Science Reference Cards

Nine exhibit starting points for Biology Lab of Horrors

1 The Organelle Asylum

How does an organelle help a cell function?

Biology background

- Organelles organize specialized jobs within eukaryotic cells.
- Mitochondria have an outer membrane and a folded inner membrane called cristae.
- Lysosomes contain enzymes that break down material for recycling.
- Ribosomes assemble proteins using information carried by messenger RNA.

Organelle: a specialized cell structure. Enzyme: a biological catalyst. ATP: a molecule used in cellular energy transfer.

Four features to show

Outer mitochondrial membrane; Inner membrane and cristae; Matrix; ATP production annotation.

Model idea

Make a paper mitochondrion on cardboard. Use a folded paper strip for the inner membrane. Add a fictional face separately from the biological labels.

Accuracy check

ATP is an energy-transfer molecule. Mitochondria transform energy rather than creating it.

Think about it: Why do folds matter in a mitochondrion?

Optional advanced extension: Explain how the electron transport chain and ATP synthase use the inner membrane.

Reading sources

OpenStax Biology 2e 4.3 Eukaryotic Cells
https://openstax.org/books/biology-2e/pages/4-3-eukaryotic-cells

OpenStax Biology 2e 4.4 The Endomembrane System and Proteins
https://openstax.org/books/biology-2e/pages/4-4-the-endomembrane-system-and-proteins

2 The Microbial Graveyard

What can colony appearance tell us about bacteria?

Biology background

- A colony is a visible population that develops from a cell or a small cluster of cells.
- Form describes the overall shape and margin describes the colony edge.
- Elevation describes the side profile. Pigmentation describes color.
- Most bacteria reproduce by binary fission after copying their DNA.

Colony: visible microbial growth. Morphology: form and appearance. Binary fission: division into two daughter cells.

Four features to show

Form such as circular; Margin such as smooth; Elevation such as raised; Pigmentation such as yellow.

Model idea

Place paper or clay colonies in a clean plastic container. Include a side-view drawing for elevation and a small binary-fission sequence beside the container.

Accuracy check

This is a craft simulation. Do not collect, grow, or open real environmental cultures.

Think about it: Can a scary-looking colony prove that a bacterium causes disease?

Optional advanced extension: Explain why one colony-forming unit does not always equal one original bacterial cell.

Reading sources

American Society for Microbiology Colony Morphology Protocol
https://asm.org/protocols/colony-morphology-protocol

OpenStax Microbiology 9.1 How Microbes Grow
https://openstax.org/books/microbiology/pages/9-1-how-microbes-grow

3 The Anatomy Crypt

How do heart structures work together to move blood?

Biology background

- The heart has two atria that receive blood and two ventricles that pump blood out.
- The right side sends blood toward the lungs. The left side sends blood toward the body.
- Valves help prevent backward flow when pressure changes.
- The septum separates the right and left sides of the heart.

Atrium: receiving chamber. Ventricle: pumping chamber. Septum: dividing wall. Valve: structure that limits backflow.

Four features to show

Right atrium; Right ventricle; Left atrium; Left ventricle.

Model idea

Make a four-chamber paper heart. Add flow arrows, simple valve flaps, and a septum. Label the four chambers and explain the extra features in your card.

Accuracy check

Right and left refer to the person's body. In a front view, anatomical right appears on the viewer's left. Red and blue are diagram conventions, not actual blood colors.

Think about it: Why does a heart model need arrows as well as chamber names?

Optional advanced extension: Compare the thickness of the left and right ventricular walls using their pumping jobs.

Reading sources

OpenStax Anatomy and Physiology 2e 19.1 Heart Anatomy
https://openstax.org/books/anatomy-and-physiology-2e/pages/19-1-heart-anatomy

4 The Mutation Station

How can a DNA change affect a protein or trait?

Biology background

- A mutation is a change in a DNA sequence.
- Substitutions replace bases. Insertions and deletions add or remove bases.
- A coding change can alter an amino acid, introduce a stop signal, or leave the amino acid unchanged.
- One HBB variant replaces glutamic acid with valine in beta-globin. Hemoglobin S can form fibers under low-oxygen conditions, distorting red cells.

Codon: three RNA bases read during translation. Variant: a DNA sequence difference. Protein: an amino-acid chain with biological functions.

Four features to show

Original DNA sequence; Changed DNA sequence; Protein consequence; Cell or trait consequence.

Model idea

Make a before-and-after sequence strip and a chain model. Connect the DNA change to the protein and cell effect. You may use the documented HBB example or a clearly marked hypothetical example.

Accuracy check

Do not imply that one variant always causes the same disease severity or that mutations are always harmful.

Think about it: Does every mutation change an amino acid?

Optional advanced extension: Use a codon chart to verify a specific DNA-to-RNA-to-amino-acid change and identify the strand shown.

Reading sources

OpenStax Biology 2e 14.6 DNA Repair
https://openstax.org/books/biology-2e/pages/14-6-dna-repair

MedlinePlus Genetics HBB Gene
https://medlineplus.gov/genetics/gene/hbb/

5 The Diseased Tissue Gallery

How can changes in cells disrupt a tissue?

Biology background

- Tissues contain organized cells that work together.
- Normal cells respond to signals that regulate division and survival.
- Cancer cells can escape some controls on division or death.
- Malignant tumors can invade nearby tissues. Some cancers spread to distant sites.

Tissue: cells working together. Tumor: abnormal mass of tissue. Malignant: cancerous and capable of invasion. Metastasis: spread to distant sites.

Four features to show

Normal organized cell layer; Controlled division annotation; Abnormal crowded growth; Invasion into adjacent tissue.

Model idea

Use paper circles or clay to make side-by-side tissue models. Keep scale and viewpoint similar. Show a boundary and label where the cancer model crosses it.

Accuracy check

This model simplifies one solid-tumor example. Not all cancers form solid tumors, and a craft model cannot diagnose disease.

Think about it: Does every tumor invade nearby tissue?

Optional advanced extension: Connect one disrupted cell-cycle checkpoint or signaling pathway to abnormal growth.

Reading sources

National Cancer Institute What Is Cancer
https://www.cancer.gov/about-cancer/understanding/what-is-cancer

6 The Cell Death Cemetery

How do apoptosis and necrosis differ?

Biology background

- Apoptosis is a regulated process that removes cells, including unneeded or damaged cells.
- During typical apoptosis, a cell shrinks and breaks into membrane-enclosed fragments.
- Necrotic cell injury commonly involves swelling and loss of membrane integrity.
- Leaking cell contents can provoke inflammation, whereas prompt clearance of apoptotic fragments usually limits it.

Apoptosis: regulated cell dismantling. Necrosis: cell or tissue death with destructive changes. Inflammation: a tissue response to injury.

Four features to show

Apoptotic cell shrinkage; Membrane-enclosed fragments; Necrotic cell swelling; Rupture and leaking contents.

Model idea

Make two short sequences of paper cells on a cemetery base. Use arrows to show the changes. Keep ghost decorations separate from cell labels.

Accuracy check

This is a basic contrast. Some necrotic cell-death pathways are regulated, so avoid claiming all necrosis is unregulated.

Think about it: Why can membrane rupture affect neighboring tissue?

Optional advanced extension: Explain how caspases help execute apoptosis and why avoiding apoptosis can benefit a cancer cell.

Reading sources

OpenStax Anatomy and Physiology 2e 4.6 Tissue Injury and Aging
https://openstax.org/books/anatomy-and-physiology-2e/pages/4-6-tissue-injury-and-aging

Alberts and colleagues Molecular Biology of the Cell Programmed Cell Death
https://www.ncbi.nlm.nih.gov/books/NBK26873/

7 The Carnivorous Greenhouse

Why do some photosynthetic plants capture prey?

Biology background

- Photosynthesis uses light energy to build carbohydrates from carbon dioxide and water.
- Carnivorous plants still photosynthesize.
- Prey supplies mineral nutrients, including nitrogen, that may be scarce in their habitats.
- Modified leaves can trap prey using mechanisms such as pitchers, sticky surfaces, or snap traps.

Adaptation: an inherited feature shaped by evolution. Photosynthesis: light-driven sugar production. Mineral nutrient: an inorganic element needed for growth.

Four features to show

Photosynthetic leaf surface; Prey trap; Digestive region; Nutrient uptake annotation.

Model idea

Build a paper pitcher plant with a smooth inner surface and a digestive region near the bottom. Add a photosynthesis annotation and explain two trap-related adaptations.

Accuracy check

A plant does not develop a new trap because it decides it needs one. Label imaginary teeth or movement as fictional.

Think about it: Why does capturing insects not replace photosynthesis?

Optional advanced extension: Discuss the costs of constructing traps and why carnivory can be advantageous in nutrient-poor habitats.

Reading sources

OpenStax Biology 2e 31.3 Nutritional Adaptations of Plants
https://openstax.org/books/biology-2e/pages/31-3-nutritional-adaptations-of-plants

OpenStax Biology 2e 8.1 Overview of Photosynthesis
https://openstax.org/books/biology-2e/pages/8-1-overview-of-photosynthesis

8 The Biological Ooze Collection

How do materials outside cells support living systems?

Biology background

- Mucus is a hydrated material containing mucin proteins with attached sugars. It helps protect and lubricate surfaces.
- Biofilms contain microorganisms associated with a surface and an extracellular matrix.
- Biofilm matrix can help cells remain attached and alter their local environment.
- Animal extracellular matrix includes molecules such as collagen and proteoglycans that support tissue organization and cell interactions.

Extracellular: outside cells. Mucin: a major mucus-forming glycoprotein. Matrix: a surrounding network of material.

Four features to show

Cells that produce or occupy the material; Structural molecules; Water or hydrated space; Function such as support or attachment.

Model idea

Choose ONE material. Use yarn for matrix fibers, paper cells, and a clear sealed plastic container. Colorless tissue paper can represent water without making real slime.

Accuracy check

A container of decorative slime alone does not demonstrate biology. Explain what each material represents. No bodily fluids or live cultures.

Think about it: Are mucus, biofilm, and animal extracellular matrix the same thing?

Optional advanced extension: Relate matrix composition to diffusion, mechanical support, or cell signaling in your chosen example.

Reading sources

OpenStax Biology 2e 4.6 Connections between Cells and Cellular Activities
https://openstax.org/books/biology-2e/pages/4-6-connections-between-cells-and-cellular-activities

OpenStax Microbiology 9.1 How Microbes Grow
https://openstax.org/books/microbiology/pages/9-1-how-microbes-grow

Mucus Current Biology Primer
https://pmc.ncbi.nlm.nih.gov/articles/PMC8759706/

9 Nature’s Monsters

How does an unusual adaptation help a real organism survive or reproduce?

Biology background

- Cymothoa exigua, the tongue-replacing isopod, is a crustacean that parasitizes fish.
- Young isopods enter a fish through its gills. A female attaches to the tongue with her legs.
- Feeding damages the tongue, which withers. The attached isopod can occupy its place and serve as a replacement.
- This is parasitism: the isopod benefits while the fish is harmed. A living host provides a place for the parasite to feed and reproduce.

Adaptation: an inherited feature shaped by evolution. Host: an organism used by a parasite. Parasite: an organism that benefits at a host’s expense.

Four features to show

Fish host and mouth; Attached isopod; Attachment legs; Feeding site and effect on host.

Model idea

Make a paper fish with a hinged mouth and a clay or paper isopod inside. Use arrows to connect attachment and feeding to the effect on the fish. Add four explained labels.

Other real monsters to investigate

Deep-sea anglerfish: a female’s bacteria-lit lure attracts prey. Parasitoid wasp: larvae develop on or in a host insect and eventually kill it. Choose one organism; research four facts and adapt the labels to its biology.

Accuracy check

“Monster” is a theme, not a scientific group. These organisms are not evil. Do not imply that all parasites replace tongues or that organisms choose to evolve traits. Mark invented behavior as fiction.

Think about it: Why is this relationship parasitism rather than mutualism?

Optional advanced extension: Explain a benefit and a cost of the adaptation, or compare parasitism with predation and parasitoid development.

Reading sources

University of Texas Marine Science Institute Tongue Snatcher
https://utmsi.utexas.edu/science-and-the-sea/radio-program/tongue-snatcher/

Woods Hole Oceanographic Institution Creature feature Anglerfish
https://www.whoi.edu/ocean-learning-hub/ocean-facts/anglerfish/

University of California IPM Parasites of Insect Pests
https://ipm.ucanr.edu/home-and-landscape/parasites-of-insect-pests/