LIFE SCIENCE

From Molecules to Organisms: Structures and Processes

Faith supporting Reason

- Recognize that life begins at conception, and respect life at all stages
- Every part of a system works more successfully when it is carrying out its intended purpose, just as we are fulfilled when we carry out God's purpose in our lives.
- The cyclic nature of all God's processes gives purpose to all molecules and organisms
- View the body as a temple and dwelling place of the Holy Spirit

Catholics making contribution to the topic

- Albertus Magnus (c.1206–1280) – Patron saint of natural sciences
- Giovanni Alfonso Borelli (1608–1679) – Often referred to as the father of modern biomechanics
- Mateo Realdo Colombo (1516–1559) – Discovered the pulmonary circuit, which paved the way for Harvey's discovery of circulation
- Louis Pasteur (1822–1895) – Father of bacteriology
- Theodor Schwann (1810–1882) – Founder of the theory of the cellular structure of animal organisms
- Johannes Peter Müller (1801–1858) – Founder of modern physiology
- Leonardo Da Vinci (1492- 1519) As an artist, he quickly became master of *topographic anatomy*, drawing many studies of muscles, tendons and other visible anatomical features.
- Fr. Damien of Molok'ai (1840-1889) Catholic priest who won recognition for his ministry in the Kingdom of Hawai'i to people with leprosy
- Andreas Vesalius (1514–1564) – Father of modern human anatomy
- Francesco Redi (1626–1697) – His experiments with maggots were a major step in overturning the idea of spontaneous generation

Science outcomes

1. Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells. (MS-LS1-1)
2. Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function. (MS-LS1-2)
3. Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells. (MS-LSI-3)
4. Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively. (MS-LSI-4)
5. Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms. (MS-LSI-5)
6. Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms. (MS-LSI-6)
7. Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism. (MS-LSI-7)
8. Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories. (MS-LSI-8)

Engineering - Experiments - Extension Activities

- Build a model of the plant and animal cells

- Microscope observation of unicellular organisms, cheek samples and cells undergoing Mitosis
- Build diagrams of Mitosis and Meiosis using pasta noodles and string
- Photosynthesis Virtual Lab: Color of the light vs. the growth of plants http://www.glencoe.com/sites/common_assets/science/virtual_labs/LS12/LS12.html Or http://www.saddleworth.oldham.sch.uk/science/simulations/waterweed.htm
- Photosynthesis Lab: Photosynthetic rate: Bubbles as function of CO2, light http://blog.canacad.ac.jp/wpmu/15bercel/2014/01/20/photosynthesis-virtual-labs/
- Dissection to relate to human body systems

Crosscutting Concepts

- Religion- Church structure vs. Cell structure comparison , Leprosy in the Bible, plagues in the Bible, Use the Bible passage to identify the protocol for treatment of boils Leviticus 13:1-14:57, Connect with boil home remedies http://www.my-home-remedies.com/boil-home-remedies.html
- ELA- Write persuasive arguments (or structured literary paragraphs) for Lamarck vs. Darwin using their observations and primary resources
- Math- Punnett squares, multiple (dihybrid) crosses, probabilities and fractions. Exponential function compared to cell growth and divisions
- P.E.- Students act out parts of a cell during the transcription of DNA in Mitosis, Skit acting out plant and animal cell parts and jobs or human body systems when foreign objects are introduced to those cells, Act out a nerve impulse being sent via sensory, inter and motor neurons to the brain or spinal cord using yarn and masking tape rolls
- Social Studies- City Cell comparison http://cellcity.wikispaces.com/

- Book: The Immortal Life of Henrietta Lacks by Rebecca Skloot: cross-cut with ELA and religion due to questions on ethical practices and human dignity (Principal approval first) http://www.sjubioethicsinstitute.com/journal/immortal-life-henrietta-lacks, Theology of the Body by St. John Paul II
- Websites: cellsalive.com for mitosis and meiosis diagrams, http://www.innerbody.com/ human body systems, kidshealth.org human body system
- Apps: Frog virtual dissections, Rat dissection app, Conquering Middle School Cell Biology app, Experience Science Biology: body systems, cell respiration, pond food chain, Science Quiz: reviews many branches of science
- Bible Verses: Isaiah 38:21 boil recovery, Leviticus 13:1-14:57 discussing boils, 1 Cor 12: 21-26 All members of the body must work together
- Field Trip: Arrowhead Stadium Sport Lab: goal is to introduce health and fitness to create healthy lifestyles call 816-920-4539 or email chiefssportslab@goarrowhead.com
- Catholic Scientists http://en.wikipedia.org/wiki/List_of_Catholic_scientists http://en.wikipedia.org/wiki/List_of_Roman_Catholic_cleric%E2%80%93scientists

Key content vocabulary: organelles, nucleus, nucleolus, nuclear membrane, chromosome, chromatin, cytoplasm, mitochondria, smooth endoplasmic reticulation, rough endoplasm reticulation, gogli body, ribosome, DNA, RNA, organ, system, tissue, cell wall, cell membrane, chloroplast, cetriole, mitosis, meiosis, adaptation, organism, unicellular, multicellular, plants, animals, human body systems, circulatory, immune, respiratory, endocrine, integumentary, skeletal, muscular, digestive, execratory, reproductive, nervous, hygiene, diet, nutrition, exercise, photosynthesis, cell respiration,

LIFE SCIENCE

Ecosystems: Interactions, Energy, and Dynamics

Faith supporting Reason

- Describe how each of us is called to be good stewards of God's earth and resources.
- Principles of noble and intelligent guardians of nature are essential to the building of a peaceful society; no peaceful society can afford to neglect either the respect for life or the fact that there is integrity to creation.
- We are called by God to be mindful of the dangers, both moral and ecological, of overconsumption.

Catholics making contribution to the topic

- Antoine Laurent de Jussieu (1748–1836) – The first to propose a natural classification of flowering plants
- St. Kateri Tekakwitha (1656-1680) model ecologist
- St. Francis of Assisi (1182-1226) He is known as the patron saint of animals, the environment
- St. John Paul II (1920-2005) wrote encyclicals on ecological thoughts
- Pierre André Latreille (1762–1833) – Pioneer in entomology

Science outcomes

1. Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem. (MS-LS2-1)
2. Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems. (MS-LS2-2)
3. Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem. (MS-LS2-3)
4. Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. (MS-LS2-4)
5. Evaluate competing design solutions for maintaining biodiversity and ecosystem services. (MS-LS2-5)

Engineering - Experiments - Extension Activities

- Collect specimens and insects representing all levels of the energy pyramid to create a model of the energy pyramid (MS-LS2-3)
- Water filtering activity epa.gov (MS-LS2-5) http://water.epa.gov/learn/kids/drinkingwater/teachers_4-8.cfm
- Competitive exclusion experiment (MS-LS2-1) (MS-LS2-4) http://www.ib.bioninja.com.au/options/option-g-ecology-and-conser/g1-community-ecology.html

Crosscutting Concepts

- Religion- Read one of St. John Paul's encyclicals and construct and argument defending his reasoning
- ELA- Analyze articles from catholicconservation.org to construct a response to our role in
- Math- Graph the results of competitive exclusion experiments, "quadrant" method of visual representation of data, or graphing of colony growth with Gause experiment http://www.ib.bioninja.com.au/options/option-g-ecology-and-conser/g1-community-ecology.html
- P.E.- Nature walk to observe how ecosystems have adapted to the introduction of humans into their environment
- Social Studies- Examine and provide evidence for the effects of resource availability on organisms and populations of humans in ancient civilizations

- Book: Community Ecology: online book chapter http://www.mhhe.com/biosci/genbio/raven6b/graphics/raven06b/other/raven06b_25.pdf
  My Side of the Mountain by Jean Craighead George, There's an Owl in the Shower by Jean Craighead

George, A Street Through Time by Anne Millard

- Websites: conservation.catholic.org Pope Francis' talks on a Catholic's role in ecology, projectnoah.org allows students to post and search pictures of insects and animals in their environment
- Movie: National Geographic documentary on Penguins https://www.youtube.com/watch?v=mNckdub0Yno&feature=youtu.be (MS-LS2-2)
- Apps: Trivia King Earth Day app, Audubon Insect and Spider Field Guide app,
- Bible Verses: Zechariah 8:12 Earth as an inheritance to the remnant of his people, Isaiah 43:20-21 creation honoring Gog, Genesis 8:11 Dove and the olive branch from the flood
- Field Trip:KSU extension: travel to or help build activities relating to ecology http://www.ksre.k-state.edu/,
- Catholic Scientists http://en.wikipedia.org/wiki/List_of_Catholic_scientists http://en.wikipedia.org/wiki/List_of_Roman_Catholic_cleric%E2%80%93scientists

Key content vocabulary: ecosystem, habitat, biotic, abiotic, producer, consumer, decomposer, scavenger, kingdom, phylum, class, order, family, genus, species, extinction, adaptation, biodiversity, symbiosis, commensalism, parasitism, mutualism, energy pyramid, food chain, food web, natural resources, population, community, population density, succession, limiting factor

LIFE SCIENCE

Heredity: Inheritance and Variation of Traits

Faith supporting Reason

- Investigate observable hereditary traits of God's children
- Everything that God created is good and unique
- All adversities that occur because of nature help to strengthen our dependence on and relationship with Jesus

Catholics making contributions to the topic

- Jérôme Lejeune (1926–1994) – Pediatrician and geneticist, best known for his discovery of the link of diseases to chromosome abnormalities
- Gregor Mendel (1822–1884) – Father of genetics
- Marcello Malpighi (1628–1694) – Father of comparative physiology

Science outcomes

1. Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism. (MS-LS3-1)
2. Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation. (MS-LS3-2)

Engineering - Experiments - Extension Activities

- Create a 3D model of the double helix DNA strand
- DNA Replication: Paper Clip Activity- use colorful paper clips to represent base pairs to demonstrate DNA replication
- Virtual lab on transcribing and translating DNA http://learn.genetics.utah.edu/content/molecules/transcribe/
- Virtual lab on gel electrophoresis http://learn.genetics.utah.edu/content/labs/gel/
- Virtual lab comparing the reproduction cycles of normal cells and cancer cells http://www.mhhe.com/biosci/genbio/virtual_labs/BL_23/BL_23.html
- Punnett Square practice calculating probability of inheriting traits.

Crosscutting Concepts

- Religion- Discussion on effects of genetic variation (cancer, genetic disorders) and how it brings us closer to Christ, research saints and people who were discriminated against because of the traits they possessed
- ELA- Compare and contrast offspring from the processes of Mitosis and Meiosis http://mrbloch516.edublogs.org/files/2013/11/asexual-vs-sexual-reading-2iu945o.pdf, Book Study Flowers for Algernon By Daniel Keyes cross cut with Religion because of moral and ethical treatment of mentally handicapped (principal approval) http://www.catholic.org/news/hf/faith/story.php?id=46492
- Math- Statistic probability of genetic variations using Punnett squares
- P.E.- Chalk Punnett square problems outside, make a human DNA model,
- Social Studies- Hitler and his desire to create his master race using selective breeding, Investigating how Rosalind Franklin (DNA structure) didn't receive a Nobel prize for her work https://www.sdsc.edu/ScienceWomen/franklin.html

- Book: Reading comparing sexual and asexual reproduction http://mrbloch516.edublogs.org/files/2013/11/asexual-vs-sexual-reading-2iu945o.pdf,

- Websites: resources for Genetics http://www.neok12.com/Genetics.htm
- Apps: GeneScreen- investigates recessive inheritable traits and diseases
- Bible Verses: Gen 1:11-12 offspring come from parents, Psalm 139:13-16 Imbedded in mother's womb,
- Movies: United Learning Mitosis and Meiosis video http://www.classroom20.com/video/649749:Video:104840
- Speaker: Geneticist (Catholic?) to discuss moral and ethical issues of genetic engineering
- Catholic Scientists http://en.wikipedia.org/wiki/List_of_Catholic_scientists http://en.wikipedia.org/wiki/List_of_Roman_Catholic_cleric%E2%80%93scientists

Key content vocabulary: dominant, recessive, Punnett square, genotype, phenotype, allele, heterozygous, homozygous, co-dominance, blood type, karyotype, pedigree, autosomal, sex-linked, probability, DNA, chromosome, gene, asexual and sexual reproduction, adaptation, heredity, mutation, biological diversity, natural selection, artificial selection, selective breeding, genetic engineering, cloning

LIFE SCIENCE

Biological Evolution: Unity and diversity

Faith supporting Reason

- Evolutionary theories are an integral part of the Science curriculum in the K-12 Catholic schools in the Archdiocese of Kansas City in Kansas. There is no conflict between theistic evolution and the teachings of the Catholic Church. Our primary focus in every facet of our Catholic school curriculum is our faith in Jesus Christ and our trust in God the Father who created all things. We also hold as part of our Catholic faith that the human soul is specially created and conferred into the human by God. It did not evolve, and it is not inherited from our parents as our bodies are.
- Even with such beautiful diversity, humans are all created in God's image and likeness
- Nothing comes from nothing; therefore, we acknowledge God's supremacy in the creation of matter and design. He is the first principle of all that exists
- Understand what the church believes in regards to cell research

Catholics making contribution to the topic

- Jean-Baptiste Lamarck (1744–1829) – French naturalist, biologist and academic whose theories on evolution preceded those of Darwin
- Wilhelm Heinrich Waagen (1841–1900) – Geologist and paleontologist
- Johann Joachim Winckelmann (1717–1768) – One of the founders of scientific archaeology
- Pope Pius the XII (1875-1958) Confirmed no intrinsic conflict between evolution and Christianity
- Fr. Robert Spitzer (Current) New Proofs from the Existence of God
- Gregor Mendel (1822–1884) – Father of genetics
- Cardinal Christoph Schönborn-(1945- present) writer on Church's stance on evolution

Science outcomes

1. Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms ***physically*** throughout the history of life on Earth under the assumption that natural laws operate today as in the past; however, the human spiritual soul is not the product of evolution but is created directly by God and conferred into the human body at the moment of conception. (MS-LS4-1)
2. Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships. (MS-LS4-2)
3. Analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationships not evident in the fully formed anatomy. (MS-LS4-3)
4. Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some organism's probability of surviving and reproducing in a specific environment. (MS-LS4-4)
5. Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired physical traits in organisms. (MS-LS4-5)
6. Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific physical traits in populations over time. (MS-LS4-6)

Engineering - Experiments - Extension Activities

- Research how an environment affected the natural selection of a species: compare how the jack rabbit in the desert is different than the cottontail in Kansas

- NOVA Guess the Embryo game helps show similarities in embryonic development across species: http://www.pbs.org/wgbh/nova/evolution/guess-embryo.html
- Smithsonian Dinosaur Dig http://paleobiology.si.edu/dinosaurs/interactives/dig/dinodig.html
- Exploring Evolution Web Lab: compare fossils, DNA and anatomy http://www2.edc.org/weblabs/exploringevolution/evolution.swf
- Peppered Moth Simulation http://peppermoths.weebly.com/
- Find evidence to support the Catholic Church's teaching in regards to evolution to write an argumentative essay- crosscut with ELA

Crosscutting Concepts

- Religion- Discuss the conferral of the soul in the human, discuss your faith evolution
- ELA- Find evidence to support the Catholic Church's teaching in regards to evolution to write an argumentative essay, Journal writing imitating Darwin or imagining you're on Darwin's voyage
- Math- Construct a geological timeline, Graphing the geographic timeline: construct a pie chart showing the amount of time of each era on Earth
- P.E.- Relays to show evolutionary advantages of adaptations, three legged race, move an orange without hands
- Social Studies- The Industrial Revolution's impact on the environment causing natural selection in the peppered moth species
- Other Art- Create a fossil dig in a shoe box with plaster of paris and shells
- Virtual Labs: fossil record: http://vft.asu.edu/VFTNilpenaH5T/panos/np1h5main/np1h5main.html or bioarchaeology to compare skull development http://vft.asu.edu/VFTBones2014/panos/boneslab1/boneslab.html

- Book: Origin of Species by Charles Darwin, Why Did All Dinosaurs Become Extinct by: Bonnie Sachtello-SawyerDon,
- Websites: catholiclab.net: hear biographies and podcast on current topics involving science and religion, http://www.pbs.org/wgbh/nova/evolution/guess-embryo.html, http://www.sciencepowerpoint.com/Evolution_Natural_Selection_Unit.html
- Apps: Fossil Finder, NHM Evolution- Journey through 600,000,000 years on Earth, Click and Learn- HHMI Biointeractive Paleoclimate, skeleton similarities
- Bible Verses: 2 Peter 3:8- Lord's time is infinite, Gen 126- Man made in God's likeness, Is 65: 17-18 New creation after death
- Movie: NOVA Dogs Decoded discusses evolution of dogs from wolves because of human influence (natural selection)
- Field Trip: Geo KS Fossil Dig http://www.kgs.ku.edu/Extension/KSfossils.html, Clinton Lake Fossil Dig, HMS Beagle in Parkville Fossil Dig http://www.hms-beagle.com/
- Catholic Scientists http://en.wikipedia.org/wiki/List_of_Catholic_scientists http://en.wikipedia.org/wiki/List_of_Roman_Catholic_cleric%E2%80%93scientists

Resources for Catholic teaching of evolution:

1. Humani Generis encyclical by Pope Pius Xii

   In Humani Generis Pope Pius XII basically said that the concept of evolution was not in and of itself completely inimical to the Catholic Faith. Nevertheless, it had to be understood from within the context of the Revelation of Christ. This means that certain principles must be maintained for a Roman Catholic to accept as possible the theory of evolution.

#1. Nothing comes from nothing. Therefore, God's supremacy in the creation of matter and in design of the universe must be acknowledged. He is the first principle of all that exists.

#2. That God, if He used evolution, did so not out of necessity imposed on Him by nature itself (as if the nature He created had authority of its own) but rather because He chose to do so out of His infinite wisdom.

#3. That the human spiritual soul is not the product of evolution but is created directly by God and infused into the human body at the moment of conception. Therefore, the spiritual souls of Adam and Eve were created by God and infused into them when the natural evolution of the human body had reached its present state.

#4. That there is no such thing as polygenism, that is, multiple pairs of humans throughout the world. According to revelation there were only two progenitors of the human race whom we call Adam and Eve. To accept polygenism is to reject the dogma of original sin and consequently the need for a Redeemer.

2. Adam, Eve and Evolution Catholic.com discusses the three possibilities of evolution and the Catholic belief
3. Catechism 317: God alone created the universe
4. Catechism 302: Creation did not spring forth complete. It is in a state of journeying towards ultimate perfection
5. CCC 366: Every spiritual soul is created immediately by God. It is not produced by the parents, and it is immortal.
6. Pope John Paul II---Message to the Pontifical Academy of Science
7. Evolution and the Catholic Church: Are They in Conflict---Americancatholic.org

Key content vocabulary: adaptation, natural selection, heredity, mutation, biological diversity, artificial selection, evolutionary trees, Darwin's Theory, extinction, fossil record, embryo, anatomy, conception