

Washington West Supervisory Union

# Science Curriculum

## Pre K - 12

April 10, 2001

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## WWSU Science Curriculum Pre K - 12

### Preface

The standards addressed here are from the *National Science Education Standards* and the *Vermont Framework of Standards and Learning Opportunities*. We also looked at many curricula available to us from throughout the state. We give special credit and thanks to the Franklin Northwest Supervisory Union and to South Burlington for their documents which helped us greatly in planning and forming our own. Thanks also to Frank Watson of VISMT and Karin Hess formerly of Thatcher Brook for reviewing our document and for helpful input along the way. We have given consideration to a variety of units of study along with comments from teachers, administrators, and community members, which we received continuously throughout the process of putting this document together.

It is expected that students will maintain science portfolios, which will include one assessment piece for each standard taught. Assessment pieces may include (but are not limited to) teacher observation notes, journal entries, photographs, audio tapes, research reports, video tapes, 3-D projects, paper pencil activities, charts, graphs, diagrams, drawings, process skills checklist, written lab reports, self assessment, etc. Currently the State of Vermont assesses student knowledge of science at grades 5, 9, and 11.

This curriculum is organized by grade levels. Each section represents the science knowledge that a student should have at that particular grade level: Space, Time and Matter; the Living World; the Human Body; and the Universe and the Environment. The *Evidence of Learning* sections represent the knowledge, which all students should have for each particular standard. The *focusing questions* are suggestions to lead the teacher through those principles, which are fundamental to the understanding of specific science concepts. *Multi age* classrooms are encouraged to schedule the topics so that all the material for those grade levels will be covered by the time the students leave the classroom.

Science *Process Skills* are included in the study of science and are associated with the process of inquiry. They appear below as a simple list, **but they are embedded throughout the entire curriculum.**

#### Science Process Skills

Observing  
Identifying and Controlling Variables  
Classifying  
Gathering, Organizing and Processing Data  
Communicating  
Measuring  
Analyzing  
Predicting  
Formulating Hypotheses  
Inferring  
Designing Investigations and Experiments

*Inquiry Science* “involves asking a simple question, completing an investigation, answering the question and presenting the result to others.” (National Science Education Standards) We have included topics that give students increased understanding of the objects and materials they encounter daily. The classroom is a limited environment. Science should extend to the outside world taking advantage of whatever resources are available. The VT Standards 7.1, 7.2, 7.3, and 7.4 addressing Inquiry Science are embedded throughout this curriculum and are not necessarily referenced on each page of this document.

The following is adapted from the Vermont Elementary Science Project:

When doing inquiry-based science:

Students view themselves as scientists in the process of learning. This is evident when they:

- Look forward to doing science
- Demonstrate a desire to do more
- Seek to collaborate and work cooperatively with peers
- Are confident in doing science; they demonstrate a willingness to modify ideas, take risks, and display healthy skepticism
- Respect individuals and differing points of view

Students accept an invitation to learn and readily pursue science exploration. This is evident when they:

- Exhibit curiosity and ponder questions
- Take the opportunity to test their own ideas

Students plan and carry out an investigation. This is evident when they:

- Design a fair test to try out an idea without being told how to proceed
- Plan ways to verify, extend, or discard ideas
- Carry out investigations while safely handling materials, observing, measuring, and recording data

Students communicate using a variety of methods. This is evident when they:

- Express ideas in a variety of ways – journals, reporting out, drawing, graphing, charting, etc.
- Listen, speak, and write about science with parents, teachers, and peers
- Use the language of process science
- Communicate their understanding of concepts being worked on

Students offer explanations and solutions while building science concepts. This is evident when they:

- Offer explanations based on previous experience and knowledge resulting from current investigations
- Use investigations to satisfy their own questions
- Sort information and make judgments as to what is important
- Are willing to revise explanations and consider new ideas as they build understanding

Students ask questions about the world around them. This is evident when they:

- Question verbally as well as through actions
- Ask questions that lead to investigations leading to further questions
- Value and enjoy asking questions as an important part of science

Students use observations. This is evident when they:

- Observe carefully rather than just look
- See details; seek patterns; detect sequences and events; notice changes, similarities, and differences
- Make connections to previously held ideas

Students critique their own science practices. This is evident when they:

- Create and use quality indicators to assess their own work
- Report and recognize their strengths and identify what they would like to improve on
- Reflect upon their learning with adults and peers

Each elementary and middle school has a resource reference book to aid in the implementation of this curriculum. Some of the books available are: Resources for Teaching Elementary School Science, National Science Resource Center; Project 2061: Benchmarks for Science Literacy; National Science Education Standards by the National Research Council; and NSTA Pathways through the Science Standards - elementary, middle, and high school editions: Guidelines for Moving the Vision into Practice.

## Science Curriculum Overview

Science Standards 7.1 through 7.4 which address the Scientific Method – Investigation, Theory, and History as well as 7.11 Systems are embedded throughout each specific topic in this curriculum. While these standards are not listed in this overview, it is the expectation that they will be included in every unit of study.

Standards 7.17 Design Technology – Systems and 7.19 Design Technology – Solutions are addressed in other WWSU curriculum documents.

**Please note this list is meant as a very brief overview and one must refer to the corresponding section of this document for the complete topic and information.**

	7.12	7.13	7.14	7.15	7.16	7.18
<b>P &amp; K</b>	properties, alike & differences	living & nonliving	human similarities and differences	earth / rocks	extracting natural resources	tool safety
<b>1</b>	electricity & magnetism	animals	senses		reuse & recycle	simple machines
<b>2</b>	states of matter	plants	body parts, digestion, skeleton, circulation	weather, water cycle		
<b>3</b>	forces / motion, solids, liquids, and gases	populations, food web	personal health, human development	pond life		
<b>4</b>	heat, light, & sound	evolution & extinction		sun & sky	natural resources	
<b>5</b>	electricity & magnetism	ecosystems, photosynthesis, classification		forces of nature & change over time		tools & machines
<b>6</b>	chemistry, energy, force		cell classification, human body systems	solar system, universe	renewable & nonrenewable resources	
<b>7</b>	chemistry of life	ecosystems, classification, characteristics of life, microbiology, evolution	endocrine & immune systems Genetics	Ecology and natural resource management	uses of technology	
<b>8</b>	magnetism, matter, atoms, forces & motion, energy, electricity					

	7.12	7.13	7.14	7.15	7.16	7.18
9		the living condition		astronomy, oceanography, meteorology, geology		
10	<b>Biochemistry</b>	ecology, cell biology, living organisms, microbiology	genetics, human body			
11/12	<b>Chemistry</b> sci. of chem., matter & energy, atomic structure, electronic configuration, periodic table, ionic compounds, covalent bonds, molecular forces, electrochemistry, carbon / organic compounds, Mole chemical equations, stoichiometry, change, gases & liquids, solutions, acids & bases, reaction rates, electrochemistry	<b>Human Physiology</b> cells, tissue	<b>Human Physiology</b> human physiology, musc./skel., nervous, digestion, respiration, circulation, excretory, endocrine, immune, & reproduction systems			
12	<b>Physics</b> physics, waves, sound & light, electricity, magnetism, & E-M radiation, chem. of life	<b>Biology II</b> structure & function of of cells, independent research, cellular respiration & gene expression, evolution, structure & function in organisms	<b>Biology II</b> reproduction of cells, molecular basis of inheritance, genetics		<b>Physics/ Biology II</b> physics, chemistry of life	

**Performance Criteria - Pre-K through 12**  
**Scientific Method**

SCIENTIFIC METHOD

This profile is a teaching tool that represents a continuum of skill levels for using the Scientific Method.

	Pre-K to 4	Grades 5 - 8	Grades 9 - 12
a. Questions	Ask questions about objects, organisms & events in the world around them.	Frame question in a way that distinguishes causes & effects.	Frame questions in a way that distinguishes causes & effects.
c. Hypothesis	Make a prediction directly related to a question.	Write a prediction directly related to the question & showing cause & effect.	Write a prediction directly related to the question & showing cause & effect.
c. Experimental Design	Relate plan directly to hypothesis, identify variable(s), select appropriate sample size, use appropriate measurement.	Relate plan directly to hypothesis, identify variable(s), select appropriate measurement independently and correctly.	Relate plan directly to hypothesis, identify variable(s), select appropriate measurement independently and correctly.
c. Data Collection	Collect and record data in an organized way. Record important observations.	Independently choose method for collecting & recording data. Record in writing accurate observation .	Independently choose methods for collecting & recording data. Record in writing accurate observation .
c,d. Data Analysis Conclusions	Draw conclusions that accurately reflect the hypothesis. Express conclusion that addresses the hypothesis & accurately reflects data & observations, e.g. orally or use manipulatives, tally, pictures, written graphs, tables, model, chart, diagrams, videos.	Express written conclusions that address the hypothesis & accurately reflect data and observations. Support written findings, e.g. graphs, charts, diagrams, models, tables, videos.	Express written conclusions that address the hypothesis & accurately reflect data and observations. Support written findings, e.g. graphs, charts, diagrams, models, tables, videos.
b,d,e. Applications and Extensions	Brainstorm questions & connections or graph data or design alternative presentation of data. Formulate & record further questions.	Brainstorm questions & connections or graph data or design alternate presentation of data. Formulate & write further questions or connect learning to new situations.	Brainstorm questions & connections or graph data or design alternate presentation of data. Formulate & write further questions or connect learning to new situations.

## **Science Curriculum - Grades PreK-4**

The science program in the elementary schools of the Washington West Supervisory Union provides young students with experiences in all aspects of the Vermont Framework of Standards and Learning Opportunities. At this level of learning, mathematics and language standards are closely intermingled with those of science. The standards shown below are embedded throughout the science curriculum. For that reason, they are not listed as separate sections in each of the topics on the following pages.

### **Inquiry, Experimentation, and Theory Scientific Method**

#### **7.1 Students use scientific methods to describe, investigate, explain phenomena, and raise questions.**

This is evident when students:

- a. Ask questions about objects, organisms, and events in the world around them;
- b. Use reliable information obtained from scientific knowledge, observation, and exploration;
- c. Create hypotheses for problems, design a fair test of their hypothesis, collect data through observation and instrumentation, and analyze data to draw conclusions; use conclusions to clarify understanding and generate new questions to be explored;
- d. Use evidence to construct an explanation, including scientific principles they already know and observations they make;
- e. Explain a variety of observations and phenomena using concepts that have been learned;
- f. Use either deductive or inductive reasoning to explain observations and phenomena, or to predict answers to questions;
- g. Recognize other points of view, and check their own and others' explanations against experiences, observations, and knowledge;
- h. Identify problems, propose and implement solutions, and evaluate products and designs; and
- i. Work individually and in teams to collect and share information and ideas.

### **Investigation**

#### **7.2 Students design and conduct a variety of their own investigations and projects. This is evident when students:**

- a. Design and conduct an experiment;
- b. Design and conduct a systematic observation;
- c. Complete a design of a physical structure or technological system;
- d. Complete a data study;
- e. Plan and manage a schedule;
- f. Complete and pure mathematics investigation; or
- g. Complete research.

### **Theory**

#### **7.3 Students understand the nature of mathematical, scientific, and technological theory. This is evident when students:**

- a. Show understanding that concepts form the foundation for theories;
- b. Look for evidence that explains why things happen;
- c. Modify knowledge when new observations are made or new knowledge is gained.

## **History of Science, Mathematics, and Technology**

- 7.4 Students understand the history of science, mathematics, and technology. This is evident when students:
- a. Investigate contributions made to science, mathematics, and technology by many different kinds of people and explain their importance.

## **Roles and Responsibilities**

- 7.5 Students analyze the roles and responsibilities of scientists, mathematicians, and technologists in social, economic, cultural, and political systems. This is evident when students:
- a. Explain how discoveries or inventions can help or hurt people.

# **Space, Time and Matter**

## **Matter, Motion, Forces, and Energy**

### **Pre K & K**

#### **VT Standard 7.12**

Students understand forces and motion, the properties and composition of matter, and energy sources and transformations. This is evident when students:

- a. Sort objects and materials according to observations of similarities and differences of properties.

#### **Focusing Questions**

How are objects the same?

How are they different?

How can we measure the differences?

#### **Evidence of Learning**

The student will:

- Sort objects according to observable properties (size, shape, weight, color, smell, sound or texture) using the senses.
- Identify and sort solid objects according to the material they are made from (wood, plastic, metal, fabric).
- Describe objects by characteristics rather than name.

#### **Vital Results**

1.17 a, c, 2.1

# **The Living World**

## **Organisms, Evolution & Interdependence**

### **Living & Non-living**

### **Pre K & K**

#### **VT Standard 7.13**

Students understand the characteristics of organisms, see patterns of similarity and differences among living organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:

- a. Identify characteristics of organisms;
- b. Categorize living organisms.

#### **Focusing Questions**

How can we tell living things from non-living things?  
How can we tell insects are living things?  
What are the stages of insect development?

#### **Evidence of Learning**

The student will:

- Classify or group living and non-living things into categories.
- Describe simply how living things use food and energy, and produce waste.
- Give examples of living things that reproduce.
- Relate an example of something that was born and died.
- Draw a picture showing how insects interact with surroundings.
- Draw or tell how animals use senses to help them survive.

#### **Vital Results**

1.17a, 2.1c, 7.5a, 7.11a,b

# **The Living World**

## **Human Body**

### **Human Similarities and Differences – Health and Safety**

#### **Pre K & K**

#### **VT Standard 7.14**

Students demonstrate understanding of the human body - heredity, body systems, and individual development - and understand the impact of the environment on the human body. This is evident when students:

- a. Recognize that there are many similarities between parents and their children, some inherited and some learned;
- b. Identify and describe environmental factors that can influence human health.

#### **Focusing Questions**

How can we keep our bodies safe and healthy?

How are humans alike and different?

#### **Evidence of Learning**

The student will:

- Explain basic hygiene habits needed to maintain health.
- Draw pictures identifying common health problems.
- Identify orally or by drawing safe and unsafe behaviors to self and others.
- Identify orally or by drawing community members/agencies that provide health care.
- Describe different external features of people.
- Describe ways that humans are more alike than different.
- Identify external parts of the human body, their function and care.

#### **Vital Results**

1.17 c, 2.1, 3.4, 3.5 a, b, c, f

# **The Universe, Earth and the Environment**

## **Theories, Systems, and Forces**

### **The Earth - Rocks**

#### **Pre K & K**

#### **VT Standard 7.15**

Students demonstrate understanding of the earth and its environment, the solar system, and the universe in terms of the systems that characterize them, the forces that affect and shape them over time, and the theories that currently explain their evolution. This is evident when students:

- a. Identify and record patterns and forces that shape the earth.

#### **Focusing Questions**

What is the Earth made of?  
How are rocks alike and different?  
How is the land different from place to place?  
How are rocks moved from place to place?  
What forces cause rocks to get smaller?

#### **Evidence of Learning**

The student will:

- Describe soil as being made up of different materials of different sizes.
- After observation, sort rocks to indicate different materials with specific properties.
- After observation of fossils, offer an explanation of how they might have been formed.
- Categorize rocks by color, shape or texture.
- Describe how wind, water, and ice can move rocks and soil from place to place.

#### **Vital Results**

1.17 a, c, 2.1

# **Design and Technology**

## **Natural Resources**

### **Extraction of Natural Resources**

#### **Pre K & K**

#### **VT Standard 7.16**

Students understand how natural resources are extracted, distributed, processed and disposed of. This is evident when students:

- a. Recognize that steps need to be followed in extracting natural resources;
- b. Show that some materials can be reused and recycled while others will be disposed of in landfills.

#### **Focusing Questions**

What are Vermont natural resources?

What are the steps involved in extracting natural resources?

#### **Evidence of Learning**

The student will:

- Name one or two Vermont natural resources.
- Describe by drawing the steps involved in extracting a natural resource.

#### **Vital Results**

1.13a, 1.20

# **Design and Technology**

## **Outputs and Impacts**

### **Tools**

#### **Pre K & K**

#### **VT Standard 7.18**

Students understand that people control the outputs and impacts of our expanding technology in communication, construction, manufacturing, power and transportation, energy sources, health technology, and biotechnology. This is evident when students:

- a. Use tools to extend their capabilities;
- b. Use tools and machines in a safe manner.

#### **Focusing Questions**

What are tools?

What are safe ways to use tools?

#### **Evidence of Learning**

The student will:

- Sort pictures of tools (or real tools) as used by children and/or adults.
- Describe or demonstrate safe ways to use age appropriate tools.

#### **Vital Results**

2.1a, 1.13a

# **Space, Time, and Matter**

## **Matter, Motion, Forces, and Energy**

### **Magnetism and Electricity**

#### **Grade 1**

#### **VT Standard 7.12**

Students understand forces and motion, the properties and composition of matter, and energy sources and transformations. This is evident when students:

- a. Observe and record the effects of electric charge (e.g., charges repel, batteries); investigate magnetic and non-magnetic materials, and materials that are conductors and non-conductors of electricity.

#### **Focusing Questions**

- What are magnets?
- What things are attracted to a magnet?
- What things are repelled by magnets?
- What is electricity?
- What is an electrical circuit?
- What are conductors and non-conductors of electricity?

#### **Evidence of Learning**

The student will:

- Sort objects according to magnetic attraction.
- Describe objects attracted or repelled by a magnet.
- Draw an electric circuit.
- Sort objects according to their ability to conduct electricity.

#### **Vital Results**

1.17 a, c, 2.1

# **The Living World**

## **Organisms, Evolution, and Interdependence**

**Animals**  
**Grade 1**

### **VT Standard 7.13**

Students understand the characteristics of organisms, see patterns of similarity and differences among living organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:

- a. Identify characteristics of organisms;
- b. Categorize living organisms.

### **Focusing Questions**

What are animals?  
How can we tell animals are living things?  
Where do animals live?  
How long have animals lived on earth?  
What are the stages of development?

### **Evidence of Learning**

The student will:

- Sort, classify, categorize into groups of animals/non-animals and types of animals (birds, insects, fish, etc.).
- Compare and contrast animal environments by writing or drawing.
- List animal survival needs.
- Classify animals as carnivorous, herbivorous, or omnivorous.
- Write or tell ways animals use energy.
- On a map or globe give examples of animals around the world.

### **Vital Results**

1.17 a, 2.1 c, d

# **The Living World**

## **Human Body**

### **Senses**

### **Grade 1**

#### **VT Standard 7.14**

Students demonstrate understanding of the human body - heredity, body systems, and individual development - and understand the impact of the environment on the human body. This is evident when students:

- a. Identify the parts of the human body, and demonstrate understanding of how the parts work together to perform functions that satisfy common needs;
- b. Identify and describe environmental factors that can influence human health.

#### **Focusing Questions**

What are our five senses?

How do our senses help us to survive?

How does the environment affect our health?

#### **Evidence of Learning**

The student will:

- Name each of the five senses and its sense organ.
- Give an example of how each sense helps us to survive.
- Identify environmental factors that affect our health.

#### **Vital Results**

1.17c, 2.1, 3.4, 3.5a, b, c, f

# **Design and Technology**

## **Natural Resources**

### **Reuse and Recycle**

#### **Grade 1**

#### **VT Standard 7.16**

Students understand how natural resources are extracted, distributed, processed and disposed of. This is evident when students:

- a. Recognize that steps need to be followed in extracting natural resources;
- b. Show that some materials can be reused and recycled while others will be disposed of in landfills.

#### **Focusing Questions**

What materials must be disposed of in landfills?

What are natural resources?

What materials can be reused or recycled?

#### **Evidence of Learning**

The student will:

- Identify materials that must be disposed of in landfills.
- Identify materials that must not be disposed of in landfills (paint cans, tires, oil, etc.).
- Identify local natural resources (i.e. forests, streams, lakes).
- Describe how material objects can be repaired and reused.
- Identify ways to recycle materials at home and school.

#### **Vital Results**

3.7b

# **Design and Technology**

## **Outputs and Impacts**

### **Simple Machines**

#### **Grade 1**

#### **VT Standard 7.18**

Students understand that people control the outputs and impacts of our expanding technology in communication, construction, manufacturing, power and transportation, energy sources, health technology, and biotechnology. This is evident when students:

- a. Understand that technology is a human endeavor;
- b. Use tools to extend their capabilities;
- c. Use tools and machines in a safe manner.

#### **Focusing Questions**

What tools/machines do we use at home and school?  
Why were tools and machines invented?  
What are machines?  
Why do we need/use tools and machines?

#### **Evidence of Learning**

The student will:

- List age appropriate tools/technology to do work at home and school.
- Explain how and why tools and machines were invented and how they have been improved over time.
- Identify simple machines by labeling pictures (screw, lever and fulcrum, ramp, pulley, and wheel).
- Describe how simple machines work.
- Explain that tools and machines were invented by people to make certain jobs easier.

#### **Vital Results**

2.1, 2.10

# Space, Time, and Matter

## Matter, Motion, Forces, and Energy

### Properties and States of Matter

#### Grade 2

#### VT Standard 7.12

Students understand forces and motion, the properties and composition of matter, and energy sources and transformations. This is evident when students:

- a. Sort objects and materials according to observations of similarities and differences of properties;
- b. Observe and describe changes of states of matter;
- e. Identify and describe several common forms of energy (e.g., light, heat, sound) and provide examples of sources, as well as some characteristics of the transmission.

#### Focusing Questions

What are the three states of matter?  
What are their properties?  
What do all forms of matter have in common?  
How can matter change its state?  
Does the amount of matter change when its shape or size or state changes?  
What is light?  
What is sound?  
How do sound and light travel?

#### Evidence of Learning

The student will:

- Identify three states of matter.
- After investigation, record the properties of each form of matter (solids - compare color, shape, size, stackability; liquids - compare color, fluidity, viscosity; gases - compare odors).
- Describe what happens when liquids are poured into various size and shape containers.
- Demonstrate that the basic material and amount of an object stays the same even though its appearance may change (water/ice; cup of corn flakes whole/crushed).
- Describe the differences between how solids, liquids, and gases behave.
- Describe how sound travels.
- Describe how light travels.

#### Vital Results

1.17 b, d, 2.1

# **The Living World**

## **Organisms, Evolution, and Interdependence**

### **Plants**

### **Grade 2**

#### **VT Standard 7.13**

Students understand the characteristics of organisms, see patterns of similarity and differences among living organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:

- a. Identify characteristics of organisms;
- b. Categorize living organisms.

#### **Focusing Questions**

How can we tell plants are living things?  
Where do plants live?  
How long have plants been on earth?  
What are seeds?

#### **Evidence of Learning**

The student will:

- After investigating various types of seeds and their characteristics, record findings in a journal or portfolio.
- Describe orally or in writing how plants reproduce (seed, bulb, spore, cutting).
- After observation, record the life cycle of a plant.
- Draw or write a description of pollination.
- State that plants need air, light, water, and soil nutrients to survive.
- State that plant waste is oxygen.
- After investigation, record the similarities and differences between parent plant and offspring.
- Describe orally or in writing the co-dependence between plants and animals.

#### **Vital Results**

1.17 a, 2.1 c, d, e, 3.9 a, 2.13

# The Living World

## Human Body

### Body Parts and Skeletal, Digestive, and Circulatory Systems Grade 2

#### VT Standard 7.14

Students demonstrate understanding of the human body - heredity, body systems, and individual development - and understand the impact of the environment on the human body. This is evident when students:

- a. Recognize that there are many similarities between parents and their children, some inherited and some learned;
- b. Identify the parts of the human body, and demonstrate understanding of how the parts work together to perform functions that satisfy common needs;
- c. Identify and describe environmental factors that can influence human health.

#### Focusing Questions

What makes a healthy person?

How are we alike and unlike our parents?

How can we take care of our physical and emotional needs?

What do humans need to grow and develop?

What are the life processes of humans?

What are the skeletal, digestive, and circulatory systems?

#### Evidence of Learning

The student will:

- Understand how rest, germs, food choices, sleep and exercise affect the body.
- Recognize ways to maintain health and safety.
- Identify and classify food groups and model the food pyramid.
- Understand and identify individual inherited and learned characteristics and behaviors.
- List human needs for survival (air, water and food).
- Explain through writing or drawing the developmental stages of a human.
- Describe the human structures that serve different functions (walking, holding, talking, etc.).
- Describe how humans ingest, digest and assimilate food.
- Describe ways that humans react to their environment.
- Identify emotional and physical needs for growth and development (touch, love, caring, communication).
- Demonstrate through role-play refusal skills, which enhance healthy choices.

#### Vital Results

1.17c, 2.1, 3.4, 3.5e

# **The Universe, Earth, and the Environment**

## **Theories, Systems, and Forces**

### **Weather and Water Cycle**

#### **Grade 2**

#### **VT Standard 7.15**

Students demonstrate understanding of the earth and its environment, the solar system, and the universe in terms of the systems that characterize them, the forces that affect and shape them over time, and the theories that currently explain their evolution. This is evident when students:

c. Identify and record patterns and forces that shape the earth.

#### **Focusing Questions**

How does weather change?  
What makes weather change?  
How does the weather change from day to day?  
How does the weather change from season to season?  
How does weather affect our activities (homes, clothing)?  
What causes air pollution?  
How can you tell if air is dirty?  
What is the water cycle?  
How does the water cycle renew our water supply on Earth?  
Where do we find water?

#### **Evidence of Learning**

The student will:

- Describe how weather determines what the air is like outside at a particular time and place.
- Observe, collect, record and analyze weather changes over time.
- Describe and record temperature, wind, cloud types, and precipitation.
- Identify forms of precipitation.
- Use thermometers, rain gauges and barometers to collect data.
- Predict weather through observations and data collection.
- Describe ways that wind as moving air can be used as energy.
- Give examples of how weather determines our activities (inside/outside, clothing, shelter).
- Explain why dirty air is harmful.
- After observation, describe water as transparent, free flowing, foamy or clear.
- List some things that dissolve in water and others that do not.
- After observation of snow, ice and frost, state that they are forms of water.
- After investigating, describe how ice turns back to water when it is warmed.
- Describe how cooled water vapor turns back into liquid water.
- Record in journal to demonstrate that when water changes form the amount stays the same.
- Locate and describe places where water can be found in school, home and community.
- Explain why dirty water may look clean.
- Recognize that there is a limit to the earth's supply of water.
- Identify ways to conserve water at school, home, and in the community.

#### **Vital Results**

1.17 b, d, 2.1, 7.11 b, d

# Space, Time, and Matter

## Matter, Motion, Forces, and Energy

### Forces, Motion – Changing States of Matter, and Gases

#### Grade 3

#### VT Standard 7.12

Students understand forces and motion, the properties and composition of matter, and energy source and transformations. This is evident when students:

- Observe and describe changes of states of matter (e.g., water);
- Observe and describe the behavior of gases in containers (e.g., pumps, balloons).
- Apply forces to objects (e.g. inertia, gravity, friction, push and pull), and observe the objects in motion.

#### Focusing Questions

What is a force?  
How do forces affect motion?  
How are motion and energy related?  
What are a solid, a liquid and a gas?  
How does matter change properties?  
How do gases behave under pressure?

#### Evidence of Learning

The student will:

- Compare and contrast the difference between kinetic energy (because of motion) and potential energy (because of location).
- Explain how energy can be used to do work.
- Define work as moving an object to a new location, and recognize that machines can be made to do this.
- Define force as any push or pull on an object (e.g., inertia, gravity, friction, push and pull)
- Demonstrate when a force is applied to an object, the object either speeds up, slows down, or goes in a different direction.
- After observation, describe how the greater the force applied to an object, the greater the change in motion the object will have; the more massive the object is, the smaller the effect a given force will have, friction will oppose motion.
- Identify and describe the position of an object by locating it relative to another object or the background.
- Observe and describe changes in states of matter (water).

#### Related Science Concepts

Heating and cooling can cause changes in the properties of materials – when energy is added to or taken from matter some of the properties are changed, (freezing, melting, boiling, evaporation, condensation).

As time passes hot or cold objects change in temperature.

Some materials conduct heat much better than others. Poor conductors can reduce heat loss.

Most matter can be classified as solid, liquid or gas. These are called states of matter.

Work is moving an object to a new location.

There are six simple machines (inclined plane, wedge, lever, screw, wheel and axle, and pulley).

Forces are defined by inertia, gravity, friction, push and pull.

There is kinetic energy (moving because of motion) and potential energy (stored because of location).

#### Vital Results

2.1, 2.2 a, b, c, d, e

# **The Living World**

## **Organisms, Evolution, and Interdependence**

### **Populations – Food Web**

#### **Grade 3**

#### **VT Standard 7.13**

Students understand the characteristics of organisms, see patterns of similarity and differences among living organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:

- c. Describe and show examples of the interdependence of all systems that support life (e.g., family, community, food chains, populations, life cycles, effects on the environment), and apply them to local systems.

#### **Focusing Questions**

How do organisms depend on each other for survival?

What is a food web or a chain of life?

What factors regulate plant/animal behavior?

How do physical and environmental factors affect living things?

#### **Evidence of Learning**

The student will:

- Classify organisms in each of the two global webs (one beginning with microscopic ocean plants and seaweed; and the other beginning with land plants) as producers, consumers, or decomposers and describe key traits of each of these categories.
- After observation of living organisms students will identify the structural features that allow them to make or find food.
- Classify populations of animals as either predator or prey and as carnivore, omnivore, insectivore, or herbivore.
- Observe and explain the feeding relationships (e.g. food chains and webs) that exist among populations of plants and animals as producers and consumers.
- Produce an illustration or model of a food chain pyramid showing the role that decomposers play.
- Produce an illustration or model of the interdependence of different living systems.

#### **Related Science Concepts**

Organisms obtain and use resources, grow, reproduce and maintain a relatively stable internal environment while living in a changing external environment.

Organisms respond to their environment by changing their behavior.

Organisms have different relationships. Some are mutually beneficial and others are competitive (e.g.; predator/prey, producer/consumer, parasite/host).

Organisms have structural features that allow them to make or find food, reproduce and survive.

There is a food web or chain of life among all living organisms.

#### **Vital Results**

1.17 a, 2.1 c, d, e, 3.9 a, 2.13

# **The Living World**

## **Human Body**

### **Human Development – Personal Health**

#### **Grade 3**

#### **VT Standard 7.14**

Students demonstrate understanding of the human body - heredity, body systems, and individual development - and understand the impact of the environment on the human body. This is evident when students:

d. Identify the pattern of human development.

#### **Focusing Questions**

What stages does the human body go through from infancy to advanced adulthood?

What effects do the choices we make about nutrition, exercise, drugs, safety, etc. have on our growing bodies?

#### **Evidence of Learning**

The student will:

- Illustrate the growth process he or she has gone through since infancy, and will continue to go through until advanced adulthood.
- Produce a poem, narrative, or model describing the effects healthy/unhealthy; safe/unsafe choices can have on a growing human body.

#### **Related Science Concepts**

All humans go through the same change process over time from infancy to adulthood.

As a person grows and matures there are healthy and unhealthy, safe and unsafe choices that can be made which will affect the physical growth, health and well being of an individual (positively or negatively).

#### **Vital Results**

1.17 c, 2.1, 3.4

# **The Universe, Earth, and the Environment**

## **Theories, Systems, and Forces**

### **Pond Life**

### **Grade 3**

#### **VT Standard 7.15**

Students demonstrate understanding of the earth and its environment, the solar system, and the universe in terms of the systems that characterize them, the forces that affect and shape them over time, and the theories that currently explain their evolution. This is evident when students:

- a. Identify and record evidence of change over time (e.g., pond life);
- c. Identify and record the interrelated parts of earth systems (seasons, time, weather, and the cause/effect relationships with pond ecosystem);
- e. Analyze and explain natural resource management (e.g., properties and uses of earth materials: rocks, soils, water, fish, wildlife, plants, trees, and gases).

#### **Focusing Questions**

How has the weather changed the earth over time?  
How do we get different seasons with different weather patterns each year?  
Why do various places get different weather?  
What are the characteristics of a pond community?  
What plants and animals can be found in ponds?  
What conditions are necessary to support life in a pond?  
What is pollution and what causes it?  
What is the water cycle?

#### **Evidence of Learning**

The student will:

- Demonstrate with a model or illustration that weathering and erosion continually break down rocks and recycle materials.
- Produce a model or illustration showing the earth's seasonal changes over time, or the weather patterns that come with each season.
- After observation, record the activity of a nearby pond over time.
- Identify carnivore, herbivore, omnivore and scavenger plants and animals.
- Make a drawing that illustrates the water cycle.
- Identify various types of pollution (air, water) and suggest ways to lessen pollution.
- Produce a model of the food chain (e.g., submerged plant, a mayfly, larva, a fish and a raccoon) to show the interdependence of a pond community.
- Describe orally or in writing how the food chain in ponds and streams depends on the oxygen levels of the water and the pollution in the water.
- Illustrate the four habitats of the pond community.
- Identify how people and nature add pollutants to water.
- Explain how human and natural processes can cause air pollution.

### **Related Science Concepts**

Weathering affects and shapes the earth's surface over time.

The earth's daily weather is affected by the seasonal changes over time.

Ponds are quiet bodies of water so shallow that rooted plants grow across them.

Light can penetrate to the bottom of most ponds so that plants can root in the muddy or sandy bottom.

Light is necessary for the process of photosynthesis and the production of chlorophyll to sustain plant life (pond ecosystem).

Water temperature is fairly constant from top to bottom. There is little wave action.

### **Vital Results**

1.17 d, 2.1, 3.9 a, 7.11 c, 7.13 a, b, c, d

# Space, Time, and Matter

## Matter, Motion, Forces, and Energy

### Energy – Heat, Light, and Sound

#### Grade 4

#### VT Standard 7.12

Students understand forces and motion, the properties and composition of matter, and energy source and transformations. This is evident when students:

- e. Identify and describe several common forms of energy (e.g., light, heat, and sound) and provide examples of sources, as well as some characteristics of the transmission (e.g., light travels in straight lines until it is reflected, refracted, or absorbed).

#### Focusing Questions

What are the various forms of energy?

What are sources of energy?

How is energy transmitted?

#### Evidence of Learning

The student will:

- Identify heat, light, and sound as forms of energy.
- Describe how energy is transmitted.
- Demonstrate kinetic and potential energy.

#### Related Science Concepts

Energy comes in many forms. Light, sound, heat, and electricity are forms of energy.

Energy is transported through materials (solids, liquids, and gases) from place to place.

Energy can be classified as kinetic (moving) or potential (stored). Energy can be changed from one form to another.

Electricity, a form of energy, can move through some materials (conductors) and can't move through others (non-conductors).

#### Vital Results

1.7 a, b, c, 2.1, 2.2 a, b, d, f, g

# **The Living World**

## **Organisms, Evolution, and Interdependence**

### **Evolution and Extinction**

#### **Grade 4**

#### **VT Standard 7.13**

Students understand the characteristics of organisms, see patterns of similarity and differences among living organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:

d. Provide examples of change over time (e.g., extinction, changes in organisms).

#### **Focusing Questions**

How do physical and environmental factors affect living things?

What factors regulate plant/animal behavior?

How do mutually beneficial or competitive relationships between organisms help them survive?

How does biological evolution and adaptation prevent or cause species to go extinct?

#### **Evidence of Learning**

The student will:

- Observe living organisms and identify structural features that allow them to make or find food and reproduce.
- Describe how an organism obtains resources, grows, reproduces and maintains a relatively stable internal environment while living in a changing external environment.
- Observe and record how organisms respond to environmental or internal stimuli by changing their behavior.
- Describe the different relationships between organisms that are mutually beneficial or competitive.
- Describe how biological evolution and adaptation prevent or cause species to become extinct.

#### **Related Science Concepts**

Living organisms have structural features that allow them to make or find food and reproduce.

Reproduction is essential to the continuation of species.

Organisms obtain and use resources, grow, reproduce and maintain a relatively stable internal environment while living in a changing external environment.

Organisms respond to environmental or internal stimuli by changing their behavior over time.

#### **Vital Results**

1.17 a, 2.1 c, d, e, 2.4, 2.13

# **The Universe, Earth, and the Environment**

## **Theories, Systems, and Forces**

### **Sun and Sky**

#### **Grade 4**

#### **VT Standard 7.15**

Students demonstrate understanding of the earth and its environment, the solar system, and the universe in terms of the systems that characterize them, the forces that affect and shape them over time, and the theories that currently explain their evolution. This is evident when students:

d. Identify and record characteristics of our solar system (e.g., nine planets, order from sun and moon; calendar).

#### **Focusing Questions**

How are the earth, moon and the sun alike and different?  
How does the sun's position change during the day and night?  
What causes day and night?  
What can we see in the day and the night skies?  
What planets are in our solar system?  
What is the sun?  
What is the importance of the sun to our planet?

#### **Evidence of Learning**

The student will:

- After observation of the sun in different places in the day sky, record that it moves across the sky from east to west.
- Produce a model, song, or narrative that demonstrates understanding that the rising and setting of the sun is due to the earth's rotation; the 24 hour rotation of the earth determines a day; a 365 day revolution around the sun determines a calendar year; the position of the earth in relation to the sun and the other planets; and the knowledge that the moon, planets, and stars are visible in the day and night skies.
- After observation, explain why the moon's apparent shape changes daily and describe its position in the sky in relation to the sun and the stars changing daily.
- Record the changes in the skies and explain the patterns as a regular pattern recurring daily and monthly.
- Describe that the sun provides us with all our energy.

### **Related Science Concepts**

The earth and other planets in the solar system revolve around the sun.

There are nine planets in our solar system, and each one has unique characteristics and distances from the sun.

The sun is a star that gives off light, heat and other kinds of energy.

The earth's rotation on its axis determines night and day.

Revolution around the sun and its tilt determine seasons.

Gravity is the main force that keeps the planets and their moons in orbit.

The moon is a natural satellite of the earth, and revolves around the earth. Other planets have moons also.

The moon has gravitational influence on the earth and causes tides.

### **Vital Results**

2.1, 7.11 c

# **Design and Technology**

## **Natural Resources**

### **Grade 4**

#### **VT Standard 7.16**

Students understand how natural resources are extracted, distributed, processed, and disposed of. This is evident when students:

- a. Recognize that steps need to be followed in extracting natural resources;
- b. Identify the most appropriate materials for particular constructions.

#### **Focusing Questions**

What are natural resources?

How do humans find and extract natural resources?

What are the social and scientific issues regarding extraction and use of natural resources?

In what ways do humans use natural resources?

#### **Evidence of Learning**

The student will:

- Produce a model or narrative describing a natural resource, how it is extracted, its usefulness in society, and the issues surrounding its use and extraction.

#### **Related Science Concepts**

Earth provides many resources that humans find valuable for construction endeavors.

There are many ways to extract natural resources from the earth.

There are best practices for extracting natural resources that will help to maintain the health of the earth.

New developments for ways to extract resources and ways to use resources are being discovered at a rapid rate.

## Science Curriculum - Grades 5-8

As students evolve through the Washington West Supervisory Union Science Curriculum, it is our intent that all of the science content standards, vital results and non-science standards are reflected in the learning opportunities provided for all students. It is important to note that middle level students will not focus on science in isolation, but rather as an integrated part of the Vermont Framework. With this in mind, the following standards numbered below are embedded throughout the science curriculum.

### **Inquiry, Experimentation, and Theory**

- 7.1 Students use scientific methods to describe, investigate, explain phenomena, and raise questions. This is evident when students:
- aa. Frame questions in a way that distinguishes causes and effects; identify variables that influence the situation and can be controlled;
  - bb. Seek, record, and use information from reliable sources, including scientific knowledge, observation and experimentation;
  - cc. Create hypotheses to problems, design their own experiments to test their hypothesis, collect data through observation and instrumentation, and analyze data to draw conclusions to clarify understanding and generate new questions to be explored;
  - dd. Describe, explain, and model, using evidence that includes scientific principles and observations;
  - e. Explain a variety of observations and phenomena using concepts that have been learned;
  - f. Use either deductive or inductive reasoning to explain observations and phenomena, or to predict answers to questions;
  - gg. Propose, recognize, and analyze alternative explanations;
  - h. Identify problems, propose and implement solutions, and evaluate products and designs;
  - ii. Work individually and in teams to collect, share, and present information and ideas.
- 7.2 Students design and conduct a variety of their own investigations and projects. This is evident when students:
- aa. Design and conduct a controlled experiment;
  - bb. Design and conduct field work;
  - cc. Completely design a physical structure of technological system (e.g. spring scales, bicycle gear shifts, timing of traffic lights);
  - dd. Complete a data study based on civic, economic, or social issues;
  - ee. Design a resource or system management plan; or
  - ff. Illustrate mathematical models of a physical phenomenon;
  - g. Complete research.
- 7.3 Students understand the nature of mathematical, scientific, and technological theory. This is evident when students:
- aa. Explain theories based upon observations, concepts, principles, and historical perspective;
  - bb. Determine the validity of a theory by examining the principles on which it was founded, the constraints that apply to its application, and the body of physical evidence that supports it; and
  - cc. Show understanding that new theories develop when phenomena are observed that are not fully explained by old theories.
- 7.4 Students understand the history of science, mathematics, and technology. This is evident when students:
- aa. Examine important contributions made to the advancement of science, technology, and mathematics, and respond to their impact on past, present, and future understanding.

- 7.5 Students analyze the roles and responsibilities of scientists, mathematicians, and technologists in social, economic, cultural, and political systems. This is evident when students:
- aa. Analyze the role and responsibilities of scientists, mathematicians, and technologists in relation to ongoing research and discoveries that impact society (e.g. the dangers and benefits of nuclear energy).

# Physical Science

## Space, Time and Matter

### Electricity and Magnetism

#### Grade 5

#### VT Standard 7.12

Students understand forces and motion, the properties and composition of matter, and energy source and transformations. This is evident when students:

ff. Investigate the relationship between electricity and magnetism (e.g. in electric motors).

#### Focusing Questions

What is electricity?  
How does electricity move from one place to another?  
How do electrical circuits provide a means of converting electrical energy into heat, light, and sound?  
What is the source of electricity in our community?  
What is magnetism?  
How do magnetic poles repel and attract each other?  
How can magnetism produce electricity?  
What are electrons?  
What are positive and negative charges?  
What are good conductors of electricity and what are poor conductors (insulators)?  
What are current and static electricity?  
What are atoms?  
What are fission and fusion energy?  
What is the electromagnetic spectrum?  
How does a turbine work to produce electricity?

#### Evidence of Learning

The student will:

- Compare series and parallel circuits, circuit breakers, insulators and conductors.
- Investigate electricity and magnetism to recognize relationships.
- Investigate static electricity.
- Identify materials for classification of insulators and conductors.
- Understand what electrons are and the role they play in positive, negative and neutral charges.
- Explain current electricity and how it flows using: a circuit, switch, direct current, alternating current, parallel circuit, etc.
- Demonstrate basic understanding of batteries and how they work.
- Describe how electricity enters home and school for our work purposes.

#### Vital Results

1.8, 2.1, 2.2, 3.1, 3.9, 7.1, 7.2

# **The Living World**

## **Organisms, Evolution, and Interdependence**

### **Ecosystems, Photosynthesis, and Classification**

#### **Grade 5**

#### **VT Standard 7.13**

Students understand the characteristics of organisms, see patterns of similarity and differences among living organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:

- aa. Identify, model and explain the structure and function (e.g. cells, tissues, organs, systems) of organisms (e.g. plants, animals, microbes) both as individual entities and as components of larger systems;
- bb. Identify and use anatomical structures to classify organisms (e.g. plants, animals, fungi);
- cc. Describe, model, and explain the principles of interdependence of all systems that support life (e.g. food chains, webs, life cycles, energy levels, populations, oxygen-carbon dioxide cycles), and apply them to local, regional and global systems.

#### **Focusing Questions**

What is an ecosystem and how are ecosystems important in our living world?  
What are populations?  
How are classes of plants and animals similar and different?  
What does a healthy ecosystem look like?  
How do the living things interact with their physical environments?  
What are cells and why are they important to the structure of living things?

#### **Evidence of Learning**

The student will:

- Explain interdependence among all living things.
- Classify plants and animals according to their physical structure - cells, organs, tissues, etc. and as part of various ecosystems.
- Identify and explain the relationship between the structure and function of living things.
- Describe the process of photosynthesis and give examples of its importance.
- Describe concepts related to ecosystems and give examples of food chains and webs.
- Define and explain what pollutants are and how they impact on a given ecosystem.
- After discussions around how humans impact on the environment, explain some of the related environmental issues that are affected by this interaction.

#### **Vital Results**

1.8, 2.1, 2.2, 3.1, 3.9, 7.1, 7.2

# **The Universe, Earth, and the Environment**

## **Theories, Systems, and Forces**

### **Forces of Nature and Change Over Time**

#### **Grade 5**

#### **VT Standard 7.15**

Students demonstrate understanding of the earth and its environment, the solar system, and the universe in terms of the systems that characterize them, the forces that affect and shape them over time, and the theories that currently explain their evolution. This is evident when students:

- aa. Identify, record, and model evidence of change over time (e.g. erosion, weathering, fossilization);
- bb. Identify evidence of, model, and explain the patterns and forces that shape the earth (e.g. geological, atmospheric);
- cc. Identify, record, model, and explain the interrelated parts and connections among earth systems (e.g. crustal plates and landforms; atmosphere, water cycle, weather and oceans).

#### **Focusing Questions**

How has the topography of the earth's crust changed over time and what forces have caused these changes?  
What are the characteristics of rocks and how are they classified?  
How do the forces of weathering and erosion break down rocks and recycle minerals?  
How do some natural processes build up the earth's surface and create various landforms?  
How are fossils formed and how do they help us understand the history of our earth's physical structure, climate and life forms?  
Why should humans be concerned with how natural forces affect the earth and natural resource management?

#### **Evidence of Learning**

The student will:

- Compare and contrast the characteristics of the earth's layers (crust, mantle and core).
- Explain how landmasses have changed throughout history.
- Classify rocks and explain how each type was formed.
- Describe and demonstrate the forces of weathering (wind, water, ice).
- Describe and demonstrate how the earth is built up (volcanoes, faulting, folding, etc.).
- Describe and give examples of how fossils are evidence of the earth's history and how climate, plants and animals have changed over time.
- Identify and describe several conservation efforts locally, nationally or worldwide.

#### **Vital Results**

2.1, 4.5 aa, bb

# **Design and Technology**

## **Outputs and Impacts**

### **Tools and Machines**

#### **Grade 5**

#### **VT Standard 7.18**

Students understand that people control the outputs and impacts of our expanding technological activities in the areas of communication, construction, manufacturing, power and transportation, energy resources, health technology, and biotechnology. This is evident when students:

bb. Demonstrate how people create and use tools to observe, measure, create, and control.

#### **Focusing Questions**

Why were these tools developed and how are they used?

How do the tools of yesterday compare with the tools we use today for the same purposes? (i.e. inventions, innovations)

How are tools and machines combined to improve their function? (complex machines)

How do machines and tools impact our society as a whole?

How are machines used as tools for manufacturing, construction, transportation and communication?

Are today's machines and scientific tools enough to satisfy the needs of the world?

How would the world today be different without the simple and complex tools used both historically and today?

#### **Evidence of Learning**

The student will:

- Give an example and describe how science and technology are used to create everyday products (clothes, food, structures, mechanical and electrical devices).
- After investigation, describe how simple and complex machines are used in today's world.
- Relate how technological tools are involved with instituting systems and establishing societal expectations.
- After experimentation, complete a simple design task that takes into account real world needs.
- Explain that technology is created by people advancing the understanding of science and that technology will continue to grow and change with the needs of society.
- Evaluate the impact of technological tools/solutions that have not been successful or have had unexpected consequences (positive or negative).

#### **Vital Results**

2.2aa, 2.4, 2.5a, c, e, f

# Space, Time and Matter

## Matter, Motion, Forces, and Energy

### Chemistry, Electricity, and Energy

#### Grade 6

#### VT Standard 7.12

Students understand forces and motion, the properties and composition of matter, and energy source and transformations. This is evident when students:

- aa. Observe and measure characteristic properties of matter (e.g. boiling point, melting point, density, buoyancy, simple chemical reactions), and use them to distinguish one substance from another;
- dd. Observe and demonstrate a qualitative understanding of the relationship between mass, the magnitude of an applied net force, and the resulting change in speed and direction;
- ee. Identify and describe common forms of energy (heat, light, sound, electricity, electromagnetic waves) and their attributes, sources, and transmission characteristics (radiation, convection, conduction of heat).

#### Focusing Questions

What are elements and compounds?

What is a chemical reaction?

What are potential and kinetic energy?

#### Evidence of Learning

The student will:

- Demonstrate understanding of conservation of matter.
- Illustrate or model to show that substances react chemically in characteristic ways with other substances to form new substances (compounds) with different properties.
- Relate chemical reactions to elements and compounds by conducting basic experiments.
- Describe common forces - friction and gravity.
- After experimentation and investigation, describe mass of an object, forces and motion.
- Explain the relationship between mass, gravity and weight.

#### Vital Results

1.17 bb, cc, 2.1

# **The Living World**

## **Human Body**

### **Cell Classification and Body Systems**

#### **Grade 6**

#### **VT Standard 7.14**

Students demonstrate understanding of the human body - heredity, body systems, and individual development - and understand the impact of the environment on the human body. This is evident when students:

- bb. Demonstrate an understanding of the human body systems for obtaining and providing energy, defense, reproduction, hormones, immunity, and coordination of physical functions;
- dd. Identify and explain the human body's pattern of development.

**Note:** The Washington West Health Curriculum also addresses this subject.

#### **Focusing Questions**

- What are cells?
- How does the human body obtain energy?
- What are the functions of the human body systems?
- How do these systems interact to keep one alive?

#### **Evidence of Learning**

The student will:

- Define reproduction as characteristic of all living systems.
- State that all organisms are composed of cells.
- Show the structure of the human systems of digestion, respiration, reproduction, circulation, excretion, movement, and for protection from disease.
- Sketch cells and observe after investigation with a microscope.

#### **Vital Results**

1.7 bb, cc, 2.1, 3.5 dd

# The Universe, Earth, and the Environment

## Theories, Systems, and Forces

### Solar System and Universe

#### Grade 6

#### VT Standard 7.15

Students demonstrate understanding of the earth and its environment, the solar system, and the universe in terms of the systems that characterize them, the forces that affect and shape them over time, and the theories that currently explain their evolution. This is evident when students:

dd. Identify, record, model, and explain the relationship of our solar system to the universe (day, year, season; sun, galaxies, energy, orbits; planet characteristics).

#### Focusing Questions

- What are the phases of the moon?
- What is the explanation for the seasons?
- What is the earth's position relative to the universe?
- What are the planets in our solar system?
- How does the sun affect our planet?
- How have the conceptual models of our solar system evolved?
- What are some of the celestial bodies that make up our universe?

#### Evidence of Learning

The student will:

- Explain how modern views of the universe emerged.
- Model the visual and physical relationships among earth, sun, moon, and the solar system.
- Describe the earth as a moving spherical planet, having unique features that distinguish it from other planets in our solar system.
- Define gravity as a ubiquitous force that holds all parts of the solar system together.
- Describe the primary energy source for the processes on the earth's surface as energy from the sun transferred by light and other radiation.
- Describe the relationship between the earth, sun, moon and the effects of tides and seasonal changes.
- State that one earth rotation determines the day (24 hours) and one revolution (365 days) around the sun determines one calendar year.
- Identify and describe celestial bodies in our solar system and universe (e.g. comets, phases of stars, meteorites).
- Interpret understandings from space probe missions, telescope findings and relevant theories.

#### Vital Results

2.1, 3.9 aa

# **Systems Analysis Grade 7**

## **VT Standard 7.11**

Students analyze and understand living and non-living systems (e.g. biological, chemical, electrical, mechanical, optical) as collections of interrelated parts and interconnected systems. This is evident when students:

- aa. Demonstrate understanding that systems are connected to other systems and that one system affects how others work;
- cc. Use physical and mathematical models to express how systems behave given a set of inputs or outputs.

# **The Living World Organisms, Evolution and Interdependence Ecosystems**

## **VT Standard 7.13**

Students understand the characteristics of organisms, see patterns of similarity and differences among living organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:

- cc. Describe, model, and explain the principles of interdependence of all systems that support life (e.g. food chains, webs, life cycles, energy levels, populations, oxygen-carbon dioxide cycles), and apply them to local, regional and global systems.

## **Focusing Questions**

- What is ecology?
- What is an ecosystem?
- What are the interconnections among the living and nonliving things in an environment?
- How do ecosystems, communities, and populations compare?
- What are the different relationships among living things in an ecosystem?
- What factors limit growth of a population?
- How do communities change through time?
- How does energy travel through an ecosystem?
- How do human activities impact an ecosystem?
- What is a biome?

## **Evidence of Learning**

The student will:

- Distinguish between the biotic and abiotic environment.
- Explain how populations, communities, ecosystems, and the biosphere are related.
- Explain how the abiotic environment relates to communities.
- Describe the functions of producers, consumers, and decomposers in an ecosystem.
- Distinguish between a food chain and a food web.
- Explain how energy flows through a food web.
- Distinguish between an organism's habitat and its niche.
- Distinguish between the two types of competition.
- Give examples of predators and prey.
- Distinguish between mutualism, commensalism, and parasitism.
- Define and give an example of coevolution.
- Describe limiting factors in an ecosystem.

- Explain why balance is important in an ecosystem.
- Describe how human activities can change the balance of an ecosystem.
- Explain the importance of conservation and land use measures aimed at protecting ecosystems.
- Discuss the reasons for the extinction of organisms and explain why people should try to save an endangered species.
- Explain the importance of biodiversity.
- Explain how rainfall and temperature affect vegetation.
- Describe how altitude, latitude, and climate determine the characteristics of a biome.
- Describe the major characteristics of several biomes.

### **Related Standards**

7.13, 7.15

### **Vital Results**

1.13, 1.16, 1.17, 1.18, 1.20, 1.4, 2.1, 2.2, 3.10

# Space, Time, and Matter

## Matter, Motion, Forces, and Energy

### Chemistry of Life

#### Grade 7

#### VT Standard 7.12

Students understand forces and motion, the properties and composition of matter, and energy sources and transformations. This is evident when students:

bb. Provide examples of substances reacting chemically to form new substances with different characteristics and describe and model the phenomena with reference to elements and compounds.

#### Focusing Questions

What chemical reactions occur in cells?

What is the relationship between an atom and a compound?

What are some common elements and compounds found in living things?

#### Evidence of Learning

The student will:

- Distinguish between elements and compounds.
- Infer whether certain compounds are organic or inorganic.
- Identify common elements in a compound.
- Distinguish between atoms and molecules.
- Define and describe carbohydrates, lipids and proteins.
- Describe a simple chemical equation.

#### Vital Results

1.17aa, cc

# **The Living World**

## **Organisms, Evolution, and Interdependence**

### **Characteristics of Life, Classification, Microbiology, and Evolution**

#### **Grade 7**

#### **VT Standard 7.13**

Students understand the characteristics of organisms, see patterns of similarity and differences among living organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:

- aa. Identify, model, and explain the structure and function of organisms, both as individual entities and as components of larger systems;
- bb. Identify and use anatomical structures to classify organisms;
- dd. Describe evolution in terms of diversity and adaptation, variation, extinction and natural selection.

#### **Focusing Questions**

Where did life come from?

How are organisms classified?

What are the fundamental differences among fungi, protists, monerans, plants and animals?

What evidence exists that supports evolution?

#### **Evidence of Learning**

The student will:

- Explain the use of classification systems.
- Use a taxonomic key to identify selected organisms.
- Compare and contrast taxonomic keys and field guides.
- Name and describe the five kingdoms used to classify all life on Earth.
- Describe some characteristics of each kingdom.
- Recognize greater and lesser degrees of likeness among groups of organisms.
- Compare vertebrates and invertebrates.
- Describe the characteristics of the major groups of invertebrates and vertebrates and give an example of an animal from each group.
- Identify structural features of the protists.
- Describe the characteristics of several types of fungi.
- Describe the characteristics of monerans.
- Classify bacteria according to shape.
- Describe the method by which bacteria reproduce.
- Explain how viruses reproduce.
- List and explain several conditions or diseases caused by microorganisms.
- Relate the means of disease prevention to the mode of transportation.
- Explain why, although microorganisms are potentially worldwide in distribution, many infectious diseases have limited distributions.
- Explain some of the beneficial roles of microorganisms.
- Describe the basic characteristics of living things.
- Identify the needs and chemistry of living things.
- Describe the environment of the early Earth.
- Identify the major events in the evolution of cells.
- Describe the historical development of the cell theory and the invention of the microscope.
- Explain the function of a cell's organelles.
- Compare and contrast the structure of a plant and an animal cell.
- Distinguish between diffusion and osmosis.
- Infer how the process of osmosis affects the cells of living things.

- Explain how a cell grows and reproduces.
- Make a model of the events that occur during mitosis.
- Describe and compare respiration and photosynthesis.
- Summarize the changes that scientists hypothesize occurred in the process of human evolution.

### **Vital Results**

1.10, 1.13, 1.16, 1.17aa, bb, 1.18, 1.20, 2.6

# **The Living World**

## **Organisms, Evolution, and Interdependence**

### **Endocrine and Immune Systems**

#### **Grade 7**

#### **VT Standard 7.14**

Students demonstrate understanding of the human body - heredity, body systems, and individual development - and understand the impact of the environment on the human body. This is evident when students:

- aa. Describe how genetic information is passed through reproduction (e.g. genes, traits, chromosomes);
- bb. Demonstrate an understanding of the human body systems for obtaining and providing energy, defense, reproduction, hormones, immunity, and coordination of physical functions;
- cc. Provide examples of how the health of human beings is affected by their genetic makeup and environmental factors (e.g. exposure to microbes, pollution).

#### **Focusing Questions**

What is the structure and function of a cell?  
How is the activity within a cell related to the functions of the entire organism?  
How do organisms reproduce?  
How are traits passed from parents to offspring?  
How can you predict which traits will be passed on to future generations?  
What is the function of the endocrine system?

#### **Evidence of Learning**

The student will:

- Describe the major endocrine glands and their functions.
- Explain how hormone levels in the body are regulated.
- Identify several disorders of the endocrine system.
- Describe the kind of information carried by a gene.
- Explain the difference between phenotype and genotype.
- Distinguish between dominant and recessive genes.
- Predict the results of a simple genetic cross using a Punnett square.
- Explain how changes in chromosomes affect heredity.
- Describe how certain human traits are transmitted from one generation to the next.
- Identify the pioneers of genetics.
- Discuss major techniques used in applied genetics.
- Describe the function of the body's immune system.
- Explain how the body fights disease-carrying organisms.
- Compare infectious and noninfectious diseases.
- Identify the function of the lymphatic system.
- Distinguish between antibiotics and antibodies.
- Describe how a vaccine works.
- Describe the reasons for bacterial resistance to antibiotics.

#### **Vital Results**

1.10c, 1.13, 1.17, 1.3, 1.20, 2.1, 3.5aa, 3.7

# **The Universe, Earth, and the Environment**

## **Theories, Systems and Forces**

### **The Environment**

#### **Grade 7**

#### **VT Standard 7.15**

Students demonstrate understanding of the earth and its environment, the solar system, and the universe in terms of the systems that characterize them, the forces that affect and shape them over time, and the theories that currently explain their evolution. This is evident when students:

- ee. Analyze and explain natural resource management and demonstrate an understanding of the ecological interactions and interdependence between humans and their resource demands on environmental systems (e.g. waste disposal, energy resources, recycling, pollution reduction);
- f. Explain how modern views of the universe emerged (i.e. scientific theories, improved instrumentation).

## **Design and Technology**

### **Outputs and Impacts**

#### **VT Standard 7.18**

Students understand that people control the outputs and impacts of our expanding technological activities in the areas of communication, construction, manufacturing, power and transportation, energy sources, health technology and biotechnology. This is evident when students:

- aa. Demonstrate an understanding that people are able to share, compile, use, and misuse technology;
- bb. Demonstrate how people create and use tools to observe, measure, create, and control; and
- d. Identify the positive and negative consequences of technology.

#### **Focusing Questions**

How do or how have humans impacted on their environment?  
What resources exist and what can be done to conserve them?  
Why is resource management important?  
How does the environment affect the health of an individual?

#### **Evidence of Learning**

The student will:

- Distinguish between renewable and nonrenewable resources.
- Explain the importance of energy conservation efforts.
- Describe some of the harmful effects and sources of air, water, and land pollution.
- Explain how pollution can be reduced.
- Predict the condition of the Earth's ecosystem in the future.
- Describe the changes that may take place when a wild area is taken over for human use.
- Describe the factors that affect any population's size and explain why populations grow and what factors limit that growth.
- Identify some of the problems that stem from population growth.
- Predict human population rates based on given criteria.
- Explain the concept of sustainable living and how public policy can make a difference in the health of our natural systems.
- Explain ways in which humans can help an ecosystem.

#### **Vital Results**

1.13, 1.14, 1.15, 1.18, 1.19, 1.2

# **Space, Time, and Matter**

## **Matter, Motion, Forces, and Energy**

### **Energy, Matter, Electricity, Magnetism, Atoms, Forces and Motion**

#### **Grade 8**

#### **VT Standard 7.12**

Students understand forces and motion, the properties and composition of matter, and energy source and transformations. This is evident when students:

- aa. Observe and measure characteristic properties of matter, and use them to distinguish one substance from another;
- bb. Provide examples of substances reacting chemically to form new substances with different characteristics, and describe and model the phenomenon with reference to elements and compounds;
- cc. Explain the relationships between pressure, volume, and the amount of gas;
- dd. Observe and demonstrate a qualitative understanding of the relationship between mass and the magnitude of an applied net force, and the resulting change in speed and direction;
- ee. Identify and describe common forms of energy (e.g. light, heat, sound, electricity, electromagnetic waves) and their attributes, sources and transmission characteristics (e.g. radiation, convection, conduction of heat);
- ff. Investigate the relationship between electricity and magnetism.

#### **Focusing Questions**

How are atoms, molecules, elements, and compounds related?  
What are characteristic properties of matter and how can they be measured and used to distinguish among substances?  
What happens in a chemical reaction?  
What are physical and chemical changes in matter?  
What are the phases of matter and how does matter change phase?  
What are mixtures and solutions?  
How can mixtures and solutions be separated?  
What is density and how can it be calculated?  
What are some practical applications of density?  
What is energy?  
What are different sources (forms) of energy?  
How are kinetic and potential energy related?  
What is the Law of Conservation of Energy?  
What are Newton's Three Laws of Motion?  
What are speed, velocity and acceleration?  
What is momentum?  
How are work and power different?  
How can machines make work easier?  
What is gravity?  
What is the Law of Universal Gravitation?  
How are static and current electricity different?  
How are series and parallel circuits different?  
How are conductors and insulators different?  
What is magnetism?  
How are electricity and magnetism related?

## Evidence of Learning

The student will:

- Understand and apply frame of reference.
- Define motion and speed.
- Calculate speed using  $s=d/t$ .
- Represent speed graphically and distinguish speed from velocity.
- Define and calculate acceleration.
- Define and calculate momentum.
- Explain the law of conservation of momentum.
- Define force, understand it as a vector quantity, and understand its relationship to motion.
- Understand what friction is, and its effect on motion, and understand types of friction.
- Describe and apply Newton's Three Laws of Motion.
- Relate gravity to the motion of falling objects.
- Explain the effect of air resistance on falling objects.
- Explain Newton's Law of Universal Gravitation.
- Explain the relationship between weight and mass.
- Define work and calculate work done.
- Explain what a machine is and how it makes work easier.
- Understand and explain efficiency and mechanical advantage of a machine.
- Explain how energy and work are related.
- List the major forms of energy and give examples.
- Explain and give examples of kinetic and potential energy.
- Explain and give examples of energy conversions.
- State the Law of Conservation of Energy.
- Practice using timing devices and measuring distances.
- Relate electric charge to atomic structure and describe the forces that exist between charged particles.
- Describe the effects of static electricity.
- Describe the nature of current electricity.
- Compare and give examples of conductors and insulators.
- Identify the parts of an electric circuit.
- Compare a series with a parallel circuit.
- Explain how electric power is calculated and purchased.
- Describe magnetism and the behavior of magnetic poles.
- Explain magnetism in terms of magnetic domains.
- Describe the Earth's magnetic properties.
- Explain what happens to a charged particle in a charged field.
- Describe how a magnetic field is created by an electric current.
- Discuss the force exerted on an electric current by a magnetic field.
- Apply the principles of electromagnetism to devices such as the electric motor.
- Explain how electricity can be produced from magnetism.
- Explain the term "matter".
- List some general properties of matter.
- Define the term "volume".
- Calculate the density of a substance when the mass and volume are known.
- Identify the four phases of matter.
- Describe the gas laws.
- Relate phase changes and heat energy.
- Distinguish between a chemical property and a chemical change.
- Distinguish among elements, compounds, mixtures and solutions.
- Identify different kinds of mixtures.

- Compare the properties of solutions with the properties of mixtures.
- Explain why elements are considered pure substances.
- Describe how chemical symbols, formulas and balanced equations are used to describe a chemical reaction.
- Describe how the atomic model has changed over time.
- Classify and describe subatomic particles.
- Identify the relationships among atomic number, atomic mass, and mass number.

### **Vital Results**

1.13a, b, c, 1.17aa, bb, cc, 2.2aa bb, cc, dd, ee, 2.4a, b, c, e, 3.1, 3.3, 3.10, 3.11

## Science Curriculum Grades 9 - 12

The Harwood Union High School science program provides students with the opportunity to attain all of the science content standards as well as a number the Vital Results and non-science content standards included in the Vermont Framework. The standards numbered below are embedded throughout the science program and their attainment is indicated by the lettered evidence following each standard.

### **7.1 Students use scientific methods to describe, investigate, and explain phenomena and raise questions. This is evident when students:**

- aaa.** Frame questions that can be investigated using scientific methods and knowledge, including manipulating variables, and predicting outcomes for untested hypotheses using scientific principles.
- bbb.** Critically evaluate the validity and significance of sources and interpretations, including scientific knowledge, observation, and experimentation.
- cc.** Create hypotheses to problems, design their own experiments to test their hypotheses, collect data through observation and instrumentation, and analyze data to draw conclusions; use conclusions to clarify understanding and generate new questions to be explored.
- ddd.** Formulate and revise explanations and models based on evidence, logical argument, and scientific principles.
- ee.** Explain a variety of observations and phenomena using concepts that have been learned.
- f.** Use either deductive or inductive reasoning to explain observations and phenomena, or to predict answers to questions.
- ggg.** Propose, recognize, analyze, synthesize, and evaluate alternative explanations.
- hh.** Identify problems and opportunities, propose designs and choose among the alternatives, implement a solution and evaluate its consequences.
- i.** Work individually and in teams to collect and share information and ideas.

### **7.2 Students design and conduct a variety of their own investigations and projects. This is evident when students:**

- aa.** Design and conduct a controlled experiment.
- bb.** Design and conduct field work.
- cc.** Completely design a physical structure or technological system.
- dd.** Complete a data study based on civic, economic, or social issues.
- ee.** Design a resource or system management plan.
- fff.** Complete a mathematical model of physical phenomena, employing methods of structural analysis.
- g.** Complete research.
- h.** Study decision options in business or public planning that involve issues of optimizations, trade off, cost benefit projections, and risks.
- i.** Complete a historical study, tracing the development of a mathematical or scientific concept and the people connected with it.

### **7.3 Students understand the nature of mathematical, scientific, and technological theory. This is evident when students:**

- aaa.** Use principles and observations to formulate theory and to explain or predict phenomena.
- bb.** Determine the validity of a theory by examining the principles on which it was founded, the constraints that apply to its application, and the body of physical evidence that supports it.
- cc.** Show understanding that new theories develop when phenomena are observed that are not fully explained by old theories.

**7.4 Students understand the history of science, mathematics, and technology. This is evident when students:**

- aa.** Examine important contributions made to the advancement of science, technology, and mathematics, and respond to their impact on past, present, and future understanding.

**7.5 Students analyze the roles and responsibilities of scientists, mathematicians, and technologists in social, economic, cultural, and political systems. This is evident when students:**

- aaa.** Analyze the impact of scientific, mathematical, and technological investigations into and findings about human society, including the ethical issues involved (e.g., the dangers and benefits of genetic engineering).

# **COURSE: EARTH-SPACE SCIENCE - GRADE 9**

## **Unit: Astronomy**

### **VT Standard 7.15**

Students demonstrate understanding of the earth and its environment, the solar system, and the universe in terms of the systems that characterize them, the forces that affect and shape them over time, and the theories that currently explain their evolution. This is evident when students:

- aaa. Identify, record, model and explain evidence of change over time;
- bbb. Identify evidence of, model, and explain the patterns and forces that shape the earth;
- ccc. Identify, model, explain, and analyze the interrelated parts and connections between earth systems;
- ddd. Identify, model, and explain the position of our solar system in the universe relative to distance and time (star and star systems, fusion, instrumentation, and simulations; the universe as a hierarchy of interrelated systems); and
- ff. Explain the emergence of modern views of the universe (past, present, and future scientific theories).

### **Evidence of Learning**

The student will:

- Frame questions that can be investigated using scientific methods and knowledge, including manipulating variables, and predicting outcomes for untested hypotheses using scientific principles.
- Critically evaluate the validity and significance of sources and interpretations, including scientific knowledge, observation, and experimentation.
- Formulate and revise explanations and models based on evidence, logical argument, and scientific principles.
- Propose, recognize, analyze, synthesize, and evaluate alternative explanations.
- Identify problems and opportunities, propose designs and choose among the alternatives, implement a solution and evaluate its consequences.
- Design and conduct a controlled experiment.
- Illustrate mathematical models of a physical phenomenon.
- Complete a historical study, tracing the development of a mathematical or scientific concept and the people connected with it.
- Explain theories based upon observations, concepts, principles, and historical perspective.
- Determine the validity of a theory by examining the principles on which it was founded, the constraints that apply to its application, and the body of physical evidence that supports it.
- Show understanding that new theories develop when phenomena are observed that are not fully explained by old theories.
- Use principles and observations to formulate theory and to explain or predict phenomena.
- Examine important contributions made to the advancement of science, technology and mathematics, and respond to their impact on past, present, and future understanding.
- Analyze the impact of scientific, mathematical, and technological investigations into and findings about human society, including the ethical issues involved.
- Understand and use number systems: natural, whole, integer, rational, real and complex.
- Represent numbers in decimal or fraction form and in scientific notation, and graph numbers on the number line in the coordinate plane.
- Understand and use unitary operations.
- Use dimensionless numbers and numbers with specific units of measure, including length, time, and rate units.

- Compare numbers using order relations, differences, ratios, proportions, percents, and proportional change.
- Understand the interrelationship of the four binary arithmetic operations, and use the properties of these operations in forming and working with algebraic expressions.
- Recognize and represent basic number patterns.
- Measure as exactly as possible or round off, as appropriate, and justify the choice.
- Understand the properties of figures relating to shape, size, location, direction, and orientation.
- Work with basic types of solid and plane figures, and with geometric patterns involving such figures.
- Use relationships between figures that involve congruence, similarity, projections, and transformations.
- Use quotient measures and product measures.
- Know, use and derive formulas for area and volume of many kinds of figures.
- Carry out conversions, scale changes, and dimensional analysis; competently use basic measurement instruments; understand issues of precision, accuracy and error analysis.
- Understand the structure of standard measurement systems (SI and customary), including basic geometric and non-geometric measures.
- Analyze geometric figures and prove things about them using deductive methods.
- Present graphs and figures.
- Formulate and solve meaningful problems in many kinds of situations using grade-related mathematical concepts and reasoning strategies.
- Formulate and carry out detailed solutions to complex problems, using appropriate problem solving techniques.
- Demonstrate understanding that analysis of systems is important to define and control inputs and outputs.
- Demonstrate understanding that systems are effectively designed when specifications and constraints are understood; systems are optimized when efficiencies are maximized; and a system is never 100% efficient (entropy).
- Observe and measure characteristic properties of, and chemical reactions between, one substance and another to distinguish between them; explain the structure of matter using the periodic properties of elements.
- Demonstrate an understanding of the atomic structure of matter in relationship to the periodic table, bonding, elements and compounds;
- Demonstrate an understanding of the conservation of matter.
- Understanding how radioactive elements decay.
- Use Newton's law to explain quantitatively the effects of applied forces; observe, explain, and model object motion in a plane; qualitatively investigate conservation of momentum as it relates to collisions, and investigate the mechanics of rolling motion.
- Provide examples of transformations of energy from one form to another.
- Provide examples of conservation of energy; and understand that light and some particles have wave and particle properties (diffraction).
- Discuss electromagnetic waves.
- Identify, record, model and explain evidence of change over time.
- Identify evidence of model and explain the patterns and forces that shape the earth.
- Identify, model, explain, and analyze the interrelated parts and connections between earth systems.
- Identify, model and explain the position of our solar system in the universe relative to distance and time (star and star systems, fusion, instrumentation, and simulations; the universe as a hierarchy of interrelated systems).
- Explain the emergence of modern views of the universe (past, present, and future scientific theories).

## **Essential Science Principles**

The student will demonstrate understanding of:

- Formation of the universe.
- Characteristics of stars including composition, temperature, motion, magnitudes, and classification.
- Astronomical distances.
- Stellar evolution.
- Star groups.
- Structure of the sun.
- Fusion, transformation of mass, chemical reactions.
- Solar activity, including sunspots, solar flares, auroras, magnetic cycle.
- Formation of the solar system, including historical models.
- Planetary systems.
- Earth's moon, including surface, interior, development.
- Lunar movements - eclipses, rotation and revolution.
- Lunar cycle - phases of the moon, calendars.
- Other satellites.

## **Vital Results**

1.1, 1.2, 1.3, 1.4, 1.8, 1.11, 1.18, 1.19, 1.20, 1.21, 2.1, 2.2, 2.3, 2.4, 2.6, 2.8, 2.9, 2.10, 2.14, 3.1, 3.2, 3.7, 3.10, 3.11, 4.5

## **Related Standards**

7.6aaa, 7.6bbb, 7.6ff, 7.6hh, 7.6I, 7.7aaa, 7.7bbb, 7.7ccc, 7.7ddd, 7.7eee, 7.7ff, 7.7h, 7.7I, 7.7j, 7.8, 7.10aa, 7.10bbb, 7.11aaa, 7.11bbb, 7.12aaa, 7.12bbb,

# **COURSE: EARTH-SPACE SCIENCE - GRADE 9**

## **Unit: Meteorology**

### **VT Standard 7.15**

Students demonstrate understanding of the earth and its environment, the solar system, and the universe in terms of the systems that characterize them, the forces that affect and shape them over time, students:

- aaa. Identify, record, model and explain evidence of change over time;
- bbb. Identify evidence of, model, and explain the patterns and forces that shape the earth;
- ccc. Identify, model, explain and analyze the interrelated parts and connections between earth systems.

### **Evidence of Learning**

The student will demonstrate knowledge of:

- Earth's uniqueness.
- Effects of revolution and rotation - seasons, time zones.
- Exploration of the earth - satellites, deep digging operations, compasses, maps, etc.
- Gravity (covered also in Astronomy).
- Plate tectonics, continental drift, including historical perspectives and impact of technology on theory.
- Deformation of the crust: isostatic adjustment, stress, faulting, folding.
- Formation of mountains.
- Earthquakes: cause, location, prediction, measurement.
- Volcanoes: major zones, types, prediction, extraterrestrial (covered also in Astronomy).
- Characteristics of the atmosphere - composition, atmospheric pressure, layers, pollution.
- Solar energy and the atmosphere - radiation, absorption, conduction, convection.
- Winds - global and local.
- Atmospheric moisture, heat energy and water, humidity, dew point.
- Cloud formation and classification.
- Precipitation - forms, causes, measurement.
- Air masses - types, particularly North American.
- Fronts - types.
- Major storms - hurricanes, tornadoes, thunderstorms, lightning.
- Weather instruments - barometers, anemometers, upper atmospheric data.
- Forecasting.
- Climate - factors that affect it including latitude, altitude, topography.
- Worldwide systems: El Nino, La Nina, North Atlantic oscillation.
- Climate zones.

### **Vital Results**

1.1, 1.2, 1.3, 1.4, 1.8, .11, 1.18, 1.19, 1.20, 1.21, 2.1, 2.2, 2.3, 2.4, 2.6, 2.7, 2.8, 2.9, 2.10, 2.14, 3.1, 3.2, 3.3, 3.7, 3.10, 3.11, 4.5

### **Related Standards**

7.6aaa, 7.6bbb, 7.6ff, 7.6gg, 7.7f, 7.7aaa, 7.7eee, 7.7ff, 7.7h, 7.7I, 7.7j, 7.10aa, 7.10bbb, 7.11bbb, 7.12ee, 7.12aaa, 7.12bbb, 7.12eee

# **COURSE: EARTH-SPACE SCIENCE - GRADE 9**

## **Unit: Oceanography**

### **VT Standard 7.15**

Students demonstrate understanding of the earth and its environment, the solar system, and the universe in terms of the systems that characterize them, the forces that affect and shape them over time, and the theories that currently explain their evolution. This is evident when students:

- aaa. Identify, record, model, and explain evidence of change over time;
- bbb. Identify evidence of, model, and explain the patterns and forces that shape the earth;
- ccc. Identify, model, explain, and analyze the interrelated parts and connections between earth systems.

### **Evidence of Learning**

The student will demonstrate knowledge of:

- Features of ocean basins.
- Sources and types of sediment.
- Properties of ocean water - salinity, temperature, density, color.
- Marine life (basic outline).
- Resources from oceans - minerals, food, fresh water.
- Ocean pollution.
- Ocean currents - surface and deep.
- Ocean waves - energy, shoreline erosion.
- Tides - source, behavior, variations, currents.

### **Vital Results**

1.1, 1.2 , 1.3, 1.4, 1.8, 1.11, 1.18, 1.19, 1.20, 1.21, 2.1, 2.2, 2.3, 2.4, 2.6, 2.7, 2.8 , 2.9, 2.10, 2.11, 2.12, 2.14, 3.1, 3.3, 3.7, 3.10, 3.11, 4.5

### **Related Standards**

7.5aaa, 7.6aaa, 7.6bbb, 7.6ff, 7.6gg, 7.7f, 7.7aaa, 7.7eee, 7.7ff, 7.7h, 7.7I, 7.7j, 7.10aa, 7.10bbb, 7.11aaa, 7.11bbb, 7.12ee, 7.12aaa, 7.12bbb, 7.12eee, 7.16

# **COURSE: EARTH-SPACE SCIENCE - GRADE 9**

## **Unit: Geology**

### **VT Standard 7.15**

Students demonstrate understanding of the earth and its environment, the solar system, and the universe in terms of the systems that characterize them, the forces that affect and shape them

over time, and the theories that currently explain their evolution. This is evident when students:

aaa. Identify, record, model, and explain evidence of change over time;

bbb. Identify evidence of, model, and explain the patterns and forces that shape the earth;

ccc. Identify, model, explain, and analyze the interrelated parts and connections between earth systems.

### **Evidence of Learning**

The student will demonstrate knowledge of:

- Geologic principles of determining relative age - superposition, unconformities, crosscutting relationships.
- Determining relative age - rates of erosion, deposition.
- Dating via glacial varves.
- Radioactive decay.
- Fossil record - formation, interpretation.
- Geologic time scale - divisions of geologic time.
- Movements of continents (covered also in Dynamic Earth) - formation of Pangaea, break-up of Pangaea.
- Geologic history of North American continent.
- Grand Canyon, an in-depth study of its formation.

### **Vital Results**

1.1, 1.2, 1.3, 1.4, 1.8, 1.11, 1.18, 1.19, 1.20, 1.21, 2.1, 2.2, 2.3, 2.4, 2.6, 2.7, 2.8, 2.9, 2.10, 2.11, 2.12, 2.14, 3.1, 3.2, 3.3, 3.7, 3.10, 3.11, 4.5

### **Related Standards**

7.5aaa, 7.6aaa, 7.6bbb, 7.6ff, 7.6gg, 7.7f, 7.7aaa, 7.7eee, 7.7ff, 7.7h, 7.7i, 7.7j, 7.10aa, 7.10bbb, 7.11aaa, 7.11bbb, 7.12ee, 7.12aaa, 7.12bbb, 7.12eee

# **COURSE: BIOLOGY - GRADE 10**

## **Unit: The Living Condition**

### **VT Standard 7.13**

Students understand the characteristics of organisms, see patterns of similarity and differences among living organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:

aaa. Demonstrate understanding of the uniqueness of the cell in different organisms (plants, animals, microorganisms) and the structures and functions of the cell (e.g., chemical reactions, diffusion of materials, direction by DNA of the synthesis of proteins, regulation, differentiation).

### **Evidence of Learning**

The student will:

- Describe the characteristics of life, including cellular organization, metabolism, homeostasis, reproduction, and growth.
- Identify the basic requirements for all living organisms.
- Recognize the uniqueness of viruses with regard to living condition.
- Explain the concept of spontaneous generation.

### **Vital Results**

1.2,1.3,1.13,1.22,2.1

### **Related Standards**

7.11aaa

# **COURSE: BIOLOGY - GRADE 10**

## **Unit: Ecology**

### **VT Standard 7.13**

Students understand the characteristics of organisms, see patterns of similarities and differences among living organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:

bbb. Demonstrate understanding of how biological organisms are classified into a hierarchy of groups and subgroups based upon similarities that reflect their evolutionary relationships (e.g., plants, animals, microorganisms).

### **VT Standard 7.15**

Students demonstrate understanding of the earth and its environment, the solar system, and the universe in terms of the systems that characterize them, the forces that affect and shape them over time, and the theories that currently explain their evolution. This is evident when students

aaa. Identify, record, model, and explain evidence of change over time (e.g., origin and evolution of the earth's biological, ecological, geological systems);

eee. Analyze and explain natural resource management and demonstrate an understanding of the ecological interactions and interdependence between humans and their resource demands on environmental systems (e.g., production, consumption).

### **Evidence of Learning**

The student will:

- Understand the concept of an ecosystem as a unit of the biosphere in which materials cycle and through which energy flows.
- Demonstrate an ability to recognize the major biotic and abiotic components of an ecosystem and the relationships between them.
- Describe the trophic relationships existing among members of a biotic community and the effects of changes in these relationships.
- Recognize the factors involved in the dynamics of populations of living organisms.
- Describe the characteristics of major ecosystem types and the changes involved in biological succession.
- Identify the major biogeochemical cycles and the factors affecting those cycles, as well as the impact that changes in those cycles may have upon living organisms.
- Develop an understanding of the impact human activities may have upon ecosystems.

### **Vital Results**

1.2,1.3,1.4, 1.5, 1.6, 1.8, 1.10,1.13,1.17, 1.18, 1.20, 2.1, 2.2, 2.6, 2.7, 3.5, 3.7, 3.1, 3.13, 4.5

### **Related Standards**

7.5aaa, 7.6bbb, 7.6hh, 7.11aaa, 7.16aaa, 7.19aaa

# **COURSE: BIOLOGY - GRADE 10**

## **Unit: Chemistry of Life**

### **VT Standard 7.12**

Students understand forces and motion, the properties and composition of matter, and energy sources and transformations. This is evident when students:

- aaa. Observe and measure characteristic properties of, and chemical reactions between, one substance and another to distinguish between them; explain the structure of matter using the periodic properties of elements;
- bbb. Demonstrate an understanding of the atomic structure of matter in relationship to the periodic table, bonding, elements and compounds; demonstrate an understanding of the conservation of matter; understand how radioactive elements decay (e.g., half life, alpha and beta emissions);
- ccc. Provide examples of transformations of energy from one form to another; provide examples of conservation of energy; and understand that light and some particles have wave and particle properties (diffraction).

### **VT Standard 7.13**

Students understand the characteristics of organisms, see patterns of similarity and differences among living organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:

- aaa. Demonstrate understanding of the uniqueness of the cell in different organisms (plants, animals, microorganisms) and the structures and functions of the cell (e.g., chemical reactions, diffusion of materials, direction by DNA of the synthesis of proteins, regulation, differentiation).

### **Evidence of Learning**

The student will:

- Differentiate among atoms, ions and molecules.
- Explain simple atomic structure including arrangement in electrons.
- Recognize major groups of elements and general trends in the periodic table.
- Compare and contrast compounds and mixtures.
- Distinguish between physical and chemical reactions.
- Define the types of chemical bonds and the reason for their formation.
- Calculate the relative age of an organic remain using the half-life principle.
- Explain the pH scale and the roles played by acids, bases, and buffers.
- Distinguish between organic and inorganic compounds.
- Explain the solvent properties of water and its importance to the cell.
- Differentiate between monomers and polymers and the formation of each.
- Compare and contrast the four principle types of macromolecules found in cells .
- Explain the structure and functioning of enzymes.
- Comprehend the roles played by organic compounds in a healthy human diet.
- Analyze tests for the identification of macromolecules.
- Recognize the subunits that make up macromolecules.
- Relate the structure of the four principle types of macromolecules to their function.

### **Vital Results**

1.10, 1.17, 2.2, 3.4, 3.10, 3.11

# **COURSE: BIOLOGY - GRADE 10**

## **Unit: Cell Biology**

### **VT Standard 7.13**

Students understand the characteristics of organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:

- aaa. Demonstrate understanding of the uniqueness of the cell in different organisms (plants, animals, microorganisms) and the structures and functions of the cell (e.g., chemical reactions, diffusion of materials, direction by DNA of the synthesis of proteins, regulation, differentiation);
- bbb. Demonstrate understanding of how biological organisms are classified into a hierarchy of groups and subgroups based upon similarities that reflect their evolutionary relationships (e.g., plants, animals, microorganisms).

### **VT Standard 7.14**

Students demonstrate understanding of the human body - heredity, body systems, and individual development - and understand the impact of the environment on the human body.

- aaa. Explain and model how information passed from parents to offspring is coded in DNA molecules (e.g., gene mutations, gene combinations);
- ddd. Identify, explain, and analyze the pattern of human development.

### **Evidence of Learning**

The student will:

- State the parts of the cell theory.
- Identify the contributions of various scientists to the development of the cell theory.
- Compare and contrast various types of cells.
- Identify the major differences between prokaryotes and eukaryotes.
- Explain the importance of surface area-to-volume ratio of cells.
- Describe the benefits and disadvantages of using different types of microscopes.
- Identify that there are specialized parts of the cell and relates the structure of organelles to function.
- Differentiate between diffusion and osmosis.
- Describe isotonic, hypotonic, and hypertonic solutions.
- Predict the direction of water movement through a permeable membrane given the solute concentration on each side.
- Compare and contrast active and passive transport.
- Compare and contrast endocytosis and exocytosis.
- Distinguish between exergonic and endergonic chemical reactions.
- Describe the structure of ATP and how it is used to power chemical reactions.
- Summarize the overall processes of both aerobic and anaerobic respiration.
- Compare the relative efficiencies of aerobic and anaerobic processes.
- Summarize the overall process of photosynthesis.
- Explain the relationship between environmental factors and the rate of photosynthesis.
- Explain the complementary nature of photosynthesis and respiration.
- Describe the general concept of chemosynthesis and its possible role in the origin of life.
- Cite the reasons for the reproduction of cells.
- Contrast sexual and asexual reproduction.
- Describe the forms of asexual reproduction.
- Explain the events occurring during each phase of the cell cycle and how it is regulated.
- Identify and illustrate the events of mitosis and describes the structures involved.
- Recognize chromosome structure and its relationship to mitosis.

- Describe the relationship between cancer and mitosis.
- Compare and contrast mitosis and meiosis.
- Describe changes in chromosome number and structure occurring in meiosis and mitosis.
- Explain the types of errors that may occur in cellular reproduction and their potential effects.
- Identify the early stages of development of a multicellular organism including the zygote, blastula, and gastrula.
- Distinguish between fraternal and identical twins and how they are formed.
- Explain cloning and how it relates to cellular reproduction.

### **Vital Results**

1.2,1.4,1.5,1.8, 1.10, 1.17, 1.18, 1.19, 1.22, 2.1, 2.2, 3.3, 3.6, 3.10, 3.11

### **Related Standards**

7.6aaa, 7.6hh, 7.7eee, 7.11aaa, 7.11eee, 7.12eee

# **COURSE: BIOLOGY - GRADE 10**

## **Unit: Genetics**

### **VT Standard 7.13**

Students understand the characteristics of organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:

- aaa. Demonstrate understanding of the uniqueness of the cell in different organisms (plants, animals, microorganisms) and the structures and functions of the cell (e.g., chemical reactions, diffusion of materials, direction by DNA of the synthesis of proteins, regulation, differentiation).

### **VT Standard 7.14**

Students demonstrate understanding of the human body - heredity, body systems, and individual development - and understand the impact of the environment on the human body.

- aaa. Explain and model how information passed from parents to offspring is coded in DNA molecules (e.g., gene mutations, gene combinations);
- ccc. Analyze and describe how the health of human beings is affected by diseases passed through DNA, environmental factors, and activities that deliberately or inadvertently alter the equilibrium in ecosystems.

### **Evidence of Learning**

The student will:

- Describe Mendel's contributions to genetics through investigating his experimental design.
- Explain Mendel's laws and how they developed from his work.
- Explain how probability is used to predict the results of genetic crosses.
- Use Punnett squares to predict the results of monohybrid and dihybrid crosses.
- Examine inheritance patterns not described by Mendel's model such as incomplete dominance, multiple alleles, sex-linked traits, co-dominance, and sex-influenced traits.
- Interpret pedigrees.
- Cite methods used to study inheritance in populations.
- Distinguish between autosomes and sex chromosomes.
- Explain sex determination in humans.
- Describe relatively common genetic disorders seen in humans, their patterns of inheritance, and methods by which they may be detected.
- Describe the composition and structure of the DNA molecule.
- Recount the various scientists who played key roles in elucidating the material of genes and the structure of DNA.
- Compare the structure, composition, and roles played by DNA and RNA.
- Detail the structures and substances involved and the events occurring during replication, transcription, and translation.
- Determine the amino acid sequence of a polypeptide given the nucleotide sequence in a strand of DNA.
- Describe the mechanisms by which gene expression is controlled.
- Detail the processes involved in forming recombinant DNA.
- Explain the use of restriction enzymes, genetic probes, and electrophoresis in isolating genes.
- Analyze a genetic fingerprint.
- Describe the potential risks and benefits of genetic engineering.

### **Vital Results**

1.3, 1.6, 1.8, 1.13, 1.15, 1.17, 1.18, 1.19, 2.1, 2.3, 3.5.

### **Related Standards**

7.5aaa, 7.6hh, 7.8aaa, 7.9ddd

# **COURSE: BIOLOGY - GRADE 10**

## **Unit: Classification**

### **VT Standard 7.13**

Students understand the characteristics of organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:

- bbb. Demonstrate understanding of how biological organisms are classified into a hierarchy of groups and subgroups based upon similarities that reflect their evolutionary relationships (e.g., plants, animals, microorganisms).

### **Evidence of Learning**

The student will:

- Describe early attempts at classifying organisms.
- Explain the role of Linnaeus in developing the modern system of classification and the factors that led him to design it the way he did.
- Know the levels of the classification hierarchy.
- Explain the scientific system for naming a species.
- Define the term species.
- Compare and contrast the characteristics of the kingdoms of life.
- Describe how modern classification takes evolutionary relationships and other factors into account.
- Use and construct a dichotomous key.

### **Vital Results**

1.10, 3.10, 3.11

# **COURSE: BIOLOGY - GRADE 10**

## **Unit: Evolution**

### **VT Standard 7.13**

Students understand the characteristics of organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:

- bbb. Demonstrate understanding of how biological organisms are classified into a hierarchy of groups and subgroups based upon similarities that reflect their evolutionary relationships (e.g., plants, animals, microorganisms).

### **VT Standard 7.15**

Students demonstrate understanding of the earth and its environment, the solar system, and the universe in terms of the systems that characterize them, the forces that affect and shape them over time, and the theories that currently explain their evolution. This is evident when students:

- aaa. Identify, record, model, and explain evidence of change over time (e.g., origin and evolution of the earth's biological, ecological and geological systems).

### **Evidence of Learning**

The student will:

- Identify possible origins of life on Earth.
- Organize important events in the history of the Earth according to the major geological eras.
- Describe possible means by which early life forms obtained energy and altered the Earth's atmosphere.
- Explain the probability of life existing extra-terrestrially.
- Summarize early attempts to explain the diversity of life on Earth.
- Detail the experiences and influences that led Darwin to develop the concept of evolution by natural selection.
- Describe the process and patterns of natural selection.
- Detail the evidence in support of evolution.
- Compare and contrast Gradualism and Punctuated Equilibrium.
- Explain the relationship between population gene frequencies and the mechanisms by which new species develop.
- Relate the concept of adaptive radiation to the phylogenies of specific groups of organisms.
- Describe the development of the first primates.
- Summarize physical and behavioral characteristics of the primates and the selective pressures, which led to their development.
- Describe the development of bipedalism and the pre-adaptations that enhanced survival of later primates.
- Understand current thought regarding the origins of the hominid line and the relationship of humans to other living primates.
- Describe various hominid species and theories relating to their role in the evolution of our *Homo sapiens*.

### **Vital Results**

1.2, 1.4, 1.6, 1.13, 1.15, 4.5

### **Related Standards**

7.11aaa

# **COURSE: BIOLOGY - GRADE 10**

## **Unit: Microbiology and Fungi**

### **VT Standard 7.13**

Students understand the characteristics of organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:

- aaa. Demonstrate understanding of the uniqueness of the cell in different organisms (plants, animals, microorganisms) and the structures and functions of the cell (e.g., chemical reactions, diffusion of materials, direction by DNA of the synthesis of proteins, regulation, differentiation);
- bbb. Demonstrate understanding of how biological organisms are classified into a hierarchy of groups and subgroups based upon similarities that reflect their evolutionary relationships (e.g., plants, animals, microorganisms).

### **VT Standard 7.14**

Students demonstrate understanding of the human body - heredity, body systems, and individual development - and understand the impact of the environment on the human body. This is evident when students:

- bbb. Demonstrate an understanding that human beings have complex biochemical systems that enable them to function and reproduce (e.g., immunity);
- ccc. Analyze and describe how the health of human beings is affected by diseases passed through DNA, environmental factors, and activities that deliberately or inadvertently alter the equilibrium in ecosystems.

### **Evidence of Learning**

The student will:

- Recount discovery of viruses and early work done with them.
- Explain why viruses are generally not considered as living organisms.
- Describe the structure and composition of viral particles.
- Compare and contrast the various types of viruses and their modes of infection.
- Identify diseases caused by viruses.
- Cite the components of the human immune response to viral infection.
- Know treatment used for viral infections.
- Describe the structure of the HIV virus, its mode of infection, the symptoms it may result in, and the way in which it may avoid destruction by the human immune system.
- Understand how epidemiologists track disease transmission.
- Explain the ways in which viruses may be used in biotechnology.
- Recount the discovery of bacteria and the scientists involved in those efforts.
- Contrast between prokaryotic and eukaryotic cells.
- Cite the characteristics of Kingdom Monera and its member groups.
- Describe the role bacteria and their relatives may have played in the early history of life on Earth.
- Differentiate between archebacteria and eubacteria.
- Identify bacteria by shape and arrangement.
- Describe the cellular structure of bacteria.
- Identify the different ways in which bacteria meet their energy needs.
- Describe the conditions favorable for bacterial growth.
- Explain bacterial reproduction and the methods by which they may exchange genetic material.

- Recount the discovery of antibiotics and problems associated with the development of antibiotic resistance in bacteria.
- Cite the methods of destroying bacteria or minimizing their reproduction.
- Describe the way in which bacteria may be employed in biotechnology.
- Identify the unifying features of members of Kingdom Protista.
- Describe the development of eukaryotic features and the hypothetical phylogeny of this group.
- Describe the environments where protists thrive.
- Compare and contrast asexual and sexual reproduction in protists.
- Differentiate between protozoa and algae.
- Describe the general characteristics of the four major groups of protozoa.
- Identify a variety of protists.
- Compare and contrast algal groups.
- Discuss uses of and diseases caused by protists.
- Explain the ecological roles played by protists.
- Relate the role that protists played in the evolution of more complex forms of life.
- Identify the characteristics of members of the Kingdom Fungi.
- Describe how fungi reproduce and obtain nutrients.
- Explain the ecological roles played by fungi.
- Identify members of the major fungal groups.
- Discuss diseases caused by fungal organisms.

#### **Vital Results**

1.2, 1.6, 1.8, 1.10, 1.18, 1.19, 2.1, 2.7, 2.11, 3.3, 3.5, 3.7, 3.10, 3.11, 3.12, 3.14, 4.5

#### **Related Standards**

7.18aaa, 7.18dd

# **COURSE: BIOLOGY - GRADE 10**

## **Unit: Zoology**

### **VT Standard 7.13**

Students understand the characteristics of organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:

- aaa. Demonstrate understanding of the uniqueness of the cell in different organisms (plants, animals, microorganisms) and the structures and functions of the cell (e.g., chemical reactions, diffusion of materials, direction by DNA of the synthesis of proteins, regulation, differentiation);
- bbb. Demonstrate understanding of how biological organisms are classified into a hierarchy of groups and subgroups based upon similarities that reflect their evolutionary relationships (e.g., plants, animals, microorganisms);
- ddd. Explain and justify how natural selection and its evolutionary consequences provide a scientific explanation for the fossil record of ancient life forms.

### **VT Standard 7.14**

Students demonstrate understanding of the human body - heredity, body systems, and individual development - and understand the impact of the environment on the human body. This is evident when students:

- bbb. Demonstrate an understanding that human beings have complex biochemical systems that enable them to function and reproduce (e.g., immunity);
- ccc. Analyze and describe how the health of human beings is affected by diseases passed through DNA, environmental factors, and activities that deliberately or inadvertently alter the equilibrium in ecosystems.

### **Evidence of Learning**

The student will:

- Describe the general characteristics of members of the Kingdom Animalia.
- Explain the evolution of early animal groups.
- Differentiate between Protostomes and Deuterostomes.
- Define and give examples of animals with asymmetrical, radial, bilateral, and spherical body arrangements.
- Compare and contrast the body structure and function of sponges, cnidarians, flatworms, mollusks, annelids, arthropods, echinoderms, and chordates.
- Relate structural adaptations to the phylogeny of animal groups.
- Describe the ecological roles played by members of each group.
- Describe the characteristics of vertebrates.
- Compare and contrast general anatomy and physiology of fishes, amphibians, reptiles, birds and mammals.

### **Vital Results**

1.2,1.4, 1.6, 1.13, 1.15, 1.18, 1.19, 2.1, 3.10, 4.5

### **Related Standards**

7.1aaa, 7.13aaa,

# **COURSE: BIOLOGY - GRADE 10**

## **Unit: Botany**

### **VT Standard 7.13**

Students understand the characteristics of organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:

- aaa. Demonstrate understanding of the uniqueness of the cell in different organisms (plants, animals, microorganisms) and the structures and functions of the cell (e.g., chemical reactions, diffusion of materials, direction by DNA of the synthesis of proteins, regulation, differentiation);
- bbb. Demonstrate understanding of how biological organisms are classified into a hierarchy of groups and subgroups based upon similarities that reflect their evolutionary relationships (e.g., plants, animals, microorganisms);
- ddd. Explain and justify how natural selection and its evolutionary consequences provide a scientific explanation for the fossil record of ancient life forms.

### **Evidence of Learning**

The student will:

- Describe the adaptations developed by early land plants that were lacking in algae.
- Compare and contrast vascular and nonvascular plants.
- Explain the reasons for the success of seed plants.
- Compare and contrast gymnosperms and angiosperms.
- Discuss the evolutionary significance of angiosperms.
- Describe seed structure.
- Compare and contrast monocots and dicots.
- Identify the parts of the flower and the role each part plays in development of seeds and fruits.
- Describe the structure and function of the parts of roots, stems, and leaves.
- Compare herbaceous and woody plants.
- Infer the age and environmental conditions from the cross section of a tree.
- Describe the ecological roles and uses of plants.

### **Vital Results**

1.2,1.4, 1.6, 1.13, 1.15, 1.18, 1.19, 2.1, 3.10, 4.5

### **Related Standards**

7.11aaa, 7.12eee, 7.16aaa

# **COURSE: BIOLOGY - GRADE 10**

## **Unit: Human Biology**

### **VT Standard 7.13**

Students understand the characteristics of organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:

- aaa. Demonstrate understanding of the uniqueness of the cell in different organisms (plants, animals, microorganisms) and the structures and functions of the cell (e.g., chemical reactions, diffusion of materials, direction by DNA of the synthesis of proteins, regulation, differentiation);
- ccc. Describe, model, and explain the principles of the interdependence of all systems that support life (e.g., flow of energy, ecosystems, life cycles, cooperation and competition, human population impacts on the world ecological system), and apply them to local, regional, and global systems;
- ddd. Explain and justify how natural selection and its evolutionary consequences provide a scientific explanation for the fossil record of ancient life forms.

### **VT Standard 7.14**

Students demonstrate understanding of the human body - heredity, body systems, and individual development - and understand the impact of the environment on the human body. This is evident when students:

- aaa. Explain and model how information passed from parents to offspring is coded in DNA molecules (e.g., gene mutations, gene combinations);
- bbb. Demonstrate an understanding that human beings have complex biochemical systems that enable them to function and reproduce (e.g., immunity);
- ddd. Identify, explain, and analyze the pattern of human development.

### **Evidence of Learning**

The student will:

- Compare and contrast the human body plan with other vertebrates.
- Identify the characteristics and functions of basic tissue types.
- Describe the function of each organ system.
- Identify the major components of the skin, musculo-skeletal, circulatory, respiratory, digestive, excretory, nervous, endocrine and reproductive systems.
- Explain the overall functioning of each of the body systems.
- Recognize the causes and effects of common diseases and disorders of individual body systems.

### **Vital Results**

1.2,1.3,1.6, 1.10, 1.13, 1.15, 1.18, 1.19, 2.1, 2.2, 2.3, 3.4, 3.5, 3.7, 3.10, 3.11, 3.14, 3.15, 4.5

### **Related Standard**

7.11aaa

# **COURSE: HUMAN PHYSIOLOGY - GRADES 11/12**

## **Unit: Introduction**

### **VT Standard 7.13**

Students understand the characteristics of organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:

- aaa. Demonstrate understanding of the uniqueness of the cell in different organisms (plants, animals, microorganisms) and the structures and functions of the cell (e.g., chemical reactions, diffusion of materials, direction by DNA of the synthesis of proteins, regulation, differentiation).

### **VT Standard 7.14**

Students demonstrate understanding of the human body - heredity, body systems, and individual development - and understand the impact of the environment on the human body. This is evident when students:

- bbb. Demonstrate an understanding that human beings have complex biochemical systems that enable them to function and reproduce (e.g., immunity).

### **Evidence of Learning**

The student will:

- Recognize that scientists build upon the earlier work of other scientists.
- Recount the developments leading to the evolution of modern medicine.
- Describe how observations of the structure of the human body led to the discovery of the function of organ systems.
- Cite how normal functioning of the human body relies upon maintenance of homeostasis.
- Explain that physicians and other health professionals practice a code of ethics when treating patients.
- Describe the concept of holistic medicine.
- Explain how solving one medical problem may present others.

### **Vital Results**

1.1,1.2,1.3,1.4, 2.7, 2.9, 3.4

### **Related Standard**

7.11aaa

# **COURSE: HUMAN PHYSIOLOGY - GRADES 11/12**

## **Unit: Epithelial Tissues**

### **VT Standard 7.13**

Students understand the characteristics of organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:

- aaa. Demonstrate understanding of the uniqueness of the cell in different organisms (plants, animals, microorganisms) and the structures and functions of the cell (e.g., chemical reactions, diffusion of materials, direction by DNA of the synthesis of proteins, regulation, differentiation).

### **VT Standard 7.14**

Students demonstrate understanding of the human body - heredity, body systems, and individual development - and understand the impact of the environment on the human body. This is evident when students:

- aaa. Explain and model how information passed from parents to offspring is coded in DNA molecules (e.g., gene mutations, gene combinations);
- ccc. Analyze and describe how the health of human beings is affected by diseases passed through DNA, environmental factors, and activities that deliberately or inadvertently alter the equilibrium in ecosystems;
- ddd. Identify, explain, and analyze the pattern of human development.

### **Evidence of Learning**

The student will:

- Identify major epithelial cell types.
- Describe the functions of cell types.
- Name the three layers of skin and describe the functions of each.
- Explain the origin of epithelial tissues, hair, and nails.
- Explain the function and biochemical nature of skin pigmentation.
- Describe common skin disorders, their causes and treatments.

### **Vital Results**

1.2, 1.3, 2.2, 3.4, 3.5, 3.7, 3.9

### **Related Standards**

7.11aaa, 7.11bbb

# **COURSE: HUMAN PHYSIOLOGY - GRADES 11/12**

## **Unit: The Musculo-Skeletal System**

### **VT Standard 7.14**

Students demonstrate understanding of the human body - heredity, body systems, and individual development - and understand the impact of the environment on the human body. This is evident when students:

- bbb. Demonstrate an understanding that human beings have complex biochemical systems that enable them to function and reproduce (e.g., immunity);
- ccc. Analyze and describe how the health of human beings is affected by diseases passed through DNA, environmental factors, and activities that deliberately or inadvertently alter the equilibrium in ecosystems;
- ddd. Identify, explain, and analyze the pattern of human development.

### **Evidence of Learning**

The student will:

- Describe the structure of bones.
- Recount the cellular elements of the skeletal system.
- Detail the development of the human skeleton.
- Identify the bones, which comprise the human skeletal system.
- Identify the connective tissue elements of the skeletal system.
- Describe the types of joints and their function.
- Identify disorders of the skeletal system and their treatment.
- Explain the role of diet and exercise in maintaining the health of the skeletal system.
- Compare and contrast the three types of muscle.
- Identify the major muscles of the body and their origins and insertions.
- Explain the chemical nature of muscle contraction.
- Discuss the importance of exercise in increasing endurance and maintaining muscle strength.
- Identify disorders of muscle tissue and their treatment.

### **Vital Results**

1.3, 1.17, 2.1, 2.5, 3.5

### **Related Standard**

7.11bbb

# **COURSE: HUMAN PHYSIOLOGY - GRADES 11/12**

## **Unit: The Nervous System**

### **VT Standard 7.14**

Students demonstrate understanding of the human body - heredity, body systems, and individual development - and understand the impact of the environment on the human body. This is evident when students:

- bbb. Demonstrate an understanding that human beings have complex biochemical systems that enable them to function and reproduce (e.g., immunity);
- ccc. Analyze and describe how the health of human beings is affected by diseases passed through DNA, environmental factors, and activities that deliberately or inadvertently alter the equilibrium in ecosystems;
- ddd. Identify, explain, and analyze the pattern of human development.

### **Evidence of Learning**

The student will:

- Describe the structure and function of a neuron.
- Explain the biochemical events involved in conduction of a nerve impulse.
- Recognize the importance of myelin sheaths.
- Identify the components of the central nervous system.
- Name the major regions of the brain and explain their functions.
- Describe the peripheral nervous system.
- Distinguish between the different types of neurons.
- Explain a motor reflex.
- Compare and contrast voluntary and involuntary reactions.
- Distinguish between the sympathetic and parasympathetic nervous system.
- Describe the structure and functioning of sensory organs.
- Cite common disorders of the nervous system and their causes.
- Recognize the effects of certain substances on the nervous system.
- Explain the neurological basis of pain.
- Explain how narcotics can cause addiction.

### **Vital Results**

1.2, 1.3, 2.1, 2.2, 3.4, 3.5, 3.7

### **Related Standard**

7.11bbb

# **COURSE: HUMAN PHYSIOLOGY - GRADES 11/12**

## **Unit: The Digestive System and Nutrition**

### **VT Standard 7.13**

Students understand the characteristics of organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:

- aaa. Demonstrate understanding of the uniqueness of the cell in different organisms (plants, animals, microorganisms) and the structures and functions of the cell (e.g., chemical reactions, diffusion of materials, direction by DNA of the synthesis of proteins, regulation, differentiation).

### **VT Standard 7.14**

Students demonstrate understanding of the human body - heredity, body systems, and individual development - and understand the impact of the environment on the human body. This is evident when students:

- aaa. Explain and model how information passed from parents to offspring is coded in DNA molecules (e.g., gene mutations, gene combinations);
- ccc. Analyze and describe how the health of human beings is affected by diseases passed through DNA, environmental factors, and activities that deliberately or inadvertently alter the equilibrium in ecosystems;
- ddd. Identify, explain, and analyze the pattern of human development.

### **Evidence of Learning**

The student will

- Name the structures of the digestive system.
- Describe how the body uses carbohydrates, lipids, and proteins.
- Explain what essential amino acids are.
- Identify the roles of individual vitamins and trace elements.
- Trace the path of food through the digestive tract.
- Describe the major digestive processes that occur at different points in digestion.
- Explain the role of the liver and pancreas in digestion.
- Detail how and where nutrients are absorbed.
- Identify the role of individual digestive enzymes.
- Explain the symptoms, causes, and treatments of common digestive disorders.

### **Vital Results**

1.2, 1.3, 1.4, 1.18, 1.19, 1.20, 2.2, 3.4, 3.5, 3.7, 3.10

### **Related Standards**

7.11aaa, 7.11bbb

# **COURSE: HUMAN PHYSIOLOGY - GRADES 11/12**

## **Unit: The Respiratory and Circulatory Systems**

### **VT Standard 7.13**

Students understand the characteristics of organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:

- aaa. Demonstrate understanding of the uniqueness of the cell in different organisms (plants, animals, microorganisms) and the structures and functions of the cell (e.g., chemical reactions, diffusion of materials, direction by DNA of the synthesis of proteins, regulation, differentiation).

### **VT Standard 7.14**

Students demonstrate understanding of the human body - heredity, body systems, and individual development - and understand the impact of the environment on the human body. This is evident when students:

- aaa. Explain and model how information passed from parents to offspring is coded in DNA molecules (e.g., gene mutations, gene combinations);
- bbb. Demonstrate an understanding that human beings have complex biochemical systems that enable them to function and reproduce (e.g., immunity);
- ccc. Analyze and describe how the health of human beings is affected by diseases passed through DNA, environmental factors, and activities that deliberately or inadvertently alter the equilibrium in ecosystems;
- ddd. Identify, explain, and analyze the pattern of human development.

### **Evidence of Learning**

The student will:

- Name the structures of the respiratory system.
- Explain how oxygen and carbon dioxide are transported in the blood.
- Explain the mechanism by which breathing is regulated.
- Relate changes in gas pressure to respiratory function.
- Associate lung capacity with respiratory health.
- Describe common respiratory disorders, their causes and treatment.
- Identify the functions of the circulatory system.
- Compare and contrast the structure and function of arteries, capillaries, and veins.
- State the function of the lymphatic system.
- Identify the elements of blood and their functions.
- Describe pulmonary and systemic circulation.
- Trace the path of blood flow through the heart.
- Explain disorders of the circulatory system, their causes and treatment.

### **Vital Results**

1.2, 1.3, 1.4, 1.8, 1.18, 1.19, 1.20, 3.4, 3.5, 3.7, 3.9

### **Related Standards**

7.11aaa, 7.11bbb

# **COURSE: HUMAN PHYSIOLOGY - GRADES 11/12**

## **Unit: The Excretory System**

### **VT Standard 7.13**

Students understand the characteristics of organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:

- aaa. Demonstrate understanding of the uniqueness of the cell in different organisms (plants, animals, microorganisms) and the structures and functions of the cell (e.g., chemical reactions, diffusion of materials, direction by DNA of the synthesis of proteins, regulation, differentiation).

### **VT Standard 7.14**

Students demonstrate understanding of the human body - heredity, body systems, and individual development - and understand the impact of the environment on the human body. This is evident when students:

- bbb. Demonstrate an understanding that human beings have complex biochemical systems that enable them to function and reproduce (e.g., immunity);
- ccc. Analyze and describe how the health of human beings is affected by diseases passed through DNA, environmental factors, and activities that deliberately or inadvertently alter the equilibrium in ecosystems.

### **Evidence of Learning**

The student will:

- Use scientific methods to describe, investigate, and explain phenomena and raise questions.
- Demonstrate understanding that analysis of systems is important to define and control inputs and outputs.
- Demonstrate understanding that systems are effectively designed when specifications and constraints are understood; systems are optimized when efficiencies are maximized; and a system is never 100 percent efficient (entropy).
- Demonstrate understanding of the uniqueness of the cell in different organisms (plants, animals, microorganisms) and the structures and functions of the cell (e.g., chemical reactions, diffusion of materials, direction by DNA of the synthesis of proteins, regulation, differentiation).
- Demonstrate an understanding that human beings have complex biochemical systems that enable them to function and reproduce (e.g., immunity).
- Analyze and describe how the health of human beings is affected by diseases passed through DNA, environmental factors, and activities that deliberately or inadvertently alter the equilibrium in ecosystems.

### **Essential Science Principles**

- Names the structures of the excretory system
- Identifies the forms of wastes produced by humans and how they are eliminated
- Details the parts of the kidney and explains how urine is formed
- Describes the dynamics of kidney function as it relates to water balance
- Traces the flow of urine from its production to elimination
- Describes the major digestive processes that occur at different points in digestion
- Identifies the role of hormones on kidney function
- Explains the symptoms, causes, and treatments of common excretory disorders
- Describes the events occurring during kidney dialysis

### **Vital Results**

1.2, 1.3, 1.4, 1.18, 1.19, 1.20, 2.2, 3.4, 3.5, 3.7, 3.10

### **Related Standards**

7.11aaa, 7.11bbb

# **COURSE: HUMAN PHYSIOLOGY - GRADES 11/12**

## **Unit: The Endocrine System**

### **VT Standard 7.13**

Students understand the characteristics of organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:

- aaa. Demonstrate understanding of the uniqueness of the cell in different organisms (plants, animals, microorganisms) and the structures and functions of the cell (e.g., chemical reactions, diffusion of materials, direction by DNA of the synthesis of proteins, regulation, differentiation).

### **VT Standard 7.14**

Students demonstrate understanding of the human body - heredity, body systems, and individual development - and understand the impact of the environment on the human body. This is evident when students:

- bbb. Demonstrate an understanding that human beings have complex biochemical systems that enable them to function and reproduce (e.g., immunity);
- ccc. Analyze and describe how the health of human beings is affected by diseases passed through DNA, environmental factors, and activities that deliberately or inadvertently alter the equilibrium in ecosystems.

### **Evidence of Learning**

The student will:

- Identify the major endocrine glands of the body, the hormones produced by each, and the action of the individual hormones.
- Compare the action of hormones with electrochemical signals of the nervous system.
- Explain the role of the hypothalamus in the regulation of hormones.
- Compare peptide and steroid hormones.
- Identify endocrine disorders, their symptoms and treatment.

### **Vital Results**

1.2, 1.3, 2.2, 2.3, 3.4, 3.5, 3.6, 3.7, 3.9

### **Related Standards**

7.11aaa, 7.11bbb, 7.18dd

# **COURSE: HUMAN PHYSIOLOGY - GRADES 11/12**

## **Unit: Reproduction and Development**

### **VT Standard 7.13**

Students understand the characteristics of organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:

- aaa. Demonstrate understanding of the uniqueness of the cell in different organisms (plants, animals, microorganisms) and the structures and functions of the cell (e.g., chemical reactions, diffusion of materials, direction by DNA of the synthesis of proteins, regulation, differentiation).

### **VT Standard 7.14**

Students demonstrate understanding of the human body - heredity, body systems, and individual development - and understand the impact of the environment on the human body. This is evident when students:

- aaa. Explain and model how information passed from parents to offspring is coded in DNA molecules (e.g., gene mutations, gene combinations);
- bbb. Demonstrate an understanding that human beings have complex biochemical systems that enable them to function and reproduce (e.g., immunity);
- ccc. Analyze and describe how the health of human beings is affected by diseases passed through DNA, environmental factors, and activities that deliberately or inadvertently alter the equilibrium in ecosystems.

### **Evidence of Learning**

The student will:

- Describe the structure of gametes and tell how each type is adapted for its function.
- Describe the structure and function of testes and ovaries.
- Trace the path of sperm from the testes to the outside of the body.
- Trace the path of an ovum from the ovary to the uterus.
- Differentiate between oogenesis and spermatogenesis.
- Relate the occurrence of the ovarian cycle to the hypothalamus.
- Compare the hormonal changes occurring during ovulation and pregnancy.
- Discuss the cellular changes subsequent to fertilization.
- Describe the primary events occurring during fetal development.
- Explain the relationship between environmental factors and fetal development.
- Describe reproductive disorders and their symptoms.
- Explain the effects of sexually transmitted diseases.

### **Vital Results**

1.2, 1.3, 1.4, 1.18, 1.19, 1.20, 3.4, 3.5, 3.7, 3.8, 3.9

### **Related Standards**

7.11aaa, 7.11bbb

# **COURSE: HUMAN PHYSIOLOGY - GRADES 11/12**

## **Unit: The Immune System**

### **VT Standard 7.13**

Students understand the characteristics of organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:

- aaa. Demonstrate understanding of the uniqueness of the cell in different organisms (plants, animals, microorganisms) and the structures and functions of the cell (e.g., chemical reactions, diffusion of materials, direction by DNA of the synthesis of proteins, regulation, differentiation).

### **VT Standard 7.14**

Students demonstrate understanding of the human body - heredity, body systems, and individual development - and understand the impact of the environment on the human body. This is evident when students:

- aaa. Explain and model how information passed from parents to offspring is coded in DNA molecules (e.g., gene mutations, gene combinations);
- bbb. Demonstrate an understanding that human beings have complex biochemical systems that enable them to function and reproduce (e.g., immunity);
- ccc. Analyze and describe how the health of human beings is affected by diseases passed through DNA, environmental factors, and activities that deliberately or inadvertently alter the equilibrium in ecosystems.

### **Evidence of Learning**

The student will:

- Describe the body's lines of defense against infection from a foreign particle.
- Recognize the four main types of immune system cells.
- Compare and contrast the roles of T and B cells in the immune response.
- Explain how immunity may be conferred.
- Describe autoimmune diseases and how they function.
- Explain the role of biotechnology in fighting viral and autoimmune disease.

### **Vital Results**

1.2, 1.3, 1.4, 1.5, 1.6, 1.8, 1.18, 1.19, 1.20, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9

### **Related Standards**

7.11aaa, 7.11bbb, 7.18aaa

# **COURSE: CHEMISTRY - GRADES 11/12**

## **Unit: The Science of Chemistry**

### **VT Standard 7.12**

Students understand forces and motion, the properties and composition of matter, and energy sources and transformations. This is evident when students:

- aaa. Observe and measure characteristic properties of, and chemical reactions between, one substance and another to distinguish between them; explain the structure of matter using the periodic properties of elements;
- bbb. Demonstrate an understanding of the atomic structure of matter in relationship to the periodic table, bonding, elements and compounds; demonstrate an understanding of the conservation of matter; understand how radioactive elements decay (e.g., half life, alpha and beta emissions);
- eee. Provide examples of transformations of energy from one form to another; provide examples of conservation of energy; and understand that light and some particles have wave and particle properties.

### **Evidence of Learning**

The student will:

- Recognize properties and states of matter.
- Recognize chemical change and express in word equations.
- Define endothermic and exothermic.
- Operate a Bunsen burner and centigram balance.
- Define mass, weight, and volume.
- Define density, use density formula, interpret graph of mass vs. volume.
- Create outline for classification of matter.
- Describe classes of compounds and mixtures.
- Learn basic SI units and conversions.

### **Vital Results**

1.3, 1.6, 1.8, 1.13, 1.15, 1.17, 1.20, 2.1, 2.2, 2.3, 2.5, 2.6-2.9, 3.3, 3.10-3.12

### **Related Standards**

7.6gg, 7.6hh, 7.7ddd, 7.7ff

# **COURSE: CHEMISTRY - GRADES 11/12**

## **Unit: Matter and Energy**

### **VT Standard 7.12**

Students understand forces and motion, the properties and composition of matter, and energy sources and transformations. This is evident when students:

- aaa. Observe and measure characteristic properties of, and chemical reactions between, one substance and another to distinguish between them; explain the structure of matter using the periodic properties of elements;
- bbb. Demonstrate an understanding of the atomic structure of matter in relationship to the periodic table, bonding, elements and compounds; demonstrate an understanding of the conservation of matter; understand how radioactive elements decay (e.g., half life, alpha and beta emissions);
- eee. Provide examples of transformations of energy from one form to another; provide examples of conservation of energy; and understand that light and some particles have wave and particle properties.

### **Evidence of Learning**

The student will:

- Distinguish between potential and kinetic energy.
- Define and differentiate between heat and temperature.
- Define, understand, and use specific heat capacity.
- Describe relationship between energy and mass.
- Learn care and use of thermometers.
- Explain the purpose of controls in experiments.
- Distinguish between hypotheses, theories, and laws.
- Recognize conservation of mass in chemical changes.
- Define and differentiate between accuracy and precision.
- Define and use significant figures.
- Understand and use scientific notations.

### **Vital Results**

1.3, 1.6, 1.8, 1.13, 1.15, 1.17, 1.20, 2.1, 2.2, 2.3, 2.5, 2.6-2.9, 3.3, 3.10-3.12

### **Related Standards**

7.6gg, 7.6hh, 7.7ddd, 7.7ff

# **COURSE: CHEMISTRY - GRADES 11/12**

## **Unit: Atomic Structure and Electronic Configuration**

### **VT Standard 7.12**

Students understand forces and motion, the properties and composition of matter, and energy sources and transformations. This is evident when students:

- aaa. Observe and measure characteristic properties of, and chemical reactions between, one substance and another to distinguish between them; explain the structure of matter using the periodic properties of elements;
- bbb. Demonstrate an understanding of the atomic structure of matter in relationship to the periodic table, bonding, elements and compounds; demonstrate an understanding of the conservation of matter; understand how radioactive elements decay (e.g., half life, alpha and beta emissions);
- eee. Provide examples of transformations of energy from one form to another; provide examples of conservation of energy; and understand that light and some particles have wave and particle properties;
- fff. Understand that alternating magnetic fields generate electric fields, and vice versa; discuss electromagnetic waves.

### **Evidence of Learning**

The student will:

- Describe how scientists probed the atom.
- Know three laws that support the atom's existence.
- Compare the Dalton, Rutherford, and Bohr models of the atom
- Calculate the mass of an atom in amu and grams.
- Learn the structure of the atom, including protons, neutrons, electrons, and isotopes.
- Define mass number and atomic number.
- Learn properties of light and its relationship to atomic theory.
- Demonstrate proficiency in flame testing and determining the identity of an unknown element.
- Learn pattern of electrons filling orbitals and energy levels.

### **Vital Results**

1.3, 1.6, 1.8, 1.13, 1.15, 1.17, 1.20, 2.1, 2.2, 2.3, 2.5, 2.6-2.9, 3.3, 3.10-3.12

### **Related Standards**

7.6ggg, 7.6hh, 7.7ddd, 7.7ff

# **COURSE: CHEMISTRY - GRADES 11/12**

## **Unit: The Periodic Table**

### **VT Standard 7.12**

Students understand forces and motion, the properties and composition of matter, and energy sources and transformations. This is evident when students:

- aaa. Observe and measure characteristic properties of, and chemical reactions between, one substance and another to distinguish between them; explain the structure of matter using the periodic properties of elements;
- bbb. Demonstrate an understanding of the atomic structure of matter in relationship to the periodic table, bonding, elements and compounds; demonstrate an understanding of the conservation of matter; understand how radioactive elements decay (e.g., half life, alpha and beta emissions);
- eee. Provide examples of transformations of energy from one form to another; provide examples of conservation of energy; and understand that light and some particles have wave and particle properties;
- fff. Understand that alternating magnetic fields generate electric fields, and vice versa; discuss electromagnetic waves.

### **Evidence of Learning**

The student will:

- Describe the history of the periodic table.
- Recognize the organization of the modern periodic table.
- Learn the trends in properties of the elements related to the periodic table and relate to atomic structure.
- Distinguish between natural and synthetic elements.

### **Vital Results**

1.3, 1.6, 1.8, 1.13, 1.15, 1.17, 1.20, 2.1, 2.2, 2.3, 2.5, 2.6-2.9, 3.3, 3.10-3.12

### **Related Standards**

7.6hh, 7.8bb

# **COURSE: CHEMISTRY - GRADES 11/12**

## **Unit: Ionic Compounds**

### **VT Standard 7.12**

Students understand forces and motion, the properties and composition of matter, and energy sources and transformations. This is evident when students:

- aaa. Observe and measure characteristic properties of, and chemical reactions between, one substance and another to distinguish between them; explain the structure of matter using the periodic properties of elements;
- bbb. Demonstrate an understanding of the atomic structure of matter in relationship to the periodic table, bonding, elements and compounds; demonstrate an understanding of the conservation of matter; understand how radioactive elements decay (e.g., half life, alpha and beta emissions);
- eee. Provide examples of transformations of energy from one form to another; provide examples of conservation of energy; and understand that light and some particles have wave and particle properties.

### **Evidence of Learning**

The student will:

- Recognize, name, and write formulas for cations, anions, polyatomic ions and binary compounds.
- Describe the nature of ionic bonding and crystal structure.
- Describe the properties of binary ionic compounds.
- Describe the energy changes associated with forming salts.
- Assign oxidation numbers to elements in compounds and ions.
- Describe electron configurations of elemental ions.
- Define hydrate and determine percent water in a given hydrate.

### **Vital Results**

1.3, 1.6, 1.8, 1.13, 1.15, 1.17, 1.20, 2.1, 2.2, 2.3, 2.5, 2.6-2.9, 3.3, 3.10-3.12

### **Related Standards**

7.6gg, 7.6hh, 7.8bb, 7.10aa

# **COURSE: CHEMISTRY - GRADES 11/12**

## **Unit: Covalent Bonds and Molecular Forces**

### **VT Standard 7.12**

Students understand forces and motion, the properties and composition of matter, and energy sources and transformations. This is evident when students:

- aaa. Observe and measure characteristic properties of, and chemical reactions between, one substance and another to distinguish between them; explain the structure of matter using the periodic properties of elements;
- bbb. Demonstrate an understanding of the atomic structure of matter in relationship to the periodic table, bonding, elements and compounds; demonstrate an understanding of the conservation of matter; understand how radioactive elements decay (e.g., half life, alpha and beta emissions);
- eee. Provide examples of transformations of energy from one form to another; provide examples of conservation of energy; and understand that light and some particles have wave and particle properties.

### **Evidence of Learning**

The student will:

- Describe how covalent bonds form.
- Compare polar and nonpolar covalent bonds.
- Use electronegativity differences to determine bond type.
- Draw Lewis dot structures.
- Predict molecular shape based on Lewis structure and VSEPR theory.
- Associate polarity of molecules with shape.
- Relate boiling points to shapes and polarities.
- Describe types of intermolecular forces.
- Describe effects of hydrogen bonds on melting and boiling points.

### **Vital Results**

1.3, 1.6, 1.8, 1.13, 1.15, 1.17, 1.20, 2.1, 2.2, 2.3, 2.5, 2.6-2.9, 3.3, 3.10-3.12

### **Related Standards**

7.6gg, 7.6hh, 7.8bb, 7.10aa

# **COURSE: CHEMISTRY - GRADES 11/12**

## **Unit: Carbon and Organic Compounds**

### **VT Standard 7.12**

Students understand forces and motion, the properties and composition of matter, and energy sources and transformations. This is evident when students:

- aaa. Observe and measure characteristic properties of, and chemical reactions between, one substance and another to distinguish between them; explain the structure of matter using the periodic properties of elements;
- bbb. Demonstrate an understanding of the atomic structure of matter in relationship to the periodic table, bonding, elements and compounds; demonstrate an understanding of the conservation of matter; understand how radioactive elements decay (e.g., half life, alpha and beta emissions).

### **Evidence of Learning**

The student will:

- Describe the bonding properties of carbon.
- Recognize and draw structural formulas for isomers of alkanes, alkenes, and alkynes.
- Relate structures of allotropes to properties of carbon.
- Name and draw structural formulas for simple organic compounds.
- Describe how polymers form.
- Describe properties of different polymer types.

### **Vital Results**

1.3, 1.6, 1.8, 1.13, 1.15, 1.17, 1.20, 2.1, 2.2, 2.3, 2.5, 2.6-2.9, 3.3, 3.10-3.12

### **Related Standards**

7.6hh, 7.7j

# **COURSE: CHEMISTRY - GRADES 11/12**

## **Unit: The Mole**

### **VT Standard 7.12**

Students understand forces and motion, the properties and composition of matter, and energy sources and transformations. This is evident when students:

- aaa. Observe and measure characteristic properties of, and chemical reactions between, one substance and another to distinguish between them; explain the structure of matter using the periodic properties of elements;
- bbb. Demonstrate an understanding of the atomic structure of matter in relationship to the periodic table, bonding, elements and compounds; demonstrate an understanding of the conservation of matter; understand how radioactive elements decay (e.g., half life, alpha and beta emissions).

### **Evidence of Learning**

The student will:

- Define the mole.
- Use the periodic table to determine relative atomic mass.
- Use relative atomic mass to determine molar mass.
- Use the factor label method to convert grams to moles, moles to grams.
- Use molar masses to determine percent composition, given a formula.
- Determine an empirical formula, given percent composition.
- Determine an empirical formula from laboratory procedures and data.

### **Vital Results**

1.3, 1.6, 1.8, 1.13, 1.15, 1.17, 1.20, 2.1, 2.2, 2.3, 2.5, 2.6-2.9, 3.3, 3.10-3.12

### **Related Standards**

7.6bbb, 7.6gg, 7.7j, 7.10aa

# **COURSE: CHEMISTRY - GRADES 11/12**

## **Unit: Chemical Equations**

### **VT Standard 7.12**

Students understand forces and motion, the properties and composition of matter, and energy sources and transformations. This is evident when students:

- aaa. Observe and measure characteristic properties of, and chemical reactions between, one substance and another to distinguish between them; explain the structure of matter using the periodic properties of elements;
- bbb. Demonstrate an understanding of the atomic structure of matter in relationship to the periodic table, bonding, elements and compounds; demonstrate an understanding of the conservation of matter; understand how radioactive elements decay (e.g., half life, alpha and beta emissions).

### **Evidence of Learning**

The student will:

- Translate word equations into formula equations.
- Distinguish between coefficients and subscripts in writing equations.
- Balance chemical equations.
- Interpret equations in terms of ratios and energy terms.
- Calculate energy changes using mole ratios and enthalpies.
- Define and recognize basic chemical reaction types.
- Identify unknown ions by comparison of precipitation reactions.

### **Vital Results**

1.3, 1.6, 1.8, 1.13, 1.15, 1.17, 1.20, 2.1, 2.2, 2.3, 2.5, 2.6, 2.9, 3.3

### **Related Standards**

7.6gg, 7.6hh, 7.7ddd, 7.7ff7.10aa

# **COURSE: CHEMISTRY - GRADES 11/12**

## **Unit: Stoichiometry**

### **VT Standard 7.12**

Students understand forces and motion, the properties and composition of matter, and energy sources and transformations. This is evident when students:

- aaa. Observe and measure characteristic properties of, and chemical reactions between, one substance and another to distinguish between them; explain the structure of matter using the periodic properties of elements;
- bbb. Demonstrate an understanding of the atomic structure of matter in relationship to the periodic table, bonding, elements and compounds; demonstrate an understanding of the conservation of matter; understand how radioactive elements decay (e.g., half life, alpha and beta emissions);
- ccc. Quantitatively apply ideal gas laws; understand concept of gas density.

### **Evidence of Learning**

The student will:

- Recognize and use mass relationships represented in chemical equations.
- Use mole ratios and molar masses to solve stoichiometric problems.
- Expand use of conversion factors in stoichiometry to include gas properties.
- Identify and use concept of limiting reactants.
- Determine percent yield in a chemical reaction.

### **Vital Results**

1.3, 1.6, 1.8, 1.13, 1.15, 1.17, 1.20, 2.1, 2.2, 2.3, 2.5, 2.6, 2.9, 3.3, 3.10, 3.12

### **Related Standards**

7.6bbb, 7.6hh, 7.7ddd, 7.7ff, 7.8cc, 7.10aa

# **COURSE: CHEMISTRY - GRADES 11/12**

## **Unit: Causes of Change**

### **VT Standard 7.12**

Students understand forces and motion, the properties and composition of matter, and energy sources and transformations. This is evident when students:

- aaa. Observe and measure characteristic properties of, and chemical reactions between, one substance and another to distinguish between them; explain the structure of matter using the periodic properties of elements;
- bbb. Demonstrate an understanding of the atomic structure of matter in relationship to the periodic table, bonding, elements and compounds; demonstrate an understanding of the conservation of matter; understand how radioactive elements decay (e.g., half life, alpha and beta emissions);
- ccc. Quantitatively apply ideal gas laws; understand concept of gas density;
- eee. Provide examples of transformations of energy from one form to another; provide examples of conservation of energy; and understand that light and some particles have wave and particle properties.

### **Evidence of Learning**

The student will:

- Define and calculate molar heat capacity from data.
- Describe and calculate temperature and enthalpy changes when substances are heated.
- Calculate molar enthalpy from laboratory data.
- Describe melting and boiling point curves and their significance.
- Define entropy and recognize increases and decreases in entropy.
- Describe effects of melting and boiling on enthalpy and entropy.
- Describe the link between nutrition and calorimetry.
- Define molar heat of fusion and molar heat of vaporization.

### **Vital Results**

1.3, 1.6, 1.8, 1.13, 1.15, 1.17, 1.20, 2.1, 2.2, 2.3, 2.5, 2.5, 2.6, 2.9, 3.3, 3.10, 3.12

### **Related Standards**

7.6bbb, 7.6hh, 7.7ddd, 7.7ff, 7.7j, 7.8cc, 7.10aa

# **COURSE: CHEMISTRY - GRADES 11/12**

## **Unit: Gases and Liquids**

### **VT Standard 7.12**

Students understand forces and motion, the properties and composition of matter, and energy sources and transformations. This is evident when students:

- aaa. Observe and measure characteristic properties of, and chemical reactions between, one substance and another to distinguish between them; explain the structure of matter using the periodic properties of elements;
- bbb. Demonstrate an understanding of the atomic structure of matter in relationship to the periodic table, bonding, elements and compounds; demonstrate an understanding of the conservation of matter; understand how radioactive elements decay (e.g., half life, alpha and beta emissions);
- ccc. Quantitatively apply ideal gas laws; understand concept of gas density;
- eee. Provide examples of transformations of energy from one form to another; provide examples of conservation of energy; and understand that light and some particles have wave and particle properties.

### **Evidence of Learning**

The student will:

- Describe the general properties of gases.
- Relate the kinetic-molecular theory to the properties of ideal gases.
- Define and use the relationship between pressure and volume for gases.
- Define and use Dalton's Law of Partial Pressures.
- Define and use the relationship between volume and temperature for gases.
- Define and use the combined gas law.
- Identify conditions for less than ideal behavior for gases.
- Interpret a phase diagram.
- Define boiling point in terms of vapor pressure.

### **Vital Results**

1.3, 1.6, 1.8, 1.13, 1.15, 1.17, 1.20, 2.1, 2.2, 2.3, 2.5, 2.5, 2.6, 2.9, 3.3, 3.10, 3.12

### **Related Standards**

7.6bbb, 7.6gg, 7.6hh, 7.7ddd, 7.7ff, 7.7j, 7.8cc, 7.10aa

# **COURSE: CHEMISTRY - GRADES 11/12**

## **Unit: Solutions**

### **VT Standard 7.12**

Students understand forces and motion, the properties and composition of matter, and energy sources and transformations. This is evident when students:

- aaa. Observe and measure characteristic properties of, and chemical reactions between, one substance and another to distinguish between them; explain the structure of matter using the periodic properties of elements;
- bbb. Demonstrate an understanding of the atomic structure of matter in relationship to the periodic table, bonding, elements and compounds; demonstrate an understanding of the conservation of matter; understand how radioactive elements decay (e.g., half life, alpha and beta emissions).

### **Evidence of Learning**

The student will:

- Distinguish among solutions, suspensions and colloids.
- Explain the role of solute and solvent.
- Define molarity.
- Solve molarity problems.
- Describe techniques for separation of mixtures into components.
- Describe effects of temperature on solution rate and solubility.
- Relate how molecular polarity affects solubility.
- Define weak and strong electrolytes.
- Define and represent the hydronium ion with a formula.
- Define and describe colligative properties, qualitatively and quantitatively.
- Compare and contrast roles of emulsifiers and surfactants.
- Explain hard water and detergent use.

### **Vital Results**

1.3, 1.6, 1.8, 1.13, 1.15, 1.17, 1.20, 2.1, 2.2, 2.3, 2.5, 2.5, 2.6, 2.9, 3.3, 3.10, 3.12

### **Related Standards**

7.6bbb, 7.6gg, 7.6hh, 7.7ddd, 7.7ff, 7.7j, 7.8cc, 7.10aa

# **COURSE: CHEMISTRY - GRADES 11/12**

## **Unit: Chemical Equilibrium**

### **VT Standard 7.12**

Students understand forces and motion, the properties and composition of matter, and energy sources and transformations. This is evident when students:

- aaa. Observe and measure characteristic properties of, and chemical reactions between, one substance and another to distinguish between them; explain the structure of matter using the periodic properties of elements;
- bbb. Demonstrate an understanding of the atomic structure of matter in relationship to the periodic table, bonding, elements and compounds; demonstrate an understanding of the conservation of matter; understand how radioactive elements decay (e.g., half life, alpha and beta emissions).

### **Evidence of Learning**

The student will:

- Distinguish between reactions that go to completion and those that reach equilibrium.
- Define chemical equilibrium.
- Predict effects of stress on equilibrium systems using Le Chatelier's Principle.
- Represent equilibrium constant expressions using concentrations or pressures of reactants and products at equilibrium.
- Calculate equilibrium constants, given concentrations.
- Interpret solubility based on the value of the solubility product constant.

### **Vital Results**

1.3, 1.6, 1.8, 1.13, 1.15, 1.17, 1.20, 2.1, 2.2, 2.3, 2.5, 2.5, 2.6, 2.9, 3.3, 3.10, 3.12

### **Related Standards**

7.6bbb, 7.6gg, 7.6hh, 7.7ddd, 7.7ff, 7.7j, 7.8bb, 7.8cc, 7.10aa

# **COURSE: CHEMISTRY - GRADES 11/12**

## **Unit: Acids and Bases**

### **VT Standard 7.12**

Students understand forces and motion, the properties and composition of matter, and energy sources and transformations. This is evident when students:

- aaa. Observe and measure characteristic properties of, and chemical reactions between, one substance and another to distinguish between them; explain the structure of matter using the periodic properties of elements;
- bbb. Demonstrate an understanding of the atomic structure of matter in relationship to the periodic table, bonding, elements and compounds; demonstrate an understanding of the conservation of matter; understand how radioactive elements decay (e.g., half life, alpha and beta emissions).

### **Evidence of Learning**

The student will:

- Recognize and describe the properties of strong and weak acids and bases.
- Explain the conductivity of acids and bases.
- Describe and explain the concept of titration.
- Define the ion product constant of water and use it to determine the concentration of hydronium or hydroxide ions.
- State the Bronsted-Lowery definition of acids and bases.
- Differentiate among mono-, di-, and triprotic acids.
- Write equations showing reactions of amphoteric substances.
- Identify conjugate acid / base pairs.
- Perform calculations using the equilibrium constant of an acid.
- Define pH.
- Understand the relationship between pH and the hydronium ion concentration.
- Describe methods of measuring pH.
- Define buffers and describe how buffers resist pH change.

### **Vital Results**

1.3, 1.6, 1.8, 1.13, 1.15, 1.17, 1.20, 2.1, 2.2, 2.3, 2.5, 2.5, 2.6, 2.9, 3.3, 3.10, 3.12

### **Related Standards**

7.6bbb, 7.6gg, 7.6hh, 7.7ddd, 7.7ff, 7.7j, 7.8bb, 7.8cc, 7.10aa

# **COURSE: CHEMISTRY - GRADES 11/12**

## **Unit: Reaction Rates**

### **VT Standard 7.12**

Students understand forces and motion, the properties and composition of matter, and energy sources and transformations. This is evident when students:

- aaa. Observe and measure characteristic properties of, and chemical reactions between, one substance and another to distinguish between them; explain the structure of matter using the periodic properties of elements;
- bbb. Demonstrate an understanding of the atomic structure of matter in relationship to the periodic table, bonding, elements and compounds; demonstrate an understanding of the conservation of matter; understand how radioactive elements decay (e.g., half life, alpha and beta emissions).

### **Evidence of Learning**

The student will:

- Describe reaction rate in terms of reactant disappearance or product appearance.
- Describe the effect of temperature on reaction rate.
- Describe the effect of concentration on reaction rate.
- Describe the effect of surface area on reaction rate.
- Describe the effect of catalysts on rate.
- Define activation of energy and describe how a catalyst affects activation energy.
- Explain the mechanism of enzyme action in terms of bonds and energy
- Define and give an example of an inhibitor.

### **Vital Results**

1.3, 1.6, 1.8, 1.13, 1.15, 1.17, 1.20, 2.1, 2.2, 2.3, 2.5, 2.5, 2.6, 2.9, 3.3, 3.10, 3.12

### **Related Standards**

7.6bbb, 7.6gg, 7.6hh, 7.7ddd, 7.7ff, 7.7j, 7.8bb, 7.8cc, 7.10aa

# **COURSE: CHEMISTRY - GRADES 11/12**

## **Unit: Electrochemistry**

### **VT Standard 7.12**

Students understand forces and motion, the properties and composition of matter, and energy sources and transformations. This is evident when students:

- aaa. Observe and measure characteristic properties of, and chemical reactions between, one substance and another to distinguish between them; explain the structure of matter using the periodic properties of elements;
- bbb. Demonstrate an understanding of the atomic structure of matter in relationship to the periodic table, bonding, elements and compounds; demonstrate an understanding of the conservation of matter; understand how radioactive elements decay (e.g., half life, alpha and beta emissions);
- eee. Provide examples of transformations of energy from one form to another; provide examples of conservation of energy; and understand that light and some particles have wave and particle properties.

### **Evidence of Learning**

The student will:

- Describe the relationship between voltage and current.
- Convert voltage and convert to energy.
- Distinguish between anodic and cathodic reactions.
- Define electrode, anode, and cathode.
- Explain the difference between electrolytic, galvanic and equilibrium cells.
- Recognize oxidation / reduction reactions.
- Determine the relative strengths of oxidizing and reducing agents.
- Explain how reactions can be driven by electrolytic cells.
- Describe the electrolytic processes.
- Describe the conditions leading to corrosion and ways to prevent it.
- Predict the direction of cell reactions and explain reactions in terms of electron transfers using standard electrode potentials.

### **Vital Results**

1.3, 1.6, 1.8, 1.13, 1.15, 1.17, 1.20, 2.1, 2.2, 2.3, 2.5, 2.5, 2.6, 2.9, 3.3, 3.10, 3.12

### **Related Standards**

7.6bbb, 7.6gg, 7.6hh, 7.7ddd, 7.7ff, 7.7j, 7.8bb, 7.8cc, 7.10aa

# **COURSE: PHYSICS - GRADE 12**

## **Unit: Motion, Force, Energy, and Momentum**

### **VT Standard 7.12**

Students understand forces and motion, the properties and composition of matter, and energy sources and transformations. This is evident when students:

- d. Apply forces to objects (e.g. inertia, gravity, friction, push and pull), and observe the objects in motion;
- dd. Observe and demonstrate a qualitative understanding of the relationship between mass, the magnitude of an applied net force, and the resulting change in speed and direction;
- ddd. Use Newton's laws to explain quantitatively the effects of applied forces; observe, explain, and model object motion in a plane; qualitatively investigate conservation of momentum as it relates to collisions, and investigate the mechanics of rolling motion;
- e. Identify and describe several common forms of energy (e.g. light, heat, and sound) and provide examples of sources, as well as some characteristics of the transmission (e.g. light travels in straight lines until it is reflected, refracted, or absorbed);
- ee. Identify and describe common forms of energy (e.g. light, heat, sound, electricity, electromagnetic waves) and their attributes, sources, and transmission characteristic (e.g. radiation, convection, conduction of heat);
- eee. Provide examples of transformations of energy from one form to another; provide examples of conservation of energy; and understand that light and some particles have wave and particle properties (diffraction).

### **VT Standard 7.15**

Students demonstrate understanding of the earth and its environment, the solar system, and the universe in terms of the systems that characterize them, the forces that affect and shape them over time, and the theories that currently explain their evolution. This is evident when students:

- d. Identify and record characteristics of our solar system (e.g. nine planets, order from sun, and movement of planets in relationship to the sun and moon; calendar);
- dd. Identify, record, model, and explain the relationship of our solar system to the universe (day, year, season; sun, stars, galaxies; gravity, energy, orbits; planet characteristics);
- ddd. Identify, model, and explain the position of our solar system in the universe relative to distance and time (stars and star systems, fusion, instrumentation, and simulations; the universe as a hierarchy of interrelated systems);
- f. Explain how modern view of the universe emerged (e.g. scientific theories, improved instrumentation);
- ff. Explain the emergence of modern views of the universe (past, present and future scientific theories).

### **Evidence of Learning**

The student will:

- Describe uniform motion graphically qualitatively using the equation  $s = vt$ .
- Understand how uniformly accelerated motion differs from uniform motion.
- Learn equations for accelerated motion, and how to apply them in different situations.
- Learn the techniques of area finding and slope-finding as they apply to motion graphs.
- Understand when to apply “tangent to curve” technique to find instantaneous velocity.
- Understand instantaneous velocity using the “limit” concept.
- Learn the difference between vector quantities and scalar quantities.
- Describe vector diagrams in terms of components and resultant; use scale properly.
- Recognize that energy can be transformed from one type to another, and one place to another.

- List a wide variety of examples in which Law of Conservation of Energy apply.
- Demonstrate in the lab that work is done when a force acts through a distance.
- Calculate Input and Output values for work and energy.
- Compare changes in potential energy to changes in kinetic energy.
- Calculate, using equations for PE and KE.
- Recognize that relativistic mass is a different number than rest mass, and that mass depends on relative velocity.
- Recognize that Einstein's interpretation broadens the Energy Conservation Law to include mass as well.
- Perform basic relativistic calculations.
- Examine the difference between "force causes motion" and "force causes acceleration."
- State Newton's Laws of Motion, and be able to identify them in action, from a broad variety of examples.
- Recognize weight as a force, and distinguish weight from mass.
- Solve problems using  $F = ma$ , with emphasis on the overall, or "net" force.
- Understand the meaning of "g" at surface of Earth and elsewhere.
- Recognize that, in a system of two bodies, the action/reaction pair of forces act on different bodies.
- Recognize what is meant by a frame of reference (observer: stationary frame).
- Recognize a limitation of Newton's Laws: they are valid in "inertial" reference frame (non-accelerated).
- Derive the "impulse = change in momentum" relationship from Newton's Second Law.
- Recognize that Force can now be defined as the time rate of change of momentum, or the derivative of momentum.
- Calculate using the Conservation of Momentum principle; two objects, linear motion.
- Demonstrate momentum conservation in the lab, for motions in both one and two planes.
- Solve problems using the " $p$  (before) =  $p$  (after)" method.
- Identify the center of mass of a uniform linear object (rod), or a more complicated object.
- Identify the moving center of mass of two objects before and after their collision.
- Identify collisions that are "elastic" (no lost KE), as well as "inelastic" (some KE lost to heat or permanent deformation).
- Recognize the Conservation Laws (Energy and Momentum) as fundamental, and applicable to modern as well as classical physics.
- Understand that the curved path of a projectile is the result of the force of gravity continually acting on it.
- Map out the entire path of a projectile, given initial conditions.
- Understand orbital motion as a special type of projectile motion.
- Demonstrate that constant force perpendicular to instantaneous velocity causes circular motion.
- Recognize that centripetal acceleration is directed toward the center of a circle, as is the force, which caused the acceleration.
- Note that gravitational force often acts as centripetal force (e.g. planetary motion).
- Recognize that Kepler's Laws of Planetary Motion act as a precursor to Newton's Law of Universal Gravitation.
- Calculate the mass of a central object, which has one or more satellites orbiting about it.
- Be able to quickly calculate the gravitational force on an object that is moving away from a much more massive object, using the inverse square relationship between force and distance.
- Understand the concept of the gravitational field surrounding a massive object, and its relationship to acceleration.
- Distinguish between "apparent weight" and actual weight, especially for objects in orbit.

### **Vital Results**

1.1, 1.2, 1.3, 1.4, 1.6, 1.8, 1.10, 1.11, 1.13, 1.15, 1.17, 1.18, 1.19, 1.20, 1.21, 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9, 2.10, 2.11, 2.12, 3.3, 3.10, 3.11, 3.15

### **Related Standards**

7.5a, 7.5aa, 7.6a, b, c, d, e, f, g, h, 7.6aa, bb, cc, ff, gg, hh, 7.6aaa, bbb, 7.7a, g, 7.7cc, dd, ee, ff, 7.7aaa, bbb, ccc, ddd, 7.8b, c, e, 7.8aa, bb, cc, 7.8aaa, bbb, ccc, ddd, 7.9a, b, 7.10a, b, c, d, e, f, g, 7.10aa, bb, cc, dd, ee, 7.10bbb, 7.11a, b, c, aa

# **COURSE: PHYSICS - GRADE 12**

## **Unit: Waves, Sound, and Light**

### **VT Standard 7.12**

Students understand forces and motion, the properties and composition of matter, and energy sources and transformations. This is evident when students:

- d. Apply forces to objects (e.g. inertia, gravity, friction, push and pull), and observe the objects in motion;
- dd. Observe and demonstrate a qualitative understanding of the relationship between mass, the magnitude of an applied net force, and the resulting change in speed and direction;
- ddd. Use Newton's laws to explain quantitatively the effects of applied forces; observe, explain, and model object motion in a plane; qualitatively investigate conservation of momentum as it relates to collisions, and investigate the mechanics of rolling motion;
- e. Identify and describe several common forms of energy (e.g. light, heat, and sound) and provide examples of sources, as well as some characteristics of the transmission (e.g. light travels in straight lines until it is reflected, refracted, or absorbed);
- eee. Provide examples of transformations of energy from one form to another; provide examples of conservation of energy; and understand that light and some particles have wave and particle properties (diffraction).

### **Evidence of Learning**

The student will:

- Understand that the restoring force in SHM is proportional to distance.
- Recognize Hooke's Law as a special case of Newton's 2<sup>nd</sup> Law.
- Distinguish between period and frequency.
- Note the connections among linear, circular, and vibrating motion.
- Solve problems involving position and velocity of vibrating motion, using sine and cosine functions.
- Understand the relationship between KE and PE in vibrating motion.
- Develop clear understanding of basic terminology: wavelength, frequency, period, amplitude, angular frequency, phase, interference, reflection, refraction, diffraction.
- Predict period of pendulum or spring by using period equation.
- Recognize that all of the various types of waves are propagations of a disturbance.
- Note difference between longitudinal and transverse waves.
- Understand how wave speed is affected by density of medium.
- Understand that waves transmit energy.
- Be able to solve problems using the velocity = wavelength X frequency equation.
- Demonstrate, using a diagram, how superposition allows waves to be added.
- Understand interference in the context of superposition.
- Be able to recognize a standing wave, and to identify the nodes or nodal lines.
- Understand the connection between pitch and frequency.
- Recognize that sound will travel through matter of different phases, but not a vacuum.
- Understand how sounding boards and boxes can amplify sound.
- Be able to explain the phenomenon of beats.
- Recognize the phenomenon of resonance, and understand that it depends on the concept of the natural frequency of an object.
- Understand the decibel scale as a power of ten scale, and be able to use a table of decibel values.
- Describe color in terms of wavelength or frequency.
- Understand a light ray as the direction of propagation of the light wave.
- Recognize that the bending of light or other waves around obstacles is dependent on wavelength.

- Understand that the angle of incidence for light reflected from a smooth surface is equal to the angle of reflection.
- Understand refraction as a consequence of change of speed of light.
- Be able to use Snell's Law to find the critical angle for a pair of substances.
- Understand that the lenses are based on the principle of refraction of light.
- Be able to find focal lengths of lenses and curved mirrors.
- Understand the difference between real and virtual images.
- Understand Young's experiment in the context of the wave model of light.
- Be able to relate interference patterns in a ripple tank to patterns for light.
- Recognize diffraction as an effect due to interference.
- Understand diffraction and interference as common wave phenomena that occur in water waves, sound waves, visible light waves, and electromagnetic waves other than visible light.
- Recognize that light reflected off a boundary can undergo a  $180^\circ$  phase change, equivalent to additional  $\frac{1}{2} \lambda$  of path difference.
- Understand how a Michelson interferometer uses path and interference fringes to make measurements.
- Understand how diffraction gratings, spectroscopes, and spectrometers can make sharp spectral lines that can be understood as resulting from constructive interference.
- Be able to explain polarization of light.

### **Vital Results**

1.2, 1.3, 1.6, 1.8, 1.13, 1.15, 1.17, 1.18, 1.20, 1.22,2.1-2.3, 2.5-2.9, 3.3, 3.10, 3.11

### **Related Standards**

7.6a, b, c, d, e, f, g, 7.6aa, bb, cc, dd, ee, ff, gg, 7.6aaa, bbb, 7.7a, b, d, e, f, g, h, I, j, 7.7cc, dd, ee, ff, 7.6aaa, bbb, ccc, ddd, 7.9a, b, 7.10a, b, c, d, 7.10aa, bb, cc, dd, 7.11a

# **COURSE: PHYSICS - GRADE 12**

## **Unit: Electricity, Magnetism, and E-M Radiation**

### **VT Standard 7.12**

Students understand forces and motion, the properties and composition of matter, and energy sources and transformations. This is evident when students:

- ddd. Use Newton's laws to explain quantitatively the effects of applied forces; observe, explain, and model object motion in a plane; qualitatively investigate conservation of momentum as it relates to collisions, and investigate the mechanics of rolling motion;
- f. Observe and record the effects of electric charge (e.g. charges repel, batteries); investigate magnetic and non-magnetic materials, and materials that are conductors and non-conductors of electricity;
- ff. Investigate the relationship between electricity and magnetism (e.g., in electric motors);
- fff. Understand that alternating magnetic fields generate electric fields, and vice versa (e.g. radio waves, x-rays).

### **Evidence of Learning**

The student will:

- Distinguish between charges at rest and charges in motion.
- Be able to give evidence to support the idea of different types of charge.
- Understand why conductors allow charges to flow more easily than insulators.
- Understand the reason that a Faraday cage limits excess charge to the outside of the cage.
- Relate Coulomb's Law to the Law of Universal Gravitation.
- Recognize that there is a fundamental amount of charge, and that we normally encounter integer multiples of that amount.
- Understand that current can refer to the movement of electrons in wires, as well as the movement of ions in solution.
- Understand that pressure difference in a fluid system is analogous to voltage difference in an electrical system.
- Be able to construct circuits and make measurements with voltmeters and ammeters.
- Understand the concept of resistance as both a way to limit the current by allowing electrical energy to dissipate as heat and as the ratio of voltage to current.
- Understand how Joule's Law relates resistance, power, and current.
- Perform experiments in which mechanical energy changes can be compared to electrical energy changes.
- Be able to apply Ohm's Law to series and parallel circuits.
- Understand the difference between resistance and resistivity.
- Understand the meaning of electric field both as space around a charged object and as a ratio of force per charge.
- Recognize that voltage must decrease as one moves away from the source of the charge.
- Understand the device called the capacitor as an application of our understanding of the field.
- Understand how capacitors are used in circuits, and the difference encountered when they are wired in a series as compared to parallel.
- Understand how resistors are used in circuits, and the difference encountered when they are wired in a series as compared to parallel.
- Be able to solve problems, on paper and with breadboard circuits, in which combinations of resistors are used.
- Understand that charge is a conserved quantity.
- Recognize that voltmeters and ammeters (analog type) rely on the magnetic effect of moving charges to produce a force proportional to the current or voltage.
- Understand that charged particles moving in a magnetic field can be deflected.
- Be able to solve for the strength of a magnetic field by understanding that it depends on the force per moving charge.

- Recognize that the Earth's magnetic field can be drawn as field lines, with directionality, on and within the globe.
- Understand that a voltage can be induced in a conductor that is moved across a magnetic field.
- Understand Lenz's Law as a consequence of the Law of Conservation of Energy.
- Understand the principles governing the operation of motors, generators, and transformers.
- Understand that electric power is the product of voltage and current.
- Recognize power outputs of primary and secondary coils as the result of energy conservation.
- Be able to determine that electromagnetic induction takes place only when a voltage is changing.
- Understand why transformers are used to send electric energy long distances over transmission lines.
- Understand how coils used in AC circuits can be described in terms of their inductance, reactance, resistance, and impedance.
- Examine the characteristics of solid-state diodes in circuits.
- Understand the concept of rectification at both the circuit and the semi-conductor junction levels.
- Understand how a transistor can amplify a current.
- Understand the basic structure of an IC.
- Recognize IC's in circuit boards of calculators and computers.
- Understand that electric oscillations are analogous to mechanical oscillations of a spring.
- Use LC circuits to produce electric oscillations.
- Understand that a changing electric field (such as produced by an AC circuit) can give rise to a changing magnetic field, and vice versa.
- Understand how the interaction between electric and magnetic fields can produce a self-propagating wave, with no need for a medium, and with no loss of energy through empty space.

### **Vital Results**

1.2, 1.3, 1.6, 1.8, 1.13, 1.15, 1.17, 1.18, 1.20, 1.22, 2.1-2.3, 2.5-2.9, 3.3, 3.10

### **Related Standards**

7.6a, b, c, d, e, f, g, h, 7.6aa, bb, cc, dd, ee, ff, gg, 7.7a, b, c, d, e, f, g, h, j, 7.8b, c, e, 7.8bb, cc, 7.8bbb, ccc, ddd, 7.9a, b, 7.10a, b, c, d, e, f, 7.10bb, cc, dd, 7.11a, 7.17a, b, c, 7.18a, b, c, d, 7.19a, b, 7.19aa, bb, 7.19aaa, bbb

# **COURSE: BIOLOGY II - GRADE 12**

## **Unit: Chemistry of Life**

### **VT Standard 7.12**

Students understand forces and motion, the properties and composition of matter, and energy sources and transformations. This is evident when students:

- aaa. Observe and measure characteristic properties of, and chemical reactions between, one substance and another to distinguish between them; explain the structure of matter using the periodic properties of elements;
- bbb. Demonstrate an understanding of the atomic structure of matter in relationship to the periodic table, bonding, elements and compounds; demonstrate an understanding of the conservation of matter; understand how radioactive elements decay (e.g., half life, alpha and beta emissions);
- eee. Provide examples of transformations of energy from one form to another; provide examples of conservation energy; and understand that light and some particles have wave and particle properties (diffraction).

### **VT Standard 7.13**

Students understand the characteristics of organisms, see patterns of similarity and differences among living organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:

- aa. Identify, model, and explain the structure and function (e.g. cells, tissues, organs, systems) of organisms, both as individual entities and as components of larger systems;
- ccc. Describe, model, and explain the principles of the interdependence of all systems that support life.

### **Evidence of Learning**

The student will:

- Understand the principles of general chemistry.
- Understand that living things are open energy systems.
- Understand that increasing levels of organization and complexity yield “emergent properties” associated with life.
- Understand that polarity of water molecules results in hydrogen bonding.
- Understand that organisms depend on the properties of water.
- Consider evolution in relation to the fitness of the environment.
- Understand the general principles of organic chemistry.
- Understand carbon atoms as versatile building blocks, variations in carbon skeletons and isomers.
- Recognize the functional groups, hydroxyl, carbonyl, carboxyl, amino, sulfhydryl, and phosphate.
- Understand life’s metabolic pathways, metabolic regulatory systems and structural organization.
- Understand life’s energy transformations and the laws of thermodynamics.
- Understand the chemistry of enzymes.

### **Vital Results**

1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.8, 1.10, 1.13, 1.14, 1.15, 1.17, 1.20, 1.21, 1.22

### **Related Standards**

7.11aa, bb, cc, 7.11aaa

# **COURSE: BIOLOGY II - GRADE 12**

## **Unit: Structure and Function of Cells**

### **VT Standard 7.13**

Students understand the characteristics of organisms, see patterns of similarity and differences among living organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:

- aa. Identify, model, and explain the structure and function (e.g. cells, tissues, organs, systems) of organisms, both as individual entities and as components of larger systems;
- aaa. Demonstrate understanding of the uniqueness of the cell in different organisms (plants, animals, microorganisms) and the structures and functions of the cell (e.g. chemical reactions, diffusion of materials, direction by DNA of the synthesis of proteins, regulation, differentiation).

### **Evidence of Learning**

The student will:

- Survey cell organelles, structure and function.
- Compare cellular organization of plants and animals.
- Understand that the cell is a living unit greater than the sum of its parts.
- Understand the upper and lower limits to cell size.
- Use the technology and techniques of microscopy.
- Understand the cell membrane and the physics and chemistry of cell transport, diffusion, osmosis, active and passive transport.
- Understand the structure and function of transport proteins.
- Understand the historical perspective on the development of the fluid mosaic model of membrane structure.

### **Vital Results**

1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.8, 1.10, 1.13, 1.14, 1.15, 1.17, 1.18, 1.19, 1.20, 1.21, 1.22, 2.1, 2.2, 2.3

### **Related Standards**

7.6aaa, bbb, ff, gg, hh, i, j

# **COURSE: BIOLOGY II - GRADE 12**

## **Unit: The Reproduction of Cells**

### **VT Standard 7.13**

Students understand the characteristics of organisms, see patterns of similarity and differences among living organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:

- aa. Identify, model, and explain the structure and function (e.g. cells, tissues, organs, systems) of organisms, both as individual entities and as components of larger systems;
- aaa. Demonstrate understanding of the uniqueness of the cell in different organisms (plants, animals, microorganisms) and the structures and functions of the cell (e.g. chemical reactions, diffusion of materials, direction by DNA of the synthesis of proteins, regulation, differentiation).

### **VT Standard 7.14**

Students demonstrate understanding of the human body – heredity, body systems, and individual development – and understand the impact of the environment on the human body. This is evident when students:

- aa. Explain and model how information passed from parents to offspring is coded in DNA molecules (e.g. gene mutations, gene combinations);
- bb. Demonstrate an understanding that human beings have complex biochemical systems that enable them to function and reproduce;
- cc. Analyze and describe how the health of human beings is affected by disease passed through DNA, environmental factors, and activities that deliberately or inadvertently alter the equilibrium in ecosystems.

### **Evidence of Learning**

The student will:

- Understand cell division in functions in reproduction, growth and repair.
- Understand mitosis, genome of eukaryotes, stages of cell division.
- Understand cytokinesis.
- Understand internal and external cues for the control of cell division.
- Compare cancer to normal cell division.
- Understand meiosis.
- Compare asexual and sexual reproduction.
- Understand three sexual life cycles: sexual, asexual, and alternation of generations.
- Understand genetic variation and sexual life cycles (independent assortment, crossing over, and random fertilization).
- Understand evolutionary adaptation and cellular reproduction.

### **Vital Results**

1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.8, 1.10, 1.13, 1.14, 1.15, 1.17, 1.18, 1.19, 1.20, 1.21, 1.22, 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.9, 2.14, 3.10

### **Related Standards**

7.6aaa, bbb, ff, gg, hh, i, j

# **COURSE: BIOLOGY II - GRADE 12**

## **Unit: Independent Research Project**

### **VT Standard 7.13**

Students understand the characteristics of organisms, see patterns of similarity and differences among living organisms, understand the role of evolution, and recognize the interdependence of all systems that support life.

### **Evidence of Learning**

The student will:

- Demonstrate principles of the scientific method.
- Integrate many branches of specialized science and mathematics in solving problems in biology.

### **Vital Results**

1.5, 1.6, 1.8, 1.17, 1.18, 1.19, 1.20, 1.21, 1.22, 2.2, 2.3, 2.4, 2.7, 2.8, 2.9, 2.10, 2.11, 2.12, 2.13, 2.14, 3.1, 3.2, 3.7, 3.14

### **Related Standards**

1.6aa, 1.8g, h, 1.17aa, bb, cc, aaa, bbb, ccc, dd, 2.2aa, bb, cc, dd, ee, aaa, 2.3aa, bb, aaa, bbb, c, 2.4a, b, c, d, e, f, 2.14a, b, c, 3.7c, d, e, f, cc, 3.14b, dd

# **COURSE: BIOLOGY II - GRADE 12**

## **Unit: Cellular Respiration and Photosynthesis**

### **VT Standard 7.13**

Students understand the characteristics of organisms, see patterns of similarity and differences among living organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:

- bbb. Demonstrate understanding of how biological organisms are classified into a hierarchy of groups and subgroups based upon similarities that reflect their evolutionary relationships (e.g. plants, animals, microorganisms).

### **Evidence of Learning**

The student will:

- Understand cellular respiration and photosynthesis as the primary energy yielding pathways in living things.
- Give an evolutionary overview of cellular respiration, fermentation, and photosynthesis.
- Compare the structure and function of mitochondria and chloroplasts.
- Understand redox reactions from released energy when electrons move closer to electronegative atoms.
- Understand glycolysis, Krebs cycle, and electron transport.
- Understand that catabolism/anabolism and that respiration has connections to many metabolic pathways.
- Understand photosynthesis as a redox process.
- Describe photosynthesis, light reactions, and Calvin Cycle.
- Describe the pigments of photosynthesis.
- Understand photosystems I and II.

### **Vital Results**

1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.8, 1.10, 1.13, 1.14, 1.15, 1.17, 1.18, 1.19, 1.20, 1.21, 1.22, 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.9, 2.14, 3.10

### **Related Standards**

7.11a, bb, cc, aaa, bbb, 7.12ee, bbb, eee

# **COURSE: BIOLOGY II - GRADE 12**

## **Unit: Molecular Basis of Inheritance, Gene Expression, and Biotechnology**

### **VT Standard 7.13**

Students understand the characteristics of organisms, see patterns of similarity and differences among living organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:

- bbb. Demonstrate understanding of how biological organisms are classified into a hierarchy of groups and subgroups based upon similarities that reflect their evolutionary relationships (e.g. plants, animals, microorganisms);
- ccc. Describe, model, and explain the principles of the interdependence of all systems that support life (e.g. flow of energy, ecosystems, life cycles, cooperation and competition, human population impacts on the world ecological system), and apply to local, regional, and global systems; and
- ddd. Explain and justify how natural selection and its evolutionary consequences provide a scientific explanation for the fossil record of ancient life forms.

### **VT Standard 7.14**

Students demonstrate understanding of the human body – heredity, body systems, and individual development – and understand the impact of the environment on the human body. This is evident when students:

- aa. Explain and model how information passed from parents to offspring is coded in DNA molecules (e.g. gene mutations, gene combinations);
- bb. Demonstrate an understanding that human beings have complex biochemical systems that enable them to function and reproduce;
- cc. Analyze and describe how the health of human beings is affected by disease passed through DNA, environmental factors, and activities that deliberately or inadvertently alter the equilibrium in ecosystems;
- dd. Identify, explain, and analyze the pattern of human development.

### **Evidence of Learning**

The student will:

- Understand the search for genetic material that led to DNA.
- Understand evidence that DNA can transform bacteria.
- Understand that viral DNA can transform cells.
- Understand the evidence that DNA is the genetic material in cells.
- Recognize the significance of a common genetic language.
- Understand DNA structure and replication.
- Understand enzymes that proofread DNA and control mutations.
- Understand DNA/RNA and protein synthesis, transcription and translation.
- Understand how genes control metabolism.
- Compare gene expression in prokaryotes and eukaryotes.
- Understand operons, transposons and signal sequences in genes.
- Compare genomes in viruses, bacteria, and eukaryotes.
- Understand the basic principles of gel electrophoresis.
- Understand methods, techniques, and prospects for biotechnology, PCR, gene therapy, and genetic engineering.

### **Vital Results**

1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.8, 1.10, 1.13, 1.14, 1.15, 1.17, 1.18, 1.19, 1.20, 1.21, 1.22, 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.9, 2.14, 3.10

### **Related Standards**

7.5aaa, 7.7aaa, bbb, ccc, ddd, eee, ff, h, i, j, 7.11aaa, 7.12fff, 7.18aaa, d, 7.19a, aaa, bbb

# **COURSE: BIOLOGY II - GRADE 12**

## **Unit: Genetics**

### **VT Standard 7.13**

Students understand the characteristics of organisms, see patterns of similarity and differences among living organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:

- aaa. Demonstrate understanding of the uniqueness of the cell in different organisms and the structures and functions of cells.

### **VT Standard 7.14**

Students demonstrate understanding of the human body – heredity, body systems, and individual development – and understand the impact of the environment on the human body. This is evident when students:

- aa. Explain and model how information passed from parents to offspring is coded in DNA molecules (e.g. gene mutations, gene combinations);
- cc. Analyze and describe how the health of human beings is affected by disease passed through DNA, environmental factors, and activities that deliberately or inadvertently alter the equilibrium in ecosystems.

### **Evidence of Learning**

The student will:

- Describe Mendel's laws and how he derived them.
- Understand that genetics depend on the laws of chance.
- Understand modes of inheritance: co-dominance, multiple alleles, pleiotropy, epistasis, polygenic inheritance.
- Understand pedigree analysis.
- Compare nature and nurture.
- Understand Morgan and the chromosome theory of inheritance.
- Understand linked traits.
- Map chromosomes using the frequency of crossing over among linked traits.
- Understand chromosomes and the inheritance of sex.
- Describe sex-linked disorders in humans.
- Describe human chromosomal alternations and disorders.
- Understand drosophila inheritance.

### **Vital Results**

1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.8, 1.10, 1.13, 1.14, 1.15, 1.17, 1.18, 1.19, 1.20, 1.21, 1.22, 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.9, 2.14, 3.10

### **Related Standards**

7.5aaa, 7.9aaa, bbb, ccc, ddd, ee

# **COURSE: BIOLOGY II - GRADE 12**

## **Unit: Evolution**

### **VT Standard 7.13**

Students understand the characteristics of organisms, see patterns of similarity and differences among living organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:

- bbb. Demonstrate understanding of how biological organisms are classified into a hierarchy of groups and subgroups based upon similarities that reflect their evolutionary relationships (e.g. plants, animals, microorganisms);
- ddd. Explain and justify how natural selection and its evolutionary consequences provide a scientific explanation for the fossil record of ancient life forms.

### **Evidence of Learning**

The student will:

- Understand descent with modification, Natural Selection.
- Compare Charles Darwin and Lamarck.
- Describe biogeography.
- Understand microevolution.
- Understand punctuated equilibrium and population genetics.
- Describe the Hardy-Weinberg theorem; Darwin and Mendel.
- Understand gene flow, mutations, nonrandom mating, and genetic drift.

### **Vital Results**

1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.8, 1.10, 1.13, 1.14, 1.15, 1.17, 1.18, 1.19, 1.20, 1.21, 1.22, 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.9, 2.14, 3.10

### **Related Standards**

7.5aaa, 7.6, 7.7aaa, bbb, ccc, ddd, eee, ff, h, i, j, 7.11aaa, 7.12fff, 7.18aaa, d, 7.19a, aaa, bbb

# **COURSE: BIOLOGY II - GRADE 12**

## **Unit: Structure and Function in Organisms**

### **VT Standard 7.13**

Students understand the characteristics of organisms, see patterns of similarity and differences among living organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:

bbb. Demonstrate understanding of how biological organisms are classified into a hierarchy of groups and subgroups based upon similarities that reflect their evolutionary relationships (e.g. plants, animals, microorganisms).

### **VT Standard 7.14**

Students demonstrate understanding of the human body – heredity, body systems, and individual development – and understand the impact of the environment on the human body. This is evident when students:

bb. Demonstrate an understanding that human beings have complex biochemical systems that enable them to function and reproduce;

dd. Identify, explain, and analyze the pattern of human development.

### **Evidence of Learning**

The student will:

- Understand that living organisms are open energy systems.
- Understand how structures complement function.
- Describe tissues, organs, and the organ system.
- Understand that Body Plans differ, survival problems do not.
- Compare the major organ systems among several groups of vertebrates.
- Compare the physiology of plants and animals emphasizing commonality in function and diversity in structure.
- Describe systems of self-defense.
- Understand immunity to disease.

### **Vital Results**

1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.8, 1.10, 1.13, 1.14, 1.15, 1.17, 1.18, 1.19, 1.20, 1.21, 1.22, 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.9, 2.14, 3.10