K-12 SCIENCE EDUCATION VISION

A K-12 Dublin City Schools science education engages *all students* in critical thinking and problem solving as they experience science and engineering. We believe that students can become scientifically literate citizens equipped with the knowledge and skills demanded by the ever-changing future, whether in the workforce or higher education.

We believe in developing our learners through high quality experiences that include:

- A challenging, collaborative and inquiry based environment.
- Opportunities to solve and investigate real-world problems that require critical and global thinking.
- Opportunities for students to build an identity as a scientist, able to interpret the natural world, participate productively in scientific practices and contribute to society in meaningful ways.
- Opportunities to research, generate and evaluate evidence and explanations that uphold or refute scientific data.

We believe these learning experiences will grow independent, confident students who will become creative, innovative adults that are capable of using informed scientific judgement to improve their world.

Instructional Agreements for Science Learning within the Dublin City Schools

1. Learning goals will be communicated to guide students through the expectations of science learning using a variety of instructional techniques and technology integration.
2. Teachers will ensure a safe, challenging learning environment focused on inquiry and science exploration.
3. Teachers will provide support to students as they learn to frame questions, assess and analyze data, and create and critique explanations – all important components of scientific and engineering practices.
4. Content standards will be learned in partnership with Ohio's Cognitive Demands for Science, Science and Engineering Practices and Nature of Science practices.

Dublin City Schools Science Graded Course of Study

Nature of Science	
One goal of science education is to help students become scientifically literate citizens able to use science as a way of knowing about the natural and material world. All students should have sufficient understanding of scientific knowledge and scientific processes to enable them to distinguish what is science from what is not science and to make informed decisions about career choices, health maintenance, quality of life, community and other decisions that impact both themselves and others.	
Scientific Inquiry, Practice and Applications	All students must use these scientific processes with appropriate laboratory safety techniques to construct their knowledge and understanding in all science content areas.
Science is a Way of Knowing	Science assumes the universe is a vast single system in which basic laws are consistent. Natural laws operate today as they did in the past and they will continue to do so in the future. Science is both a body of knowledge that represents a current understanding of natural systems and the processes used to refine, elaborate, revise and extend this knowledge.
Science is a Human Endeavor	Science has been, and continues to be, advanced by individuals of various races, genders, ethnicities, languages, abilities, family backgrounds and incomes.
Scientific Knowledge is Open to Revision in Light of New Evidence	Science is not static. Science is constantly changing as we acquire more knowledge.

Scientific and Engineering Practices:

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

Ohio's Cognitive Demands for Science	
Cognitive Demand	**Description**
DESIGNING TECHNOLOGICAL/ ENGINEERING SOLUTIONS USING SCIENCE CONCEPTS	Requires students to solve science-based engineering or technological problems through application of scientific inquiry. Within given scientific constraints, propose or critique solutions, analyze and interpret technological and engineering problems, use science principles to anticipate effects of technological or engineering design, find solutions using science and engineering or technology, consider consequences and alternatives, and/or integrate and synthesize scientific information.
DEMONSTRATING SCIENCE KNOWLEDGE	Requires students to use scientific practices and develop the ability to think and act in ways associated with inquiry, including asking questions, planning and conducting investigations, using appropriate tools and techniques to gather and organize data, thinking critically and logically about relationships between evidence and explanations, constructing and analyzing alternative explanations, and communicating scientific arguments. (Slightly altered from National Science Education Standards)
INTERPRETING AND COMMUNICATING SCIENCE CONCEPTS	Requires students to use subject-specific conceptual knowledge to interpret and explain events, phenomena, concepts and experiences using grade-appropriate scientific terminology, technological knowledge and mathematical knowledge. Communicate with clarity, focus and organization using rich, investigative scenarios, real-world data and valid scientific information.
RECALLING ACCURATE SCIENCE	Requires students to provide accurate statements about scientifically valid facts, concepts and relationships. Recall only requires students to provide a rote response, declarative knowledge or perform routine mathematical tasks. This cognitive demand refers to students' knowledge of science fact, information, concepts, tools, procedures (being able to describe how) and basic principles.

HUMAN ANATOMY AND PHYSIOLOGY

Human Anatomy and Physiology Course Goals:
Human Anatomy and Physiology comprises a systematic study in which students will examine human anatomy and physical functions. They will analyze descriptive results of abnormal physiology and evaluate clinical consequences. A workable knowledge of medical terminology will be demonstrated.

LEVELS OF ORGANIZATION	
Content Statement	**Content Elaboration**
AP.LO.1: Hierarchy of organization	● Building on knowledge about cell structures and processes from middle school and Biology, this topic focuses on the increasing complexity of cells to organ systems.
AP.LO.2: Types of tissues	● The human body is composed of four types of tissues: epithelial, connective, muscle and nervous. This topic includes a broad overview of the structure, function and location of each tissue type. ● Investigations are used to understand types of tissues in a variety of lab scenarios
AP.LO.3: Homeostasis	● A theme that is explored throughout the course. Homeostasis involves positive and negative feedback mechanisms that continuously monitor and adjust the body's internal conditions. This homeostatic imbalance can result in a variety of conditions.
AP.LO.4: Anatomical terminology	● Standard anatomical position is to be used as a reference point. Each area of the human body is identified by region. The features and structures of the body, relative to each other, are described by directional terms. The body and its organs can be divided by planes. The organs are located in cavities.

SUPPORT AND MOTION	
Content Statement	**Content Elaboration**
AP.SM.1: Integumentary system	● The integumentary system consists of skin and accessory structures. The skin is composed of two major layers: the epidermis, the dermis. ● The accessory structures can include sweat glands, sebaceous glands, arrector pili

	muscles, hair follicles and nails. Skin functions include protection, temperature regulation, excretion and sensory perception. Homeostatic imbalances are explored.
AP.SM.2: Skeletal system	● The skeletal system is composed of bones, cartilage, joints and ligaments. ● Bones make up most of the skeleton. There are four main cell types that compose bone tissue, each with a specific function: osteogenic cells, osteocytes, osteoblasts and osteoclasts. ● The microscopic anatomy of compact bone includes osteons. ● Bones are classified by their shape. The structure of a typical long bone can be explored. ● Specific bones of the skeleton can be studied by their subdivisions: the axial skeleton and the appendicular skeleton. ● Cartilage is found in areas of the nose, ears, ribs and joints. ● Joints can be classified by structure or by function. The general structure of synovial joints may be explored. Ligaments connect bone to bone, stabilizing joints. ● The skeletal system provides support for the human body, protects soft organs, allows for movement due to attachment of muscles, stores minerals and fat and forms blood cells. ● Processes of the skeletal system include hematopoiesis, ossification and bone growth and remodeling. ● A comparison of male to female, juvenile to adult or human to other vertebrate skeletons may be explored. ● Homeostatic imbalances are explored. Ex: osteoporosis, malnutrition, fractures, anterior cruciate ligament (ACL) injuries and arthritis. ● Lab investigations are used to understand and explain the skeletal system in a variety of experiences and design scenarios that can incorporate scientific reasoning, comparative analysis, communication skills and real-world applications.
AP.SM.3: Muscular system	● The muscular system consists of three types of muscle cells: skeletal, smooth and cardiac. ● The primary function of the muscular system is to contract, thereby, moving the body and internal fluids, maintaining posture, generating heat and stabilizing joints. ● Muscles are controlled voluntarily and/or involuntarily. ● Heart muscle cells are mononucleated, branched and striated. Intercalated disks are characteristic of cardiac muscle and aid in communication between cardiac muscle cells. ● Smooth muscle cells, found in the hollow organs and blood vessels, are mononucleated, spindle-shaped and nonstriated.

	● Skeletal muscle cells, found attached to bones and skin, are multinucleated, cylindrical and striated. ● The muscles of the body can be studied by group, which include the muscles of the head, face and neck, the trunk and the upper and lower limbs. ● Processes of the muscular system include gross body movements produced by skeletal muscles as they interact with the skeletal system, and muscle contraction. ● The connection between the nervous system and the skeletal system should be explored through the study of action potentials and the resulting contraction of sarcomeres, as described by the sliding filament theory. ● Energy processing and muscle responses to stimuli can be studied along with building muscle tissue through exercise. The effects of steroids can also be investigated. ● Homeostatic imbalances are explored. These include, but are not limited to, muscular dystrophy and atrophy. ● Lab investigations are used to understand and explain the muscular system in a variety of inquiry and design scenarios that can incorporate evolutionary concepts, scientific reasoning, comparative analysis, communication skills and real-world applications.

INTEGRATION AND COORDINATION	
Content Statement	**Content Elaboration**
AP.IC.1: Nervous system	● The nervous system consists of neurons and supporting cells that combine to form nerves, the spinal cord and the brain. ● The primary functions of the nervous system are sensation, integration and response. ● A comparison of the structures and functions of the central and peripheral nervous systems should be explored. The central nervous system is composed of the brain and spinal cord. The peripheral nervous system includes the remaining nervous tissue. ● A neuron consists of dendrites, a cell body and an axon. Neurons conduct electrical impulses along their membranes and at synapses. ● Brain cells can detect and respond to these impulses. ● Neuroglial cells help to support neural function. ● The brain consists of three major parts: the cerebrum, cerebellum and brainstem. ● The cerebrum is divided into lobes and hemispheres. Functions of the cerebrum that may be explored include voluntary muscle control, memory, sensory perception, emotions and speech.

	● The cerebellum is primarily responsible for balance and coordination. ● The brainstem, a part of the autonomic nervous system, includes structural divisions that perform basic life functions such as breathing and heart rate. ● The spinal cord is a continuation of the brainstem. The spinal cord is a bundle of nerve tracts that transmits nerve signals between the brain and the body through electrical impulses. ● Nerves are bundles of neurons that transmit impulses between the peripheral and central nervous systems. The study of nerves can include the cranial and spinal nerves, as well as the different nerves and nerve plexuses of the peripheral nervous system. ● Supporting structures of the central nervous system include the meninges and cerebrospinal fluid which protect the central nervous system. ● Processes of the nervous system are action potential propagation, simple nerve pathways (reflex arc) and neurotransmitter function. ● Homeostatic imbalances are explored. These include, but are not limited to, the effects of drugs, mental illnesses, spinal injuries, concussions, meningitis and multiple sclerosis (MS). ● Investigations are used to understand and explain the nervous system in a variety of inquiry and design scenarios that can incorporate evolutionary concepts, scientific reasoning, comparative analysis, communication skills and real-world applications.
AP.IC.2: Special senses • Sense of sight • Senses of hearing and balance • Senses of taste and smell	● The special senses consist of sight, hearing, balance, smell and taste. ● Each sense involves a network of feedback processes and consists of distinct structures. ● Sense of sight: The eye provides visual environmental feedback and includes primary and accessory structures. Light enters through the pupil and is then focused by the lens onto the retina at the visual axis. The optic nerve transmits the electrical impulses to the brain where they are translated. The accessory structures provide lubrication, protection and support to the eye. Processes include stimulation of the photoreceptors (rods and cones) by light. Homeostatic imbalances are explored. These include, but are not limited to, certain types of blindness, conjunctivitis, glaucoma, astigmatism, hyperopia, myopia and cataracts. Investigations are used to understand and explain the sense of sight in a variety of inquiry and design scenarios that can incorporate evolutionary concepts, scientific reasoning. ● Senses of hearing and balance The ears respond to a range of sounds and provide a sense of equilibrium. The structures include those of the outer, middle and inner ear. Processes of hearing and balance should be explored including the perception of sound and spatial awareness. Homeostatic imbalances are explored. These include,

	but are not limited to, certain types of hearing loss, otitis media, lack of balance (e.g., vertigo), tinnitus, auditory processing, motion sickness and Meniere's syndrome. Investigations are used to understand and explain the senses of hearing and balance in a variety of inquiry and design scenarios that can incorporate evolutionary concepts, scientific reasoning, comparative analysis, communication skills and real-world applications. ● Senses of taste and smell: The senses of taste and smell occur primarily in the oral and nasal cavities. The structure of taste buds and olfactory cells are the foundation of taste and smell. The location, structure and afferent pathways of taste and smell receptors should be addressed. Processes include activation of chemoreceptors and transmission of electrical impulses to the brain, where they are integrated. Homeostatic imbalances are explored. These include, but are not limited to, age-related sensitivities, taste preferences, anosmia and olfactory auras. Investigations are used to understand and explain the senses of taste and smell in a variety of inquiry and design scenarios that can incorporate evolutionary concepts, scientific reasoning, comparative analysis, communication skills and real-world applications.
AP.IC.3: Endocrine system	● The endocrine system is composed of glands that secrete hormones resulting in a response in target cells or organs. ● Glands with their associated hormones may include pituitary, hypothalamus, thyroid, thymus, parathyroid, pineal, pancreas, adrenal, ovaries and testes. ● The endocrine system results in regulating metabolism, maintaining homeostasis, regulating growth and development, and controlling reproduction through hormonal release. ● The processes involved in the endocrine system should include a comparison of negative and positive feedback systems. Negative feedback examples can include regulation of blood glucose levels, calcium levels, blood pressure and temperature. ● Positive feedback examples can include oxytocin in childbirth and hemostasis. ● Homeostatic imbalances are explored. These include, but are not limited to, hyper- and hypo- functions of glands, diabetes (type I and type II), gigantism and dwarfism.

TRANSPORT	
Content Statement	**Content Elaboration**
AP.T.1: Blood	● Blood is composed of plasma and formed elements: red blood cells (erythrocytes),

	white blood cells (leukocytes), and platelets (thrombocytes). ● The primary functions of blood are transportation, protection and regulation. ● Plasma, the most abundant component of blood, is the liquid portion that transports dissolved nutrients, waste, hormones, antibodies and proteins throughout the body. ● Red blood cells carry oxygen used during cellular processes throughout the body. ● White blood cells identify and protect the body against infectious disease and foreign cells. ● Platelets bind together when a blood vessel is damaged resulting in blood clot formation. ● The major ABO blood types, A, B, AB and O, are determined by the presence or absence of antigens on the surface of red blood cells. An additional antigen is present or absent on the surface of red blood cells determining Rh factor. Blood type antibodies are found in plasma. ● Processes related to blood include the production of blood cells and platelets, and hemostasis. ● Homeostatic imbalances are explored. These include, but are not limited to, sickle cell anemia, hemophilia, deep vein thrombosis, leukemia and lymphoma. ● Lab investigations are used to understand and explain blood in a variety of inquiry and design scenarios that can incorporate evolutionary concepts, scientific reasoning, comparative analysis, communication skills and real-world applications.
AP.T.2: Cardiovascular system	● The cardiovascular system consists of the heart and blood vessels. ● The heart is mostly comprised of cardiac muscle which is supplied with oxygenated blood by coronary arteries. ● The structure of the heart includes four chambers, four valves and major vessels leading to and from the heart. ● The flow of blood through the heart, pulmonary and systemic circuits should be explored. ● Blood flows from arteries, to arterioles, to capillaries, to venules, then to veins. In the capillaries, oxygen, nutrients, and chemical messengers diffuse out (leave) and carbon dioxide and other waste products diffuse in (enter). ● Veins have valves that keep the blood flowing toward the heart. ● The primary function of the cardiovascular system is the transport of oxygen, carbon dioxide, hormones, nutrients, waste products and chemical messengers. ● Processes involved in the cardiovascular system include the cardiac cycle and cardiac and conductive pathway which is measured by electrocardiograms and blood pressure. ● Homeostatic imbalances are explored. These include, but are not limited to, a variety

	of cardiovascular diseases and structural imperfections of the heart, valves and vessels. ● Examples include, but are not limited to, myocardial infarction, aneurysm, atherosclerosis, hypertrophic cardiomyopathy, hypo/hypertension and arrhythmias. Investigations are used to understand and explain the cardiovascular system in a variety of inquiry and design scenarios that can incorporate evolutionary concepts, scientific reasoning, comparative analysis, communication skills and real-world applications.

ABSORPTION AND EXCRETION	
Content Statement	**Content Elaboration**
AP.AE.1: Digestive system	● The Digestive system is divided into alimentary canal and accessory organ. ● The alimentary canal is made of four tunics ● Each organ of the alimentary canal has specific functions ● The digestive system has 4 main functions ● Chemical vs mechanical digestion ● Anatomy ○ Mouth ○ Pharynx ○ esophagus ○ Stomach ■ The stomach produces enzyme and ph gastric fluid ○ small intestine ■ duodenum, jejunum, ilium ■ modifications to enable absorption ■ The Duodenum is mostly for chemical digestion ○ large intestines ● Different enzymes break down different macromolecules ● Accessory organs ○ Teeth types ○ Tooth anatomy ○ Salivary glands ○ Pancreas

	○ Liver and Gallbladder ● Movement through the canal is parasympathetically controlled ● Chemical digestion breaks down materials from polymers to simpler polymers or monomers ● Activities in the mouth, pharynx, and esophagus ● Activities in the stomach ● Activities in small intestine ○ Regulation of pancreatic juice and bile secretion ● Activities in the large intestine ● Nutrition ● Metabolism ● Cholesterol ● Basal metabolic rate ● Total metabolic rate ● Body temp regulation
AP.AE.2: Respiratory system	● The respiratory system is comprised of the airways, lungs and diaphragm. ● The airways include the nasal and oral cavities, pharynx, larynx, trachea, bronchi, bronchioles and alveoli. ● The respiratory system transports and exchanges gases including oxygen and carbon dioxide. ● Processes involved in the respiratory system include respiration mechanics and gas exchange. ○ Respiration mechanics is the process by which humans breathe and includes the movement of the diaphragm and pressure-volume relationships. ○ Gas exchange refers to the diffusion of gas across the alveolar epithelium in the respiratory system and capillary endothelium of the cardiovascular system. ● Lung volumes and capacities can be measured using spirometry. ● Homeostatic imbalances are explored. These include, but are not limited to, asthma, chronic obstructive pulmonary disease (COPD), tuberculosis, cystic fibrosis and the effects of smoking and pollution. ● Investigations are used to understand and explain the respiratory system in a variety of inquiry and design scenarios that can incorporate evolutionary concepts, scientific reasoning, comparative analysis, communication skills and real-world applications.

REPRODUCTION

Content Statement	Content Elaboration
AP.R.1: Reproductive system	● The reproductive system is comprised of internal and external organs and hormones. ● The ovaries and testes produce gametes that fuse to form a zygote, a single cell that develops into an embryo and eventually an adult. ● A comparison of male and female anatomy should be explored. The female body has the function of providing protection and nourishment for the developing fetus until birth. If all is successful, a new generation of offspring will occur. ● The processes of the reproductive system include oogenesis, spermatogenesis and fertilization. Additional processes can include birth, lactation and menstruation. ● Homeostatic imbalances are explored. These include, but are not limited to, infertility, chromosomal disorders, endometriosis, cancer, Human Papillomavirus (HPV), and sexually transmitted diseases (STD's). ● Investigations are used to understand and explain the reproductive system in a variety of inquiry and design scenarios that can incorporate evolutionary concepts, scientific reasoning, comparative analysis, communication skills and real-world applications.