

Next Gen — PLANT SCIENCE

Materials Lists for EXPLORING Activities

LESSON A1–1: Cellular Biology

Examining Plant Tissues and Cells

- 70 percent ethanol
- 95 percent ethanol
- coverslips
- Fast Green stain
- filter paper
- forceps or tweezers
- herbaceous stem
- iodine or methylene blue
- leaves
- microscope
- microscope slides
- onion bulb
- petri dish or watch glass
- pin
- razor blade
- roots
- safranin stain

LESSON A2–1: Leaf Structure and Functions

Leaf Cells

- 2 beakers
- 2 coverslips
- 2 dropper bottles
- 2 microscope slides
- compound microscope
- distilled water
- leaves of purple heart wandering Jew (*Setcreasea pallida*, 'Purple Heart')
- prepared slide of lilac (*Syringa*) leaf
- saline solution

Chlorophyll Fluorescence

- 25 mL graduated cylinder
- acetone
- filter paper
- flashlight
- funnel
- mortar and pestle
- ring stand or funnel rack
- safety goggles
- spinach leaves
- test tube

LESSON A2–2: Transpiration

Transpiration Rates

- balance or scale
- distilled water
- fan
- floodlight
- greenhouse misting system or spray bottle
- plants (bedding plants or herbaceous houseplants)
- small plastic bags (bags with zipper locks do not work well)
- string or plastic-bag ties
- tape and marker
- thin plastic wrap (e.g., Saran™ Premium Wrap)

LESSON A3–1: Stem Structure, Functions, and Growth

Stem Comparisons

- sunflower (*Helianthus*) stem cross-section microscope slide
- corn (*Zea mays*) stem cross-section microscope slide
- basswood (*Tilia*) two-year stem cross-section microscope slide
- microscope

LESSON A3–2: Material Transport

Translocation in Cut Flowers

- containers (bud vases, beakers, jars, etc.)
- floral dyes or red and blue food coloring
- knife
- floral cooler or refrigerator
- plastic bag
- white standard carnations
- fan

LESSON A4–1: Root Structure and Functions

Auxins and Root Growth

- 3 small paint brushes
- 5 bean seedlings (selected from 10 bean seeds planted)
- 5 flasks (150 mL)
- 10 mL of isopropyl alcohol
- 10 pots (2¹/₄ inch)
- 105 mL of indole-3-acetic acid solution (IAA), 1 : 10,000
- 105 mL of indole-3-acetic acid solution (IAA), 1 : 1,000,000
- 300 mL of distilled water
- cotton balls
- graduated cylinder (100 mL)
- metric ruler
- safety goggles
- scalpel
- soilless mix
- wax pencil

LESSON A4–2: Water and Mineral Absorption

Mycorrhizae and Plant Roots

- 6-inch standard pots (four pots for each student or group)
- balance
- bucket
- conventional or microwave oven
- cookie sheet
- covered 2-quart casserole dish

- dissecting microscope
- fresh field soil
- horticultural sand or construction sand
- labeling materials
- organic seeds that have not been treated with fungicides (Two plant species should be used, including one that benefits from mycorrhizae—e.g., corn, marigold, sunflower—and one that does not—e.g., broccoli, mustard, radish.)
- phosphorus-free nitrogen fertilizer
- ruler
- shovel

LESSON A5–1: Flower Structure and Functions

Flower Dissection

- dissecting needle
- flowers
- glass slides and coverslips
- hand lens
- microscope
- razor blade
- thionin stain

LESSON A5–2: Pollination and Fertilization

Influence of Temperature on Pollen Germination

- controlled temperature chambers (10°, 21°, 38°C)
- damp paper towels
- dissecting needle
- fresh yellow onion
- magnifying lens
- metric ruler
- microscope
- microscope slides
- petri dishes
- pollen (from a flower of a tomato or cucumber plant)
- razor blade
- thionin stain
- tweezers

LESSON A6–1: Photosynthesis

Photosynthesis and Light

- beakers
- black cardboard or construction paper
- cornstarch
- ethyl alcohol
- eye protection
- green potted plant or outdoor plant
- hot plate or Bunsen burner
- Lugol’s iodine solution
- pan
- paper clips
- petri dish
- scissors
- sugar
- test tubes
- tongs

Photosynthesis and Carbon Dioxide

- beakers
- ethyl alcohol
- eye protection
- green potted plant or outdoor plant
- hot plate or Bunsen burner
- Lugol’s iodine solution
- pan
- petri dish
- petroleum jelly
- tongs

Photosynthesis and Chlorophyll

- beakers
- ethyl alcohol
- eye protection
- hot plate or Bunsen burner
- Lugol’s iodine solution
- materials for sketching
- pan
- petri dish
- tongs
- variegated plant (e.g., coleus, geranium, or philodendron)

Photosynthesis and Water

- beakers
- ethyl alcohol
- eye protection
- green potted plant
- hot plate or Bunsen burner
- Lugol's iodine solution
- pan
- petri dish
- tongs

LESSON A6–2: Cellular Respiration

Cellular Respiration

- 100 mL graduated cylinder
- 3 respirometers
- 50 mL graduated cylinder
- dye
- electronic scale
- glass beads
- ice
- masking tape (sticky side up) to act as a sling
- paper towels
- peas (germinating and non-germinating)
- personal protective equipment (safety goggles or glasses, apron, gloves)
- stopwatch/timer (You may use your own.)
- thermometer
- water bath
- weighing boat
- weights (Metal washers work.)
- For respirometer assembly:
 - 15% KOH
 - absorbent cotton
 - eyedropper
 - glass vials
 - nonabsorbent cotton
 - parafilm or petroleum jelly (for sealing purposes)
 - stoppers with sealed 1 mL serological pipettes

LESSON B1–1: Nucleic Acid Structure and Function

Extracting DNA from Wheat Germ

- 150 mL beakers
- 95 percent ethanol
- candy thermometer
- cheesecloth
- clean glass rod or glass pipette
- detergent solution
- disposable plastic pipettes
- eyedropper (optional)
- hot plate
- ice
- meat tenderizer
- microscope
- mortar and pestle
- pans for preparing hot-water and ice baths
- test tube
- untoasted wheat germ

Replication, Transcription, Translation

- *No materials required.*

LESSON B1–2: Heredity

Genetic Variation

- lab sheet
- pen or pencil

Genetic Variation in Corn

- 1 ear of corn from a first-generation cross between homozygous parents
- 1 ear of corn from a second-generation cross for two traits
- lab sheet
- pen or pencil

LESSON B1–3: Evolution and Plant Domestication

Genetic Variation and Selection

- bean seeds (soaked)
- graph paper
- mature leaves from the same tree or plant species
- millimeter ruler
- string

LESSON B1–4: Recombinant DNA Technology

DNA Cloning

- DNA cloning kit
- lab sheet
- laboratory equipment specified by kit to supplement kit contents
- safety glasses

Chocolate-Flavored Strawberries

- cacao DNA (linear)
- lab sheet
- ligase (tape)
- plasmid DNA (circular)
- restriction enzyme (scissors)

LESSON B2–1: Sexual Propagation

The Role of the Embryo in Germination

- grains of wheat or barley (25 grains of each per experiment)
- 12 or more petri dishes, with lids and filter papers, per student or group
- gibberellic acid solution
- iodine solution (for starch test)
- gelatin or agar starch
- razor blade

LESSON B2–2: Asexual Propagation

Tissue Culture of Blackberry Seeds

- 1 bamboo food skewer, 8 to 10 inches long, that can be used to manipulate seeds
- 1 small jar of 10 percent bleach solution
- 1 small jar with 100 ml of sterile distilled water
- 1 small jar with sterile potato dextrose agar medium
- 12" × 12" cheesecloth square
- 2 or 3 sterile paper towels
- 4" × 4" cheesecloth square
- 70 percent ethanol
- blackberries
- brown lunch bag
- clear plastic bag (unused) large enough to insert both hands and the materials into (Floral bouquet bags work well.)
- masking tape
- forceps
- razor blade

Tissue Culture of Venus Flytraps

- 1 stainless steel needle-like tool to tease the plants apart, such as a stainless steel turkey trussing pin
- 12" × 12" cheesecloth square
- 2 bamboo food skewers, 8 to 10 inches long, that can be used to extract plants from the test tubes and carry plant parts down and into the tissue culture medium
- 2 or 3 sterile paper towels
- 2 test tubes with Venus flytrap multiplying medium
- 2 test tubes with Venus flytrap rooting medium
- 2-liter bottle
- 70 percent ethanol
- brown lunch bag
- clear plastic bag (unused) large enough to insert both hands and the materials into (Floral bouquet bags work well.)
- masking tape
- marker
- parafilm strips
- sphagnum moss
- stage 2 Venus flytraps in multiplying media

Tissue Culture of Boston Ferns

- 1 stainless steel needle-like tool to tease the plants apart, such as a stainless steel turkey trussing pin
- 12" × 12" cheesecloth square
- 2 bamboo food skewers, 8 to 10 inches long, that can be used to extract plants from the test tubes and carry plant parts down and into the tissue culture medium
- 2-liter bottle
- 2 or 3 sterile paper towels
- 70 percent ethanol
- brown lunch bag
- clear plastic bag (unused) large enough to insert both hands and the materials into (Floral bouquet bags work well.)
- forceps
- jar with prepared multiplying medium for Boston fern
- masking tape
- marker
- parafilm strips
- razor blade
- sphagnum moss
- stage 2 Boston ferns
- test tubes with prepared rooting medium for Boston fern

LESSON C1–1: Nutrients for Plant Growth

Testing for Nutrients

- lab sheet
- leaf and stem samples from plants to be tested (Use representative plants in large growing conditions.)
- pen or pencil
- personal protective equipment
- plant tissue testing kit
- soil samples (Take the samples from the root zone of plants from which tissue samples are obtained.)
- soil test kit

LESSON C1–2: Biogeochemical Cycles

The Nitrogen Cycle

- Inquiries in Science: Exploring the Nitrogen Cycle Kit
- Materials not included in the kit:
 - 1 air pump with tubing and air stone
 - 1 pair of scissors
 - 1 small fish net
 - 3 aquariums or buckets (at least 5 gal.)
 - 3 cotton balls
 - distilled or tap water (14 gal.)
 - lab sheet
 - markers
 - masking tape

LESSON C1–3: Soil Biology and Chemistry

Assessing Nutrient-Holding Capacity

- 8-inch standard pots (one for each soil sample)
- commercial fertilizer
- lab sheet and pencil
- soil / growing media samples (field or garden soils, potting soil, greenhouse growing mix, vermiculite, rock wool, sand, etc.)
- soil test kit
- water

Cation Exchange Capacity

- 0.01 N aqueous NaOH solution
- 0.2 N KCl solution
- calcium test reagent
- digital balance
- distilled water
- filter paper
- funnel test tubes
- glass stirring rod
- graduated cylinder
- lab sheet and pencil
- marking pencil
- phenolphthalein indicator

- plastic cups
- polypropylene beakers
- soil (You will be assigned one of four samples.)
- titration apparatus
- weighing dish

LESSON C2–1: Plant Growth Regulators and Tropisms

Phototropism in Monocotyledon Shoots

- 4 lightproof boxes (lined with black construction paper or sprayed inside with black paint)
- 4 pots (4-inch)
- corn seeds
- cutting tool
- growing medium
- lab sheet and pencil

Geotropism in Germinating Monocotyledon Seeds

- 5 percent chlorine bleach solution
- beaker or jar
- cardboard
- corn seeds
- lab sheet and pencil
- paper towels
- pins
- resealable plastic bag
- tape

LESSON C2–2: Herbicide Action

Differential Effects of Herbicides

- 3 planting trays or small pots
- 10 potted broadleaf plants
- box fan
- lab sheet and pencil
- labels
- marking pen
- monocotyledonous and dicotyledonous seeds (corn and soybeans or oats and radishes are good specimen combinations)

- nonselective herbicide (Roundup®, KleenUp®—readily available at garden centers)
- personal protective equipment
- potting soil or soilless mix
- selective herbicide, premixed in spray bottle (2,4-D, 2,4,5-T, MCP, Ortho® Weed B Gon®, or Ortho® Grass B Gon®M—readily available at garden centers)

Plant Responses to the Rate of Herbicide Application

- 2 small to medium potted plants of three different species (Begonia, vinca, and geranium are recommended, but any broadleaf plants will work. Grass plants may also be included, if desired.)
- 2,4-D in a ready-to-use spray formulation, such as Ortho® Weed B Gon® or Nufarm Weedone®
- clear tape
- lab sheet and pencil
- labels
- marking pen
- personal protective equipment
- plastic wrap or nonabsorbent material

LESSON C3–1: Plant Pathology

Brown Rot

- empty resealable clear plastic bag
- fruit with pustules of brown-rot fungus inside a resealable clear plastic bag that is closed and aerated
- healthy fruit of the same kind as the diseased fruit
- lab sheet
- marker
- paper towels
- pencil
- toothpicks

LESSON C3–2: Insect Pests of Crops

Insect Pest Description

- computer with Internet access

LESSON D1–1: Sustainable Crop Production Practices

Windbreak Evaluation

- anemometer (revolving-cup type) for each person
- azimuth compass
- clinometer, hypsometer, or Abney level
- flags or stakes
- lab sheet for each person
- measuring tape (100-foot)
- pencil for each person
- stopwatch or wristwatch for each person (synchronized)
- whistle, cell phone, or walkie-talkie for each person for signaling

Nutrient Management

- 2 large flats or trays at least 4 inches deep and with drainage holes
- corn seeds
- lab sheet
- legume seeds (soybean or alfalfa) with rhizobia inoculum
- pen or pencil
- potting soil
- soil test kit (commercial kit that includes a test for nitrogen)

LESSON D1–2: Crop Production and the Environment

Eutrophication in Ponds

- 3 beakers (1-liter size)
- complete soluble fertilizer
- cover slips
- distilled water
- eyedropper
- graduated cylinder
- grow lights or bright window
- lab sheet
- microscope
- pen
- plastic wrap (Glad® Press'n Seal® works well.)
- pond water sample (with organisms)
- slides
- stirring rod
- wax pencil

Groundwater Contamination

- 100 mL beaker
- 2-liter clear plastic bottle
- clean sand
- cutting tool
- disposable syringe
- lab sheet
- masking tape or rubber band
- pen or pencil
- pump sprayer from a bottle of all-purpose cleaner
- red food coloring
- small piece of nylon fabric
- small stones (pea gravel)
- spray container with water
- transparent straw
- water

LESSON D2–1: Forest Ecology

Forest Ecosystem Evaluation

- Biltmore stick
- lab sheet
- materials for staking out a plot
- pencil

Line Transect Study of Tree Species

- caliper or Biltmore stick
- clipboard
- field identification guide or dichotomous key for regional tree species
- lab sheet
- log sheet
- marking flags or plastic marking tape
- measuring tape
- pencil

LESSON D2–2: Prairie and Rangeland Ecology

Field Study of a Prairie Ecosystem

- field guide to North American insects
- field guide to North American mammals
- field guide to North American prairies
- field guide to prairie plants
- lab journal
- lab sheet
- pen or pencil

Next Gen — ANIMAL SCIENCE

Materials Lists for EXPLORING Activities

LESSON A1–1: Cellular Biology

Osmosis and Diffusion in an Egg

- clear corn syrup
 - container (beaker, clear cup, or jar)
 - distilled water
 - electronic balance
 - 1 fresh chicken egg per group
 - graduated cylinder
 - masking tape and marker
 - paper towels
 - white vinegar
-

LESSON A1–2: Tissue Types and Functions

Examining Animal Tissue Types

- microscope
 - pen or pencil
 - tissue slides provided by instructor
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LESSON A1–3: Skeletal System Structures

“Pickled Chicken Bones!”

- bleach
- chicken bones (legs)
- device with a camera (optional)
- digital scale
- disposable gloves
- jars or containers
- metric ruler
- paper towel
- pen or pencil

- tape or marker
- tongs
- towel
- vinegar
- water

LESSON A1–4: Muscular System Structures

The Power of Fiber!

- 12-inch section of yarn
- disposable gloves
- pen or pencil
- piece of cubed meat
- plastic knife
- plate or tray
- toothpicks

LESSON A1–5: Immune System Structures

Investigating How Animals Fight Diseases

- device with Internet access
- E-unit and/or other research materials
- printer
- word processing and media applications

LESSON A1–6: Circulatory System Structures

The Amazing Heart!

- animal heart
- device with Internet access
- dissecting tray
- magnifying glass
- pen or pencil
- plastic gloves
- tweezers

LESSON A1-7: Respiratory System Structures

Investigating Cow Lungs

- a set of cow lungs (preserved)
- lab apron
- magnifying glass
- pen or pencil
- plastic gloves
- safety glasses
- scalpel
- tweezers

LESSON A1-8: Nervous System Structures

A Sheep's Eye

- blunt probe
- disposable gloves
- dissection tray
- fine scissors
- lab apron
- paper
- pen or pencil
- preserved sheep's eye
- safety goggles
- scalpel
- tweezers

LESSON A1-9: Renal System Structures

Investigating Kidney Filtration

- beaker
- coffee filter
- disposable gloves
- lab apron
- pipets (3)
- test tubes (3)
- safety goggles
- solutions:
- Benedict's (15 drops)

- biuret (15 drops)
- IKI solution (2 drops)
- test solution (20 mL)
- wax marker pen

LESSON A1–10: Integumentary System Structures

Exploring an Animal's Skin

- APA/MLA manual or website
- device with Internet access and typing capabilities
- pen or pencil
- printer

LESSON A2–1: Embryology

Chicken-Embryo Microscope Slides

- embryo slides for specific hours between 18 and 96
- microscope
- pen or pencil

LESSON A2–2: Growth and Development

Chick Growth and Development

- balance
- bedding
- chick food
- chick of undetermined breed
- device with Internet access (or a book on chicken breeds)
- feed container
- heat lamp
- housing area
- pen or pencil
- ruler
- water
- watering container

LESSON A2-3: Growth Promotants

All That Stress

- bucket
- headphones
- ice
- phone or device to play music on
- problem to solve (maze, complex dot-to-dot, or trivia game)
- water

LESSON A3-1: Dietary Nutrients

Testing for Food Nutrients

- 250 mL beaker
- Benedict's solution
- biuret solution
- fat source (vegetable oil)
- hot plate
- Lugol's iodine solution
- paper towels
- pipettes
- protein source (milk)
- safety glasses
- samples of animal food (dry, wet, hay, silage, etc.)
- starch source (bread or crackers)
- Sudan IV
- sugar source (Karo syrup)
- test tubes
- water

LESSON A3-2: Digestive System Structures and Processes

Fermentation in the Rumen

- 1 packet (or 1 tbsp.) of yeast
- $\frac{1}{4}$ cup or 50 mL of corn syrup
- 2-liter plastic bottle
- 500 mL of warm water (80°F to 100°F)
- balloon
- funnel

- measuring cup
- measuring spoons
- measuring tape

Simulation of Digestion

- 1/2 banana
- 1/4 cup (or 50 mL) of water
- 1 leg of hosiery
- 5 saltine crackers
- paper towels or newspaper
- plastic sandwich bag with sealing capabilities
- scissors
- small, reusable container

Absorption of Nutrients

- amylase enzyme tablet
- assorted beakers and test tubes
- Benedict's solution
- cornstarch (at least 5 g)
- dialysis tubing
- distilled water for rinsing and cooling
- hot distilled water (for making a "cell," at least 500 mL)
- hot water bath
- iodine solution
- string or thread
- wax pencil

LESSON A3-3: Cellular Respiration

Cellular Respiration in Yeast

- apple cider (40 mL)
- balloon (latex)
- flask (50 mL)
- measuring tape
- spoon
- yeast (1/2 teaspoon)

Exercise and Cellular Respiration

- beaker
- bromothymol blue
- eye dropper
- graduated cylinder
- stop watch
- straw
- tap water

LESSON B1–1: Nucleic Acid Structure and Function

DNA Extraction from Calf Thymus

- 0.9% NaCl (0.9 g of NaCl in 100 ml distilled water)
- 10% dishwashing solution (10 ml in 90 ml water)
- 95% ethanol (kept in a freezer)
- calf thymus (sweetbread)
- cheesecloth
- glass stirring rod or glass pipette
- microscope
- mortar and pestle
- scissors and/or scalpel
- small graduated cylinder
- test tubes

Replication, Transcription, Translation

- *No materials required.*

LESSON B1–2: Heredity

Genetic Variation

- pen or pencil

LESSON B1–3: Evolution and Animal Domestication

Artificial Selection of Dogs

- coin
- pen or pencil

LESSON B1–4: Recombinant DNA Technology

DNA Cloning

- DNA cloning kit
- lab sheet
- safety glasses
- laboratory equipment needed to supplement the kit

Chocolate-Flavored Milk

- cacao bean DNA (linear cutout)
- lab sheet
- ligase (tape)
- plasmid DNA (circular cutout)
- restriction enzyme (scissors)

LESSON B2–1: Reproductive Systems and Processes

Evaluation of Semen

- 2.9% sodium citrate solution
- disposable gloves
- droppers
- fresh or frozen semen (bull)
- hot plate
- lab apron
- microscope
- pen or pencil
- safety goggles
- semen stain (eosin-aniline blue stain or similar product)
- several microscope slides and cover slips
- several test tubes
- slide warmer
- thermometer or temperature sensor for water bath
- water bath
- wooden sticks

LESSON B2–2: Reproductive Technologies

The Insemination Box

- AI gun
- cardboard box or plastic storage tub (2' × 3' or larger)
- duct tape
- foam can cozies (four)
- hair scrunchies
- long veterinary gloves (disposable)
- nylon
- pen or pencil
- scissors
- small paper cup
- straws filled with simulated semen
- towels
- **OPTIONAL MATERIALS**
 - pool noodle (or rope)
 - mop head (or rope)
 - black, white, and brown paint

LESSON C1–1: Animal Behaviors

Pecking Order of Chicks

- 1 cardboard box per lab group (preferably 1' by 1' or larger)
- 2 chicks (at least one week of age) per lab group
- 2 different colored markers (preferably red and blue)
- 2 plastic lids per lab group
- chicken feed (preferably chick starter feed)
- scale or balance
- tap water

LESSON C1–2: Animal Welfare

Designing a Livestock Facility

- paper and pencil
- laptop
- internet access
- crafting materials for building a model (cardboard, poster board, craft sticks, etc.)

LESSON C2–1: Feedstuffs and Feeding Methods

Dissecting Horse Feed

- calculator
- digital scale
- pen or pencil
- small cups
- tablespoon
- textured feed (equine)
- white paper

Calculating Dry Matter

- digital scale (or equivalent, in grams)
- microwave (or laboratory oven)
- microwavable plate
- pen or pencil
- samples of stored hay

LESSON C2–2: Balancing Animal Feed Rations

Balancing Rations

- *No materials required.*

LESSON C4–1: Animal Health

Vital Signs of Canines

- disposable gloves
- dog
- leash and collar
- muzzle (if needed)
- petroleum jelly
- thermometer
- timer

LESSON D1–1: Sustainable Animal-Production Practices

Sustainable Grazing Methods

- containers to receive runoff (4, light in color)
- grass flats (4)
- grow light or sunny location
- pair of dice
- pen or pencil
- scissors
- string or yarn
- watering can

LESSON D1–2: Animal Waste Management

Eutrophication in Ponds

- 3 beakers (liter size)
- composted manure (“tea”)
- cover slips
- distilled water
- eyedropper
- graduated cylinder
- grow lights or bright area
- microscope
- pen or pencil
- plastic wrap
- pond water sample (300 mL, with organisms)
- slides
- stirring rod
- wax pencil

Groundwater Contamination

- 2-liter bottle (clear)
- beaker (100 mL)
- clean sand
- cutting tool
- disposable syringe
- drinking straw (transparent)
- masking tape
- pen or pencil
- pump sprayer from a bottle of all-purpose cleaner

- red food coloring
- rubber band
- small piece of nylon fabric
- small stones (pea gravel)
- spray container with water
- water

LESSON D2–1: Population Ecology

Fluctuation of Moose and Wolf Populations

- calculator
- graph paper
- worksheet
- pencil

LESSON D2–2: Biodiversity

Why Biodiversity Is Important

- paper and pencil, laptop, or other means to keep notes