

Careers in the fields of Genetics and or Biosciences
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Overview

Careers: Students what would you like to do after high school?

With the above question asked in a middle or high school classroom, discussion now begins on what lies ahead in the future of our young people. They will give you such answers as; I want to be a doctor, lawyer, engineer, rap star, nurse, hair stylist or any number of other choices. Through all of our discussions I have never heard them choose a field from the genetics or bioscience areas. Education throughout the splendor of its entirety still has a difficult time exposing young people to all of the unique career areas that the world has to offer. Statistics show that the fastest growing career areas today are coming from these two particular areas of study. Life as we know it, is constantly changing. First we had the industrial revolution, which at the time dramatically change the use of hand tools and handmade items. Workers became more productive, which meant more items were produced. This made products available to the poor and not just for the rich. Other effects from the Industrial Revolution: pollution increased and working conditions were harmful, employers hired women and children making them work long hours. This truly was a time for change. We can see career choices are as important as having good health. The importance of this curriculum will be measured by our students when and if they use this knowledge and embark on one of the most interesting and compelling career areas in today's ever changing job market.

Another giant step in time came with the invention of the computer. Who invented the computer? Why was it invented? How will it be used? All are questions that cannot be easily answered. In this unit, students will find the computer a very useful tool with the amount of research that will be required to complete this project. In 1936, Konrad Zuse invented the first freely programmable computer, the Z1, in 1942 Atanasoff and Berry were the first in the computing business with ABC Computers. The first computer used vacuum tubes. In 1948, John Walter and Brattain and William Shockley introduced the transistor, which greatly changed the history of the computer. In 1974, Scelbi and Mark-8 Altains and IBM 5100 computers became the first consumer computer.

Genetics and Bioscience careers will speed right into the future with space exploration: the study of cells in space, the effects of drugs on the body while in space, cloning for the purpose of research in space. There are many points these careers open up for public inspection. On October 4, 1957, the world's first artificial satellite was launched, which was the size of a basketball. The satellite

weighed 183 pounds and took 98 minutes to orbit the earth. The launch created new political, military technological, and scientific developments. We now see life is no longer planted on earth, but replanted in space with the creation of the world's first space station. With this technology comes the scientific breakthrough of the future. Careers using computers are essential and limitless, from their use in our microwave ovens to the controversial world of cloning. This technology is worlds apart from a time when it was perceived that to relieve a headache, a doctor drilled holes in your skull. Bioinformatics is a data management tool, which uses computational techniques that combines mathematics, computer science, and biology with the purpose of uncovering patterns within sets of biological data.

Rational

George Westinghouse High School is located in a predominately Black section of the city of Pittsburgh, Pa. Our students sometimes are left out of the loop when it comes to the so-called spreading of the educational wealth. This unit on careers in Genetics and Biosciences will give the students knowledge of career choices that may not be considered traditional jobs. The Genetics career is so vast that students need to be able to access the many opportunities that may be offered. The use of the computer is essential in today's world. To turn on the television today, you now use an infrared hand held control. They will use the computer to search web sites and master some of the technical English terms that present themselves.

This unit will have the students research, gather, define, and collate career information, which can be used by any group of high school or middle school students in understanding the steps to finding a career. This unit will be technology-based and adaptive to many of the school districts plans to include technology across content areas. Students need to have access: I feel this unit will help to prepare them to thoroughly research, apply, receive, understand, and maintain a career of their choice.

Objectives

This unit will be the roadmap for students. The students will research, gather, exchange, define, exclude, and collate career information on the Genetics and Bioscience careers through the use of the computer that combines links between genomics and computing. The content standards produced by the Pittsburgh Public School District in the areas of Career Education and Work: Reading, Writing, Speaking and Listening: Science and Technology is an inclusive part of this unit. This unit also includes the Pittsburgh School Districts Literacy Plus and Pennsylvania Standards and Assessment Initiative.

Strategies

This unit contains a wide variety of options, first we will discuss, "What is a career"? Fully exchanging information on the question above, we will look at the unit to be completed. Each step carefully explained to maximize objectives and comprehension. Students will receive a brief history in the area of Genetics and Biosciences; this will cover the early stages of cell structure and DNA, right up through genetics,

bioscience, space and technology. Students will learn where to locate the information required to complete the research project. Students will have at the beginning of each class a question and answer session, to lay the groundwork for better understanding. After school tutoring will also be available for the students. Each career area will contain an overview along with a question and answer session. PowerPoint, key terms, and conclusion will be fully discussed to make this unit one that students will continue to use well after completion.

Classroom Activities

Day 1

Objective

Students using the computer, books magazines, personal conversion, and the Pittsburgh Public Schools content standards. You will also use the Pittsburgh School District Literacy Plus criteria's and the Pennsylvania Standards and Assessment for reading, writing, speaking and listening. You are going to complete a research project involving and evolving a career in either the genetics or biosciences areas.

Introduction

Can anyone give me information on genetics or bioscience careers? Does anyone know of someone who works in either of these areas?

“Students you will pair up in groups of two or three for the purpose of researching a career in genetics and or biosciences. Each student within each group will dissect a different career area, of their choice. The focus from each of your career selection will center on the Human Genome Project and how your career choice relate. Within your group each students will research the history of their career choice through the present day surrounding the Human Genome Project, combining job description, educational requirement, latest news, glossary of terms, acronyms, medical applications, ethical issues, and current research in progress. Each student will work independently on all aspects of the project. Students will utilize the group for support and for exchanging ideals, resources, and morale support. A PowerPoint presentation by each student will be given to help in their final presentation before peers, faculty, administration, and parents.” In conclusion, students will complete a research project involving one of the careers in appendix # 3 with emphasis surrounding the Human Gemome Project. Student and teacher evaluation will follow the rubric listed in the appendix # 2.

Materials

Students will need to have access to a computer, books, periodicals, personal contacts, and school standards.

Summary

Students using all available resources will complete a research project evolving a career in either genetics or bioscience areas.

Classroom Activities

Day 2

Objective

Students will discuss proper techniques for gathering information. Following the school standards and the rubric located in later sections.

Introduction

“Students your research project is on careers, you will need to identify your career choice than proceed with where you can locate the information needed. You must also generate a list of question you would like to have answered.” (example) Can a Genetic Counselor help a family deal with their son/daughters birth defect? Where exactly will this information be found? What heading should I be looking for? What information will answer my questions? What information is important? Should I try to contact a Genetic Counselor to help in my research? Students will explain proper techniques for gathering information.

Summary

Students must be able to gather, exchange, define, exclude, and collate career information.

Questions

Name three sources where you can find information?

What information will I need to complete the assignment?

Do I need additional explanation?

Teacher Books and Resources

Edited by Delpos, Manuela, and Salthe, Stanley N. *Evolutionary Systems*. Kluvier Academic Publishers, 1998

Tiley, N. A. *Discovering DNA*. Von Nostrand Company, Inc., 1983

Walvoord, Sheri S. *The Introduction to Genetics*. Macmillan Publishing Company, 1993

Dunn, L. C. *A Short History of Genetics*. New York; McGraw-Hill, 1965

Springes, Karen. The Search for Adam & Eve, *Newsweek*, 11 January 1988, pp. 45-52

Web Sites

Discoveryschool.com, "Understanding Space Travel." 2000. April, 2002

Understanding Space Travel (This web contains Information to help students understand space travel.)

<http://www.school.discovery.com/lessonplans/programs/understanding-spacetravel/index>.

NASA. "Sputnik and The Dawn of The space age" October, 2000. April, 2002

Contains information about the first satellite being launched.

<http://www.hq.nasa.gov/office/pao/History/sputnik/>

Mary Bellis. "The History of Modern Computers and Their Inventors" 2002. April, 2002

Contains information about the beginning of computers.

<http://inventors.about.com/library/blcoindex.htm?once=true&>

U.S. Department of Energy of Science, Human Genome Project. "Human Genome Project" May, 2002. March, 2002. Contain information about history of Genome Project.

<http://www.ornl.gov/hgmis/project/about.html>

nsgc. "Careers in Genetic Counseling" 1995. March, 2002.

Contains information about a career in Genetic Counseling.

<http://www.nsgc.org/CareerInformation.asp>

unknown. "A Trip To The Past" April, 2002. April, 2002.

Contains information about the Industrial Revolution.

<http://members.aol.com/mhirotsu/kevin/trip2.html>

Heather Sparks. "New Technology That Could Save Your Life" March, 2002. April, 2002. Information on how drugs react in space.

http://www.space.com/businesstechnology/technology/space_medicine_020313-1.html

Betty Mansfield. "The Challenges and Impact of Human Genome Research for Minority Communities" July, 2000. June, 2002. Outlines the future of the Genome Project for the Minority Community.

Max Ingman. "Mitochondria DNA Clarifies Human Evolution" May, 2001. February, 2002. Information on what is Mitochondria DNA.

<http://www.actionbioscience.org/evolution/ingman.html>

Beverly Mertz. "A Short History of Mapping" 1991. February, 2002

Contains a brief overview of gene mapping.

http://www.accessexcellence.org/AB/IE/short_History_of

Thomas k. Grose. "How Powerful New Computers Are Helping Researchers Revolutionize Drug Development" December, 2001. March, 2002

<http://www.time.com/time/europe/digital/magazine/09868,192141.00html>

PBS. "Careers in Genetics and Related Fields" September, 97. June, 2002

Contains information about careers.

<http://pbs.org/gene/career/61-option.html>

Student Resources (All Web Sites contains links, that will increase students research capabilities.)

“Understanding space travel” 2000

<http://www.school.discovery.com/lessonplans/programs/understanding-spacetravel/index>

“Mitochondria DNA Clarifies Human Evolution”

<http://www.actionbioscience.org/evolution/ingman.html>

“A Short History of Mapping”

http://www.accessexcellence.org/AB/IE/short_History_of_Mapping

“Human Genome Project”

<http://www.ornl.gov/hgmis/html>

“New Technology That Could Save Your life”

http://www.space.com/business/technology/space_medicine_020313-1/html

“The History of Modern Computers and their Inventors”

<http://www.inventors.about.com/library/blcoindex/html>

“How Powerful New computers are Helping Researchers Revolutionize Drug Developments”

<http://www.time.com/time/europe/digital/magazine/0.9868,192141.00/html>

“Careers in Genetic Counseling”

<http://www.nsgc/careerinformation.asp.html>

“Careers in Genetics and Related Fields”

<http://www.pbs.org/gene/career/61-option.html>

Appendix

Career and Education Work Standards

Through the Pittsburgh Public School District a set of content standards were developed. The following standards are incorporated throughout each student's writings.

1. All students explore the multiple purposes of work and the range of career options, including entrepreneurship, and relate them to their individual interests, aptitudes, skills and values.
2. All students assess how changes in society, technology, government and the economy affect individuals and their careers and require them to continue learning.
3. All students understand and demonstrate the importance of relating their academic and technical/vocational skills-for example interviewing, creative thinking, decision making, problem solving, understanding and giving written and oral instruction-to their ability seek, obtain, maintain, and change jobs.
4. All students completing a technical/vocational education program exhibit the skills required to succeed in a particular occupation for which they are prepared.

Students will research a career using the computer, with an emphasis around genetics, Bioinformatics, and Biosciences, which can produce computational science information.

Science and Technology Standards

- 1 All students explain the relationships among science, technology and society.

- 2 All students construct and evaluate scientific and technological systems using models to explain or predict results.
- 3 All students evaluate advantages, disadvantages and ethical implications associated with the impact of science and technology on current and future life.

Reading, Writing, Speaking and Listening Standards

- 1 All students use effective research and information management skills, including locating primary and secondary sources of information with traditional and emerging library technologies.
- 2 All Students read and use a variety of methods to make sense of various kinds of complex texts.
- 3 All Students respond orally and in writing to information and ideas gained by reading narrative and informational texts and use the information and ideas to make decisions and solve problems.
- 4 All students analyze and make critical judgments about all forms of communication, separating fact from opinion, recognizing propaganda, stereotypes and statements of bias, recognizing inconsistencies and judging the validity of evidence.
- 5 All students exchange information orally, including understanding and giving spoken instructions, asking and answering questions appropriately, and promoting effective group communications.

- 6 All students listen to and understand complex oral messages and identify their purpose, structure and use.

- 7 All Students compose and make oral presentations for each academic area of study that is designed to persuade, inform or describe.

Assessment

Student evaluation is as follows:

Students will be evaluated on the points system 0-5, with 0 being the poor and 5 being Mastery.

Poor Somewhat Proficient Proficient Above Proficient Mastery
0-----5

Research

Terminology

Comm. Skills

Analytical Skills

Decision Making

Problem Solving

Written and Oral

PowerPoint

Group participation

Description of Evaluators:

Research: Student must use a variety of resources and maintain a notebook. The teacher will review notebooks every two days for comments or suggestions.

Terminology: Words must be defined and placed in notebook titled glossary.

Communication Skills: When addressing peers, teachers, administrators, or parents, students must possess communication skills that show content knowledge.

Analytical Skills: Students will become proficient when determining what is valuable information.

Decision Making: Students will improve their time management skills, as to meeting timeline points.

Problem Solving: Student will encounter various roadblocks that require problem-solving abilities.

Written and Oral Instruction: Students will follow all instruction; it is the student's responsibility on points of clarity.

PowerPoint Presentation: Students will present certain data through the use of PowerPoint.

Group Participation: Each student must exchange ideas with members of their group.

Modifications for IEP: Adapted grading

Work will be graded based on what is written in the IEP. Work will be considered performance based with the understanding of each student's functioning level. Weight grades to reflect student's strength. Compare the student only to him or herself. Don't be rigid or inflexible. Look for improvements based on information requested, require only part of the information to be learned. Do not count spelling errors. Strategies that may be used for the project in the classroom:

- Peer Tutoring
- Computer programs
- Ability grouping
- Cooperative learning
- Pacing
- Pre-teaching Vocabulary
- Highlight handouts
- Positive reinforcement
- Immediate feedback

Basic principles underlying inclusion:

- Inclusion is a basic value that extends to all children: everyone belongs and everyone is welcome.
- Inclusion is not conditional, and programs must fit the child rather than children fitting the program.
- Special education must become an integral part of general education, and the two separate systems must become unified in their efforts to meet the needs of children.
- Children with disabilities must be full and active participants in school and community, occupying socially valued roles.

Teacher Evaluation is as follows:

Teacher will be evaluated on the points system:

Students will evaluate the teacher by drawing a line next to each heading ranging from poor to mastery.

Poor Somewhat Proficient Proficient Above Proficient Mastery
0-----5

Assignment

Introduction

Comm. Skills

Written and Oral

Instructions

Time

Information

Requested

Rubric

List of career choices are as follows:

- 1) **Medicine & Genetics:** Medical genetics, genetic counseling, genetic nursing. Gene testing, gene therapy. Organ transplantation, fertility, and reproduction. Public health. Pharmaceutical industry and suppliers, Pharmacogenomics, Chemical, vaccine, medicine development and production. Database development, operation, use. Communication, work with regulatory agencies.
- 2) **Agriculture and wildlife:** Genetic modification of foods and seeds. Biopesticide and nutraceutical development. Wildlife management: Identification, protection of endangered species. Authentication of consumables such as wine, caviar.
- 3) **Computational Biology (including Bioinformatics)** Database creation, data analysis, modeling, data transfer. Supercomputing. Mathematics, statistics, actuarial field.

- 4) **Engineering Disciplines** Bioprocessing chamber, vat design and production. Toxic-waste cleanup. Instrumentation development. Creation of new energy sources via engineering, life science research. Biomedical engineering.

- 5) **Business** Biosciences industry investing. Marketing and sales. Banking.

- 6) **Law and Justice** Education. Patent specialties. Specialties in ethical, legal, and social issues. Gene and paternity testing. DNA forensics—in the laboratory, in the field, in the courtroom.

- 7) **History and Anthropology** Use of genetics to study population,
- 8) migration patterns. Study of inheritance over evolutionary time.

- 9) **Military** Soldier identification. Pathogen identification. Biological and chemical warfare protection. Radiation-exposure assessment.

- 10) **Space Exploration** Research into space effects. Search for other life forms, evidence of life.

- 11) **Bench Science** Sequencing of many organisms, including human. Data analysis, computation. Functional genomics.

Key Terms: INTERACTIVE WORD WALL

(Definition) A word wall is a systematically organized collection of words displayed in large letters on a wall or other large display place in the classroom.

(Purpose) The interactive word wall is designed to: support the teaching of important general principles about words and how they work.

Provide reference support for students during reading and writing activities.

Promotes group learning.

(Connections)

- Words that relate to the content
- Words that are embedded in the lesson
- Words that connect to important concepts
- Words that students request frequently
- Words that relate to a theme

The Interactive Word Wall is part of the School Districts Literacy Plus and Pennsylvania Standards and Assessment Initiative.

Allele- The different forms of the gene for a trait.

Artificial chromosomes- Artificially constructed vectors that combine the essence of a eukaryotic chromosomes-an origin for DNA replication, a centromere, and telomeres- with foreign DNA.

Autosome- All the chromosomes in a cell other than the sex chromosomes.

Biotechnology- The manipulation of organisms or their components to perform practical tasks to provide useful products.

Chromosome walking- a method of physically mapping DNA by making fragments overlap and then using probes to find the overlapping ends.

Clone- An exact genetic replica of a living being.

Cloning Vector- A DNA molecule that can carry foreign DNA into a cell and replicate there.

Codominance- A characteristic that is equally expressed when paired with another similar characteristic.

Complementary DNA- DNA which contains the coding sequence for a gene but no introns. It is artificially produced.

Crossing-over- The process in which homologous pieces of chromosomes switch places.

DNA- Deoxyribonucleic acid

DNA fingerprint- Specific pattern of bands, that is of forensic use.

DNA library- A library for the collection of genes.

Dominant- A characteristic that is expressed over other characteristics of a single trait.

Embryology- The study of the development of the individual from egg to birth or hatching.

Ethical- Relating to or involving questions of right and wrong.

Eugenics- A science that deals with the improvement (by control of human mating) of hereditary qualities of a race or breed.

Evolution- A theory that the various types of animals and plants have their origin in other preexisting types and that the distinguishable differences are due to modifications in successive generations.

Exon- Part of the DNA that codes for amino acids that form part of the protein.

Gel electrophoresis- a technique, which separates macromolecules (nucleic acid or proteins) on the basis of size, electrical charge, and other physical properties.

Gene cloning- Process of preparing well-defined, gene-sized pieces of DNA in multiple identical copies.

Genetic code- The biochemical basis of heredity consisting of codons in DNA and RNA that determine the specific amino acid sequence in proteins and appear to be uniform for all known forms of life.

Genetic engineering- the direct manipulation of genes for practical purposes.

Genes- The building blocks of DNA, which serve as transmitters of hereditary characteristics.

Genomic library- the complete set of thousands of recombinant-plasmid clones each carrying copies of a particular segment from the initial genome.

Genotype- The gene makeup of an individual. The genetic components of a trait.

Heredity- The sum of the qualities genetically derived from one's ancestors.

Heterozygous- Having two different alleles for a trait.

Homeotic genes- Genes that control key events in the development of an organism.

Homozygous- Having two identical alleles for a trait.

Human Genome Project- An international effort to map the entire human genome ultimately by determining the complete nucleotide sequence of the DNA of each human chromosome (the 22 autosomes and the X and Y sex chromosomes).

Hybrid- Individual organisms that is heterozygous for a given trait.

Incomplete dominance- the blending of traits when two genes are expressed equally.

Law of dominance- when two pure traits are mixed, the dominant trait will be expressed.

Law of independent assortment- Mendel's law which states that traits are inherited independent of one another.

Mutate- To change either the physical relation of chromosomes or the genetic sequence in an organism.

Nucleic acid hybridization- the process by which the DNA of a gene is determined by its base pairing with a complementary sequence on another nucleic acid molecule.

Nucleic acid probe- the complementary molecule, a short single-stranded nucleic acid that can be either RNA or DNA, which is used in nucleic acid hybridization.

Nucleotide- The basic unit of nucleic acids consisting of a five carbon sugar, phosphate, and a base (cytosine, guanine, thymine, adenine or uracil).

Nucleus- The control center of a cell.

Oncogenes- A type of gene that, when activated, may cause cancer.

Operon- A group of genes that regulate the production of a protein by regulating the amount of mRNA.

Phenotype- The physical expression of a genetic. The physical appearance of a trait as a result of the genes that is present.

Polymerase chain reaction (PCR)- A technique by which any piece of DNA can quickly amplified (copied many times) without using cells

Recessive- A characteristic that is not expressed when paired with the dominant characteristic.

Recombinant DNA- DNA in which genes from two different sources are linked.

Restriction enzymes- Enzymes that cut DNA molecules at a limited number of specific locations.

Activities

Day 1 & 2

Assessment

- A. Introduction
- B. Research
- C. PowerPoint
- D. Conclusion

Terms

- A. Definition of key Terms

Day 3

Careers in Genetics and Biosciences

- A. Industrial Revolution
- B. Cause & Effect

Day 4

Introduction to Computers

- A. Beginning
- B. Inventors
- C. Common Usage
- D. Computers in the Classroom

Day 5

Space Age

- A. First Launch
- B. Space Race
- C. Space & Technology
- D. Space Station

Day 6 & 7

Genetics & Biosciences

- A. History of EVE
- B. Mitochondial DNA
- C. Genome
- D. Human Genome Project

Day 8 & 9

PowerPoint Presentation

- A. Layout
- B. Opening
- C. Points
- D. Summary

Day 10

Conclusion

POWERPOINT PRESENTATION

CAREERS IN GENETICS AND BIOSCIENCES

Students you will deliver material of a technical nature to an audience unfamiliar with the topic or vocabulary. The material may be complex or heavy with details. To present technical material effectively, use the following guidelines.

OPENING

1. Establish some common ground between presenter and audience.
2. Look for participation.

In your opening, establish the point of your topic to your audience. Give a brief preview of the listeners. Take into account your audiences knowledge base in the topic when using words to explain a subject. Focus on the importance of the topic to your audience, and you will have more attentive listeners. Ask you audience questions, get them involved.

Point

- 1 Use clear language to state point.
2. Use evidence both verbal and visual to support your point.

3. Highlight your point by using an example.
4. Develop a logical transition or bridge to your next point.

If you have several points, steps, or key ideals use several slides. Determine if your audience is to understand a new idea, learn a process. Back up each point with adequate explanation. Supplement your presentation with technical support data in hard copy or disk. Develop each point adequately to communicate with your audience.

Close

1. Summarize your points.
2. State your conclusion. Make it relevant to your audience.

Determine the best closing for your audience and your presentation. Close with a summary, offer options, recommend a strategy, suggest a plan, you want to have a goal. Keep your focus throughout your presentation, and you will more likely achieve your purpose.

History

Students must first begin by researching the Human Genome Project. The assignment required is based on this research project. The background information will allow the students to understand the complexities of their assignment. Their research will begin with Mitochondria DNA and Human Evolution. DNA is two chains intertwined around each other to form a ladder. Recent DNA studies state that life, as we know it began in mother Africa. Mutation occurred in our DNA, with these changes scientist have discovered through (Polymorphism) that on the outside we are all unique, but on the inside we are all generally the same. Because information is so well guarded between anthropologists we have read opposing views on how modern humans evolved. They do agree that we evolved from Africa and spread around the world, 1 to 2 million years ago.

Mitochondrial DNA, which is maternal, is used to construct the evolutionary tree. Because the mitochondrial DNA can only be inherited from the mother, this allows bloodlines to be established. This information explains the beginning of life from one mother, subsequently she was named Eve. The mitochondria are the first genome to be entirely sequenced, but until recently, technology could not study an appreciable size of the genome. This study is important in the field of population genetics.

Population genetics gives strong support to the Africa origin theory, this now allow times and dates to be applied to the tree, which puts onus on evolution and migration of the species. Understanding the mitochondrial DNA was the beginning, now we must understand the Human Genome Project. Project goals are to identify all of the approximately 30,000 genes in the human DNA, determine the sequences of the 3 billion chemical base pairs that make up human DNA, store this information in a database, improve tools for data analysis, transfer related technologies to the private sector, and address the ethical, legal, and social issues that may arises from the project. Since the government is spearheading the project, private industry is receiving much-needed grants and awards, along with this spawning a multi-billion dollar biotechnology industry fostering new medical applications.

What is a genome? A genome is the entire DNA in an organism, including its genes. Genes carry information for making all the proteins required by all organisms. Learning about DNA can help researchers discover new ways to diagnose, treat, and possibly prevent disorders that affect us.