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Radiation in the Human Body

A unit design for North Carolina High School Physical Science, Earth and Environmental Science, and Biology

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Teaching Units for High School Science Developed by

Duke University Graduate Students in Pharmacology 693/694

Master of Arts in Teaching (MAT)

http://sites.duke.edu/rise/duke-courses/pharm-693694/

Radiation in the Human Body

(Physical Science, Biology, and Earth and Environmental Science)
15 days

Stage 1—Desired Results

Established Goals (from NC Standard Course of Study, Common Core State Standards, etc.):

- PSc.2.1.4 **Interpret the data presented in the Bohr model** diagrams and dot diagrams for **atoms and ions of elements 1 through 18.**
  - Describe the charge, relative mass, and the location of protons, electrons, and neutrons within an atom.
  - Calculate the number of protons, neutrons, electrons, and mass number in neutral atoms and ions.
  - Explain how the different mass numbers of isotopes contributes to the average atomic mass for a given element (conceptual, no calculations).
  - Explain Bohr's model of the atom.
- PSc.2.3.1 Compare nuclear reactions including alpha decay, beta decay, and gamma decay; nuclear fusion and nuclear fission.
  - Compare alpha, beta, and gamma decay processes –alpha decay reduces the mass of an atom by 4 and the atomic number by 2; beta decay increases the atomic number by 1 (a neutron decays into a proton and electron); gamma rays are electromagnetic waves released from the nucleus along with either an alpha or beta particle
  - Compare the processes of fission (splitting of a very large atom) and fusion (joining of atoms) in terms of conditions required for occurrence, energy released, and the nature of products.
- PSc.2.3.2 Exemplify the radioactive decay of unstable nuclei using the concept of half-life.
  - Conceptually explain half-life using models
  - Perform simple half-life calculations based on an isotope's half-life value, time of decay, and/or amount of substance.
- PSc.3.1.1 Explain thermal energy and its transfer.
  - Compare thermal energy, heat, and temperature.
  - Compare conduction, convection, and radiation as methods of energy transfer.

- Bio 1.1.3 Recall that chemical signals may be released by one cell to influence the development and activity of another cell.
- Biol 2.1.1 The input of radiant energy which is converted to chemical energy allows organisms to carry out life processes.
  - Within ecosystems energy flows from the radiant energy of the sun through producers and consumers as chemical energy that is ultimately transformed into heat energy.
- Bio.2.2.1 Infer how human activities (ex. pollution) may impact the environment.
- Bio.2.2.1 Summarize how humans modify ecosystems through population growth, technology, **consumption of resources and production of waste**.
- Bio.3.1.3 Mutations can be random and spontaneous or caused by **radiation and/or chemical exposure**

- EEn.1.1.3 Explain how the sun produces energy which is **transferred to the Earth by radiation.**
  - Compare combustion and nuclear reactions (fusion and fission) on a conceptual level. Identify fusion as the process that produces radiant energy of stars.
  - Identify the forms of energy (electromagnetic waves) produced by the sun and how some are filtered by the atmosphere (X-rays, cosmic rays, etc.).
  - Summarize how energy flows from the sun to the Earth through space
- EEn.2.2.1 Explain the consequences of human activities on the lithosphere past and present.
  - Explain ways to mitigate detrimental human impacts on the lithosphere and maximize sustainable use of natural resources.
- EEn.2.2.2 Compare the various methods humans use to acquire traditional energy sources (such as peat, coal, oil, natural gas, nuclear fission, and wood).
  - Compare the methods of obtaining energy resources: harvesting (peat and wood), mining (coal and uranium/plutonium), drilling (oil and natural gas) and the effect of these activities on the environment.
- EEn.2.7.3 Explain how human activities impact the biosphere.
  - Summarize ways to mitigate human impact on the biosphere.
- EEn.2.8.1 Evaluate alternative energy technologies for use in North Carolina
  - Critique the benefits, costs and environmental impact of various alternative sources of energy for North Carolina (solar, wind, biofuels, **nuclear fusion**, fuel cells, wave power, geothermal).

Understandings:
Students will understand . . .

- the effects of radiation on human DNA in terms of mutagenic capabilities inside the cell,
- perceived versus actual health risks of radiation
- how nuclear energy is being used in the United States and in North Carolina in comparison to the rest of the world
- the roles various levels of government play in supervising radioactive processes.
- the impacts of nuclear energy on the lithosphere, especially concerning nuclear energy disasters and the management of nuclear waste

Essential Questions:

- How do scientists view risk of radioactivity/radiation in society in comparison to non-scientist individuals?
- How do the processes associated with nuclear energy production affect humans and other life on Earth?
- What are the differences between naturally occurring radiation and human-generated radiation from nuclear energy use?
- Is radiation detrimental to life on Earth?
- What are the advantages and disadvantages to nuclear energy production?
- How is radiation used in health care?
- How does radiation affect life on a cellular level?
- What social and political issues surround the science of radiation?
- How is energy transferred through radiation?

Students will know . . .

- Vocabulary:energy, thermal energy, radiant energy, half-life, radiation, convection, conduction, nuclear fusion and fission, mutation, isotope, atom, Geiger counter, cancer, mutagenic, radioactivity, atomic number, proton, electron, nucleus, neutron, electromagnetic wave, chemical energy, radioactive decay, x-ray

Students will be able to . . .

- support opinions/arguments with scientific evidence on the various effects of radioactivity
- perform basic half-life calculations
- use internet search engines to research radioactivity levels of everyday objects
- discuss/debate with peers on the merits and risks of nuclear energy use

Stage 2—Assessment Evidence

Performance Tasks:

- Radioactivity in Everyday Objects WebSearch
- Town Hall Meeting on Nuclear Energy Plant
- Extension: Nuclear Energy Disaster Project and Presentation
- Build an Atom

Other Evidence:

- Vocabulary Quiz (Part I and II)
- Exit Tickets
- Warm-ups
- Unit Test (multiple choice and short answer)

Stage 3—Learning Plan

Learning Activities:

Day 1:

- Radiation KWL Warm-up
- Unit overview
- What is Radiation? guided notes-
    - types of energy, radiation v. conduction v. convection

Day 2:

- Vocabulary Flash Cards (radiation, convection, conduction, atom, element, half-life, isotope, thermal energy, proton, electron)-
- Overview of the Atom (Atomic number, mass, atomic structure, etc.)
- Design an Atom

Day 3:

- Warm up: Review/Practice of Atomic Theory and Periodic Table Preview
- Elements and Periodic Table Video/Guided Practice
- Isotopes and Half-Life and Radioactivity, Oh my!

Day 4:

- Warm-up: Vocabulary Review Game--Find Your Match Game
- Nuclear Fission v. Fusion
    - Veritasium video

Day 5:

- Vocabulary Quiz
- Human Energy Use Overview (Traditional and non-traditional energy sources)
    - What is nuclear energy?
    - Energy Use by Nation Stations (using Google data)--*laptops required*

Day 6:

- New Vocabulary Flash Cards (Vocab Part II)
- Discussion/Sharing data on Nation Stations
- North Carolina Energy Use

Day 7:

- Intro to Nuclear Energy Disasters: Case Study Chernobyl Documentary
    - Radioactive Wolves (PBS) and Response questions
- Optional Extension: Nuclear Energy Disaster Project

Day 8:

- Human Impacts of Nuclear Energy on the biosphere and lithosphere
    - nuclear waste disposal and management

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Day 9:

- Radiation levels present in daily life--personal annual radiation dose calculations
    - discussion of radiation regulation and everyday exposure levels

Day 10:

- Vocabulary Quiz Part II
  Biological Radiation (x-rays, testing, etc.)

Day 11:

- Radiation-induced mutations
    - thymine dimers, skin cancer (with brief video)
- Radiation in Cancer Patients

Day 12:

- Warm up: Socratic app opinion poll
- Socratic Seminar discussion on differences between scientist understanding and general public understanding
    - cell phone news articles, Hyping Health Risks excerpts, case study text of choice
- Exit poll Socratic app

Day 13:

- Townhall Meeting on nuclear energy in the Triangle

Day 14:

- Unit Review Day
- Students work in groups of 3-4 to complete study guides using notes and work completed during unit
- Students participate in review game

Day 15:

- Warm-up: Silent Study (10 minutes)
- Unit Test
- When students finish, provide 2-3 options for current events articles relating to physiological effects of radiation on the human body. Students complete 10-sentence minimum summary including three sentence minimum opinion/response to current event (summary is extra credit on unit test).