Home Lab Activities for Introductory Biology Delivered At-A-Distance

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The objectives of this presentation were to 1) demonstrate that many biology activities done in traditional laboratories can be done effectively, safely and cheaply in students' homes and 2) discuss the problems encountered with developing and delivering home labs.

To cut down on time required for students to attend a traditional laboratory, we devised 54 activities that students could do in their homes. Home lab manuals ($CDN 10 to print two manuals) and home lab kits ($33 for 30 expendable items) were supplied as part of the course materials ($114 for commercial text, study guide and lab manual; $14 for other materials) for two introductory courses delivered at-a-distance. The home lab kits needed to be supplemented by 110 food and miscellaneous items found in most homes as well as model kits, computer programs and video tapes loaned from our library (2 compulsory kits and 27 optional items). Compulsory lab activities are summarized in Table 1, optional activities in Table 2.

Problems encountered in producing the home lab activities included: time limitations for development, repeatability of results done with different items or organisms, safety and liability concerns, testing the home labs with appropriate subjects, copyright permissions, disagreements within the course team (three authors, two lab technicians, one editor, two illustrators), and lack of student input into the design of the lab activities. Problems encountered in delivery of the courses by the university included: continuous enrollment (i.e. no semester breaks to allow complete changes of course materials), people in course materials department not accustomed to dealing with many items in the home lab kits, and getting commercial computer simulations to work on many kinds of computers used by students. Student delivery problems included the traditional problems of students: not reading instructions, skipping certain activities and poor use of available help from tutors and the library. From the students' perspective, problems included: lab activities that did not work, little evaluation for the lab work, long waits for library materials, activities that took too long, too many lab activities, results of some activities were too obvious to bother doing the activities, and missing items from the home lab kits.

Although there are problems, home labs can work. One must consider the subject matter, backgrounds of students, available technologies, safety factors, and cost.

Table 1. Introductory Biology Home Lab Materials (compulsory).
Italics indicate that an item was used in a previous activity.

Home Lab Activity	**Home Lab Kit**	**Student Provided Materials**
Water		
cohesion and adhesion (2 activities)	dropper	oil, water, toothpicks, detergent, paper towel, hard surface
capillary action	Petri dish, modeling clay (3 colors), 3 capillary tubes	*water*, food coloring, *paper towel*, metric ruler
surface tension	2 glass cover slips	*water*, container
pH	pH paper and color chart	10 water-based items, plate
Isomers		
Isomers	*modeling clay*	*toothpicks*, mirror
Simple chemical tests		
sugars, fats, proteins (2 activities)	razor blade	forceps, aluminum foil, scissors, pencil, matches, candle, metal lid, paper, 2 sugars, 2 fats, 2 proteins, 4 other foods, water (for fire)
starch	3 test tubes, *dropper*, 1 1-mL syringe	knife, onion, potato, 2 tablespoons (for crushing), filter, iodine, aluminum foil cookie sheet, apron (optional)
Microscopy		
sectioning	*razor blade*, *modeling clay*	rolling pin, wax paper (optional)
magnification		
Diffusion and osmosis		
diffusion	3 250-mL beakers, *dropper*, thermometer	wax pencil/marker, water (3 temperatures), *food coloring*
osmosis (2 activities)	dialysis tubing, 3 *250-mL beakers*	*wax pencil/marker*, *scissors*, *water*, string/dental floss, syrup, *metric ruler*, raisins, fresh grapes
Enzymes (experiment)		
enzyme concentration and temperature (2 activities)	5 *test tubes*, 4 -250-mL beakers, 1 *1-mL syringe*, 2 3-mL syringes, *dropper*, *thermometer*	teaspoon, corn starch, 2 cups, *iodine*, *water* (2 temperatures), saliva, tongs/clothes pin, elastic band
Fermentation (experiment)		
fermentation	*thermometer*, 4 *3-mL syringes*, *1 1-mL syringe*, 4 *250-mL beakers*, *modeling clay*	4 *teaspoons*, measuring cup, 4 glasses, *wax pencil*, sucrose, 2 carbohydrates, clock, *water*, yeast

Table 1. Continued

Photosynthesis (experiment)		
carbon fixation	*Petri dish, dropper*	plant, paper, paper clips, *tongs, scissors, iodine, water*, methanol, 2 pans
Home Lab Activity	**Home Lab Kit**	**Student Provided Materials**
Genetics		
mitosis and meiosis (2 activities)	pipe cleaners (2 each of 4 kinds), *modeling clay*	*scissors*/wire cutters
Mendelian genetics		
albino corn	corn kernels	*cup*, soil, plant pot(s), tray, *water*
DNA	kit (library)	
human traits		
pedigree		2 family traits
karyotypes	2 printed sheets	*scissors, ruler*, glue/tape
Hardy-Weinberg equilibrium	control, PTC and SB paper	calculator (optional)
Protein synthesis		
protein synthesis	kit (library)	
Evolution		
natural selection (simulation)		colored paper, *scissors*, bags, *calculator* (optional)
Systematics		
classification and keys		
Biodiversity		
fungi (bread mold, etc.)	*razor blade*, magnifying lens, *Petri dish*	bread/fruit, fresh mushroom, paper
seed plants	*razor blade, magnifying lens*	knife/pruning shears, branch and cones of conifer
Plant structure		
transpiration	*razor blade, magnifying lens*	2 live plants, food coloring, water, 2 containers, clock, ruler
leaves, stems, flowers, fruits, seeds (5 activities)	*magnifying lens, razor blade, corn kernels*	6 plants, woody twig, *knife*, 2 simple flowers, 5 fruits, dried bean seeds, *water, container, iodine*
seed germination	2 *Petri dishes*, corn kernels, unknown seeds	*bean seeds, paper towels, scissors, water, aluminum foil*, light

Table 1. Continued

Sense Organs (human)		
blind spot, afterimages (2)		white, yellow, blue paper, pen
chemo-, proprio-, thermo-receptors (3)	*dropper*	*knives*, apple, *potato, paper towel, sucrose*, table salt, vinegar, tonic water, *water (various temperatures)*, measuring spoons, *measuring cup, cups, ruler, pen, metal probe (teaspoon)*
breathing rate		paper bag
Total	**Total**	**Total**
44 activities (including 4 experiments)	**30 items plus 2 library kits**	**More than 100 items**

Table 2. Introductory Biology Home Lab Materials (optional).

Home Lab Activity	**Library**	Student Provided Materials
isomers	1-2 chemical model kits	
microscopes	2 audiotapes/slide kits	
DNA	4 videotapes	
DNA technology		5 newspaper articles, television story
Evolution	2 videotapes	
population genetics	1 computer program simulation	*calculator (optional)*
biodiversity	5 videotapes	
dissection		*knife*, plastic gloves, newspaper, fresh fish
physiology	8 videotapes	
ecology	1 videotape	
Total	**Total**	**Total**
10 activities	20 videotapes, 2 model kits, 2 audio/slide kits, 3 computer disks	11 items

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