk/products/nervphys.htm)

The Modeling Workshop's Nerve model: This freeware model program uses the Hodgkin-Huxley equations to describe the genesis of an action potential. Membrane potential is a function of the charge separation across the membrane and membrane capacitance; charge separation is the integral over time of current flowing through the membrane; and current is the sum of sodium, potassium, and leakage (other ions) ion currents. Each of these currents is a function of membrane potential and ion conductances, and the conductances are voltage sensitive. (physiology.umc.edu/themodelingworkshop/Model%20Library/Nerve/Nerve.HTML)

Carnegie Mellon University's HHsim: Graphical Hodgkin-Huxley Simulator: This freeware computer program is a graphical simulation of a section of excitable neuronal membrane using the Hodgkin-Huxley equations. HHsim is simple educational software designed specifically for graduate or undergraduate neurophysiology courses. The user interface can be mastered in a couple of minutes and provides many ways for students to experiment. (cs.cmu.edu/~dst/HHsim)

Simulator-Based Learning Methods and Self-Experimentation Kits for Physiology Experiments

Rescue Critters' "Critical Care Jerry" is a realistic, full-size dog manikin that has the ability to aspirate air and fluid from the thoracic cavity to simulate trauma as well as jugular vascular access. It features a realistic airway and representations of the trachea, esophagus, epiglottis, working lungs, and an artificial pulse (the pulse is simulated by a tube representing an artery in the groin). In the front paws and neck, tubes can be filled with a red fluid to practice taking blood samples or placing catheters. Accessories include a carrying case with a kneeling pad, an endotracheal tube, a syringe, a brush, and five disposable lungs. (rescuecritters.com/p12.html)

Biopac's VO₂ & RER self-experimentation kit records absolute volume of O₂ and CO₂ in a 60-second interval. The experimental objection is to obtain absolute VO₂ and RER values for

a subject at rest (optional segments include hyperventilation and recovery from exercise) and to demonstrate the relationship between VO₂ and RER. Students use the equipment to safely experiment on themselves by breathing through a mouthpiece while exercising (optional) or hyperventilating (optional). (biopac.com/Education.asp?Cid=413&Level=3)

Biopac's Aerobic Exercise Physiology self-experimentation kit allows students to record ECG, heart rate, airflow, and skin temperature under a variety of conditions. Students will see how their respiration pattern, the electrical activity of their heart, heart rate, and skin temperature change to meet changing metabolic demands. They perform a number of tasks designed to reach their personal maximum heart rate. (biopac.com/Education.asp?Cid=379&Level=3)

Computer-Based Learning Methods for Psychology

Psychology Software Tools' PsychMate enables students to take part in 30 classic and current psychology experiments, covering research in the areas of cognition, perception, social psychology, reaction-time procedures, human factors, and cognitive neuroscience. The student software includes an experiment-launcher that allows students to launch experiments quickly and easily. (pstnet.com/products/PsychMate/)

Thomson-Wadsworth's "Sniffy the Virtual Rat" is an engaging, interactive software program that provides students with a virtual laboratory where they can explore operant and classical conditioning by performing experiments that demonstrate most of the major conditioning phenomena discussed in textbooks on the psychology of learning. "Sniffy Lite" demonstrates the most basic phenomena of operant and classical conditioning but does not have the complexity and flexibility for advanced learning topics. "Sniffy Pro" is a comprehensive simulation of advanced learning phenomena. It has been field tested at several colleges and universities for use in learning and animal behavior courses. (wadsworth.com/psychology_d/special_features/sniffy.html)

Computer-Based Replacements for Pharmacology Experiments

The British Pharmacological Society's "pharma-CAL-ogy" is a state-of-the-art, computer-assisted learning platform that features more than 50 software and teacher-workbook titles produced by pharmacologists. The titles cover various areas of study, including drug metabolism, drug targets, neuropharmacology, cardiovascular system, simulations, clinical development, asthma, and inflammation. (pharmacology.com)

Dr. Ian E. Hughes' Isolated Phrenic Nerve-Diaphragm computer program simulates the effects of drugs on the skeletal muscles and the motor nervous system of a laboratory rat. The available drugs are acetylcholine, lignocaine, gallamine, tubocurarine, pancuronium, atracurium, fazadimium, hexamethonium, triethylcholine, choline, 4-aminopyridine, succinylcholine, edrophonium, neostigmine, atropine, carbachol, streptomycin, physostigmine, dantrolene, decamethonium, and unknowns. Tetanic stimulation is also simulated. (oslovet.veths.no/produkt.aspx?produkt=32)

Sheffield Biosciences' Respiration Pharmacology program is an interactive program based on pulmonary-function data obtained from guinea pigs to teach the fundamental pharmacology of the airways. The "Introduction" and "Methods" sections of the program use

a combination of text and high-resolution color graphics to describe the pharmacology and nervous control of the airways and the apparatus used to monitor airway function. The “Experiments” section allows the user to demonstrate the effects of spasmogens in albumin-sensitized (allergic) animals. The simulated responses (pulmonary resistance, pulmonary compliance, and blood pressure) are derived from actual experimental data and are displayed in high-resolution graphics. (sheffbp.co.uk)

Simulator-Based Replacements for Pharmacology Experiments

Medical Education Technologies Inc.’s (METI) Human Patient Simulator teaches students about the effects of morphine by using a simulated human system. Among the simulator’s many features, the developers include its “[a]utomatic recognition and response to administered drugs and drug dosages.” (meti.com/products_ps_hps.htm)

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