# Biology Benchmark Goals
# Arkansas Department of Education

**These benchmarks were developed by a team of master biology teachers, May 2002**

- Nature of Science and Introduction
- Biology Goals (Inquiry and Content)
- Origin of Scientific Terms

The following is an outline for a high school biology course based on the Arkansas Science Framework. It is important that students understand the nature of science and scientific inquiry. These should be incorporated into most lessons. It is expected that students will be tested on the nature of science, inquiry, and the content concepts.

## The Nature of Science

**Science is a way of looking at the universe and asking questions. These questions are limited to matter and energy, which are governed by natural laws and can be measured with the instruments of science.**

**Practitioners of scientific inquiry base their conclusions upon supported evidence. Historically, three general principles have emerged that guide scientific inquiry:**

1) **Science can only study natural events and use natural explanations to explain natural phenomena.**
2) **Science attempts to develop conceptual schemes that are potentially capable of giving rise to theories that can be tested.**
3) **Science deals in probabilities, not in absolutes.**

**In the biological sciences four themes are investigated:**

1) **The physical and chemical foundations at the cellular level.**
2) **The unity (genetics) and diversity (evolution) of life.**
3) **Organismal biology (classification, form and function).**
4) **Ecological and behavioral relationships.**

These themes are expressed as the six goals of this document with elaborations under each goal to emphasize important points.

Correlation to the 9-12 Life Science of the Arkansas Frameworks numbers and shown beside each numbered goal objective in parentheses. For example:

| **Framework #** | **Outline #** |
|---|---|
| 2.3 | (2.01) Investigate the molecular basis of heredity/DNA (replication, protein synthesis) |

# Inquiry

**Introduction: The learner will demonstrate an understanding of life science as a process of inquiry.**

**(Framework # 1.1, 1.2, 1.5, 1.7, 1.9, 1.6, 1.10)**

**Investigate the 4 content goals while incorporating:**

1. Historical and cultural aspects
2. Standard safety procedures
3. Laboratory experiences
4. Scientific method

**Scientific Method Involves (order may vary):**

- Identify the problem
- Gather background information through a search of the literature
- Formulate a testable hypothesis based on supportive research
- Identify and select experimental variables (dependent and independent variables) and controlled conditions
- Collect materials and design an experimental procedure to test the hypothesis (repeat for validity)
- Make observations and collect data in a usable efficient format (tables, graphs, maps, cross sections)
- Identify possible sources of error (incorrect measurements, faulty equipment and human error)
- Draw a conclusion based on quantitative and qualitative data that accepts or rejects the hypothesis
- Communicate and defend your results (oral and written)

- Use technology, concept mapping, flow diagrams, sketches, and mathematical formulas to improve investigations and communication
- Formulate and revise scientific investigations using logic and evidence
- Analyze scientific explanations and models
- Note the differences between observations, hypotheses, theories, and laws.
- Describe the nature of science
- Identify questions that science can and cannot answer
- Stimulate students to identify questions and concepts that guide scientific investigations
- Design and conduct concise scientific investigations both independently and collaboratively

# Content

**(These concepts should be covered; however, the order is left to the school district.)**

| | |
|---|---|
| **Goal 1:** | **The learner will demonstrate an understanding of the physical, chemical, and cellular basis of life.** |
| **Framework#** | **Goal #** |
| 2.1, 2.2 | (1.01) Evaluate chemical and biochemical processes and regulatory mechanisms of cells to form conclusions as they relate to:<br>• Homeostasis<br>• Enzymes, proteins, carbohydrates, lipids, nucleic acids |
| 2.2 | (1.02) Describe the structure and function of cell organelles |
| 2.17 | (1.03) Compare and contrast the structure and function of prokaryotic and eukaryotic cells |
| 2.2 | (1.04) Differentiate cell membrane transport processes<br>• Diffusion<br>• Osmosis<br>• Active Transport<br>• Passive Transport |
| 2.2 | (1.05) Compare and contrast the processes of bioenergetics<br>• Anaerobic Respiration<br>• Aerobic Respiration<br>• Photosynthesis |
| 2.2 | (1.06) Describe and label the stages of the cell cycle |
| 2.2, 2.3 | (1.07) Describe and label the stages of meiosis |

| | |
|---|---|
| **Goal 2:** | **The learner will demonstrate an understanding of the continuity of life and changes in organisms over time.** |
| **Framework#** | **Goal #** |
| 2.3 | (2.01) Investigate the molecular basis of heredity/DNA (replication, protein synthesis) |
| 2.3 | (2.02) Use Mendel's Laws to interpret patterns of inheritance. |
| 2.3 | (2.03) Recognize application of DNA technology:<br>● Forensics<br>● Medicine (health and disease)<br>● Agriculture |
| 2.4, 2.7 | (2.04) Examine the development of the theory of biological evolution<br>• Origin of Life<br>• Geologic time, fossil records, and dating techniques<br>• Natural Selection, speciation, and adaptive radiation<br>• Patterns of Change (mimicry, camouflage)<br>• Variations<br>• Mutation/Adaptation<br>• Changes in population |

**Goal 4:** **The learner will demonstrate an understanding of organismal biology.**

| Framework# | Goal # |
|---|---|
| 2.9 | (3.01) Relate the variety of living organisms to their evolutionary relationships (Cladistics, Systemic Phylogeny) |
| 2.9 | (3.02) Classify organisms according to currently accepted systems |
| 2.14, 2.15 | (3.03) Determine form and function of organisms<br>• Organ systems of animals (including levels of organization: cells, tissues, organs, organ systems, and homeostasis)<br>• Functional systems of plants (transport, reproduction, regulation) |
| 2.3, 2.6 | (3.04) Compare and contrast the processes of reproduction, growth, development, and regulation in major phyla of organisms |
| 2.16, 2.17 | (3.05) Describe the structure of viruses and bacteria and explain their biological relationships with organisms (beneficial and pathogenic) |

**Goal 4:** **The learner will demonstrate an understanding of ecological and behavioral relationships among organisms.**

| Framework# | Goal # |
|---|---|
| 2.10 | (4.01) Identify the interrelationships among organisms, populations, community, ecosystems, and biomes |
| 2.12 | (4.02) Analyze the flow of energy through various cycles: nitrogen, carbon, water, and oxygen |
| 2.13 | (4.03) Investigate and explain the interactions in an ecosystem: food chains, webs, and pyramids |
| 2.18 | (4.04) Evaluate and explain the behavioral interactions resulting from the combination of heredity, evolution, and environment |

## Applications

**Goal 5:** **The learner will demonstrate an understanding of the connections and applications in biology.**

| Framework# | Goal # |
|---|---|
| 3.1 | (5.01) Describe the roles of biology in everyday life |
| 3.1 | (5.02) Describe various life science careers and the training needed for the selected career |
| 3.2 | (5.03) Evaluate long-range plans for resource use<br>• Environmental Concerns<br>• Economic Concerns<br>• Health Concerns<br>• Recycling |
| 3.3 | (5.04) Identify environmental problems and propose possible solutions<br>• Human Population Growth<br>• Acid Precipitation<br>• Global Changes in Climate<br>• Ozone Depletion<br>• UV Radiation |

| | |
|---|---|
| 3.4, 3.5 | (5.05) Use mathematics, science equipment, and technology as tools to communicate and solve problems |
| 3.6, 3.7 | (5.06) Describe the connections between pure and applied science as they relate to everyday life |
| 3.3 | (5.07) Identify the role that evolution plays in antibiotics and pesticide resistance, genetic engineering, genetic counseling, bioethics, and outcomes from the human genome project |

# Origins of Scientific Terms

Listed below is a collection of Latin and Greek root words that will be commonly used within a biology course as new terms are used. Also provided are correlated meanings and examples. These are not all the terms or concepts found in a first year biology course.

| Root | Meaning | Example |
|---|---|---|
| ad | next to | adhesion |
| aeros | air | aerobic |
| an | without | anaerobic |
| ana | away | anaphase |
| andro | male | androgen |
| anthos | flower | Anthozoa |
| anti | against | antibiotic |
| aqua | water | aquatic |
| archae | ancient | Archaebacteria |
| arthron | jointed | arthropod |
| artios | even | artiodactyl |
| askos | bag | ascus |
| aster | star | Asteroidea |
| autos | self | autoimmune |
| bi | two | bipedal |
| bios | life | biome |
| carn | flesh | carnivore |
| ceph | head | cephalopod |
| chloros | pale green | chlorophyll |
| chroma | colored | chromosome |
| cide | kill | insecticide |
| circa | about | circadian |
| con | together | convergent |
| cyte | cell | phagocyte |
| de | remove | decompose |
| dendron | tree | dendrite |
| dens | tooth | dental |
| derma | skin | epidermis |
| di | two | disaccharide |
| dia | apart | diastolic |
| dormire | sleep | dormancy |
| echinos | spine | Echidna |
| eco | house | ecosystem |
| ella | small | organelle |
| endo | within | endosperm |
| epi | upon | epidermis |
| eu | true | eukaryote |
| exo | outside | exoskeleton |
| ferre | carry | Porifera |
| gastro | stomach | gastrodermis |
| genesis | origin | biogenesis |

| | | |
|---|---|---|
| genos | make | genome |
| gons | reproductive | gonad |
| gravis | heavy | gravitropism |
| gymnos | naked | gymnosperm |
| gyne | female | gynecology |
| halo | salt | halophile |
| haplo | single | haploid |
| hemi | half | hemisphere |
| hemo | blood | hemophilia |
| herba | plant | herbivore |
| heteros | mixed | heterotrophic |
| homeo | same | homeostasis |
| homo | human | homologous |
| homos | alike | homozygous |
| hydro | water | hydrolysis |
| inter | between | internode |
| intra | within | intracellular |
| isos | equal | isomer |
| -itis | inflammation | gastritis |
| jugare | join | conjugate |
| karyon | seed | prokaryote |
| keras | horn | keratin |
| kokkus | berry-shape | streptococcus |
| leukos | white | leukocyte |
| logy | study | biology |
| lympha | water | lymphocyte |
| lysis | loosen | photolysis |
| makros | large | macromolecule |
| megas | large | megaspore |
| mesos | middle | mesophyll |
| meta | after | metamorphosis |
| micro | small | microscope |
| monos | single | monocotyledon |
| morphe | form | morphology |
| nemo | thread | nematocyst |
| neuro | nerve | neuron |
| nodus | knot | internode |
| nomia | law | taxonomy |
| oligos | few | Oligochaeta |
| omnis | all | omnivore |
| ornis | bird | ornithology |
| osteon | bone | osteoarthritis |
| ovum | egg | oviduct |
| paleo | ancient | paleontology |
| para | beside | parasite |
| pathos | disease | pathology |
| pedis | foot | pseudopodia |
| per | through | permeable |
| peri | around | pericardium |

| | | |
|---|---|---|
| phago | eat | phagocytosis |
| photos | light | phototropism |
| phulon | related | phylogeny |
| phyllon | leaf | cholorphyll |
| phyton | plant | epiphyte |
| pilus | hair | pili |
| pinna | feather | pinnate |
| plasma | mold | plasmolysis |
| pod | foot | Arthropoda |
| polys | many | polymer |
| post | after | posterior |
| pro | before | prokaryote |
| protos | first | protocells |
| pseudes | false | pseudopod |
| re | again | reproduce |
| rhiza | root | mycorrhiza |
| scop | look | microscope |
| soma | body | chromosome |
| sperma | seed | gymnosperm |
| stasis | staying | homeostasis |
| stoma | mouth | stomata |
| syn | together | photosynthesis |
| telos | end | telophase |
| terra | Earth | terrestrial |
| therme | heat | thermocline |
| thulakos | pouch | thylakoid |
| trans | across | transpiration |
| trich | hair | trichome |
| trope | turn | gravitropism |
| throphe | nourish | heterotrophic |
| uni | one | unicellular |
| vacca | cow | vaccine |
| vorare | to devour | carnivore |
| xeros | dry | xerophyte |
| zoa | animal | protozoa |
| zoon | animal | zoology |
| zygous | joined | zygote |