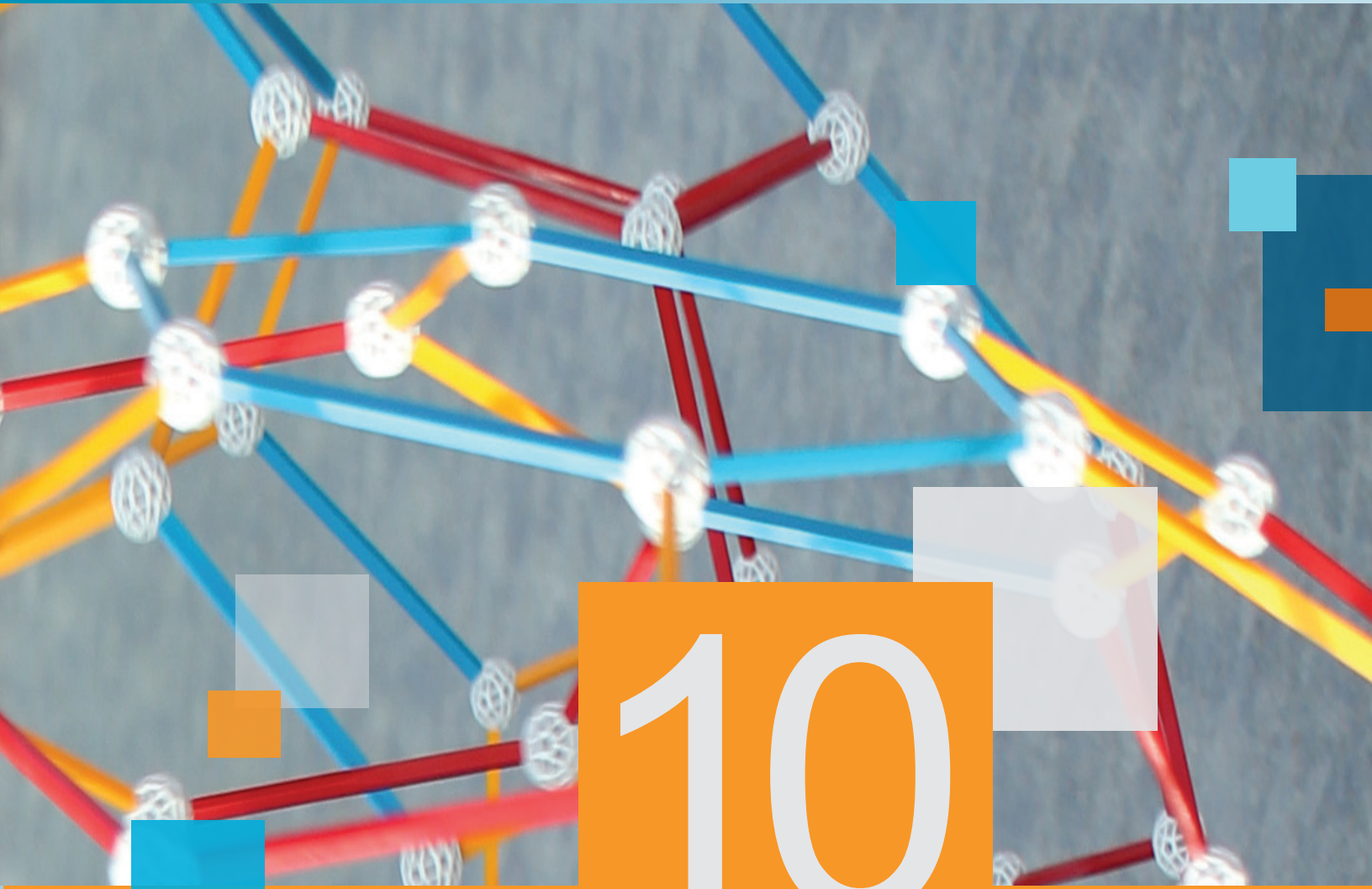


NANOTECHNOLOGY

LESSON PLAN FOR SCIENCE 10 - BRANWORK



Science Teachers,

This lesson plan was designed for grade 10 and meets Alberta Education curriculum learning outcomes for science (see the following page for program of studies reference). The plans are easy to understand and implement without any specialized training, additional work or study. Best of all, they make this interesting subject matter engaging to teach.

The lesson plans were focus tested in seven schools throughout Alberta, incorporating teacher's feedback, and received great reviews. These plans provide the tools necessary to guide students through interactive experiences with nanotechnology that will help them understand this aspect of science. Included in the lesson plans are:

- a short explanation on what is nanotechnology,
- an activity description,
- time requirements,
- materials,
- an assessment rubric, and
- an in-depth teacher's background for reference.

Each lesson was designed in a way that allows you to quickly adapt it to your specific class needs and/or level of knowledge. If you wish to go deeper into the material, you can use the links provided under References or Bibliography. These lesson plans are complemented by a Nano Resource DVD for additional resources such as comic strips, videos, photos and more information related to teaching and understanding nanotechnology. These resources are also available for downloading at nanolessonplans.alberta.ca.

Did You Know?

The University of Alberta, the University of Calgary, and the Northern Alberta Institute of Technology all offer nanotechnology programs to train the next generation of curious and bright minds.

As you can see, the subject of nanotechnology is rich with opportunities for learning. We hope you will find the lesson plans worth implementing and include this fascinating area of science in your science program for the year.

If you require more information on additional nanotechnology learning experiences, or have any questions about the information provided, please contact nanoAlberta at 780-450-5111 or email nano@albertainnovates.ca. For grades 7 to 12 check out our travelling Scanning Electron Microscope (SEM) program and book it for your school today. This free program supplies the Microscope for a week and an Alberta certified science teacher will come and work with you and your class or school. A great complement to the nano lesson plans. Visit nanolessonplans.alberta.ca for more information on the SEM program.

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These lesson plans are available to view online and can be downloaded free at nanolessonplans.alberta.ca

Limited additional copies are available for ordering from the Learning Resource Centre at lrc.education.gov.ab.ca

For information, including reproduction for commercial purposes, please contact: Alberta Innovates - Technology Futures
nanoAlberta
Phone: 780-450-5111
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This information was accurate, to the best of our knowledge, at the time of printing. Science technology and education information are subject to change, and you are encouraged to check our website (nanolessonplans.alberta.ca) for updated lesson plans, additional resources and sources.

**Program of Studies Reference:
Science 10 –
Cycling of Matter
in Living Systems**

Key Concepts

- Microscopy and the emergence of cell theory
- Cellular structures and functions and technological applications

Skills

- Initiating and Planning
- Reforming and recording
- Communications and Teamwork

Attitudes

- Interest in Science
- Collaboration
- Scientific Inquiry

STS

- Imaging technology and the current understanding of the cell
- Describe the function of cell organelles and structures

**Check out these other great
Nanotechnology Lesson Plans**

Nanotechnology: Lesson Plan for Grade 4 Science
Slippery Leaves

Nanotechnology: Lesson Plan for Grade 5 Science
Small is Different–Classroom Chemistry

Nanotechnology: Lesson Plan for Grade 6 Science
Forestry Nano Superheroes–Trees and Forests

Nanotechnology: Lesson Plan for Grade 7 Science
Nanotechnology and the Environment – Smart Dust

Nanotechnology: Lesson Plan for Grade 8 Science
Nanovision–Light and Optical Systems

Nanotechnology: Lesson Plan for Grade 9 Science
Carbon’s Nanocaper–Matter and Chemical Change

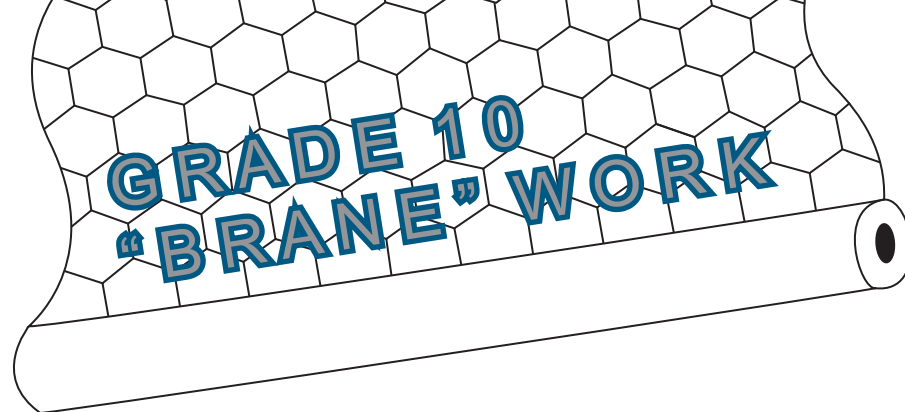
Nanotechnology: Lesson Plan for Chemistry 20
Putting it Together-Self Assembly
–The Diversity of Matter and Chemical Bonding

Nanotechnology: Lesson Plan for Biology 30
Medical Applications of Nanotechnology
–Cell Division, Genetics, and Molecular Biology

Did You Know?

Nanotechnology opens students to a wide variety of occupations in an even wider variety of industry sectors. Consider that nanotechnology may be encountered and used in some way by:

- Applications Technician
- Bio Material Engineer
- Cancer Researcher
- Characterization Scientist
- Chemical Technologist/Engineer
- Chemist
- Coating Scientist
- Computational Physicist
- Contact Metallization Process Engineer
- Electron Microscopy Technician
- Materials/Nanotechnology Scientist
- Materials/Metallurgical Engineer
- Mechanical Engineering
- Molecular Biologist
- Molecular Imaging Technologists
- Nanobiologist
- Nanoparticle Development Scientist
- Nanotechnology Business Manager
- Nanotechnology Laboratory Technician
- Nanotoxicologist
- Optical Engineer
- Pharmacologist
- Process Quality Engineer
- Product Marketing Manager
- Tissue Engineer
- Wafer Fabrication Development/Process Engineer



ACTIVITY DESCRIPTION

This activity has students take the information taught about cell structures (particularly, but not limited to, cell membranes) and use it to investigate how nanoscience and technology have used these basic principles to advance human and plant health and diagnostics. This is, after a brief introduction, a research project followed by a communication/presentation of results. It is recommended that students work in groups of not more than three.

Note that “brane” is used as an abbreviation of membrane, with “Brane Work” intentionally made to sound like “Brain Work”.

TIME REQUIRED

80 minutes spread over two class periods, with a 1-2 week break in between.

- The first session introduces the concepts of nanoscience and nanotechnology and builds on the information already presented in class.
- The second session is used to present the results. Its length depends on the number of students in the class. Presentations of different types (PowerPoint, Skit, Pecha Kucha, video, etc.) are encouraged.

MATERIALS

This activity does not require in-class materials except those needed for developing presentations, and the student “teaser” sheets at the back of this lesson.



GLOSSARY

- nanoscience
- nanotechnology
- nanoparticles
- biomimicry
- quantum dots
- membranes

CLASS PREPARATION

Introduction

10 - 15 minutes

Introductory NanoScience PowerPoint Presentation

As an introduction to nanotechnology, teachers may wish to present the PowerPoint presentation created by NanoSense (SRI International) found at:

<http://nanosense.org/activities/sizematters/index.html> under “Lesson 1—Introduction to Nanoscience”.

Summarize cell structures and, particularly, cell membrane make-up, including markers or antigens on the cell membrane for immune system identification. Differences between the membrane composition of healthy cells, diseased cells, cancer cells, bacteria, and viruses can also be identified.

Antigens can be used to anchor drug delivery systems or nanoshells, which may be used in cell identification and destruction.

Student Sheet on biomarkers, quantum dots, and nanoshells

Student Sheet on water purification using membranes

Assessment:

- depth of research
- ability to communicate a scientific/technological topic clearly
- teamwork component
- general understanding of the topic
- ability to tie the nanotechnology research into the importance of understanding cell functions

ASSESSMENT

Example rubric.

Presentation: suitable for PowerPoint, Pecha Kucha, video, podcast

	POOR	FAIR	GOOD	EXEMPLARY
KNOWLEDGE	Group does not have grasp of information; questions cannot be answered	Group is uncomfortable with information and is only able to answer rudimentary questions	Group is at ease with content, but fails to elaborate	Group demonstrates full knowledge (more than required) with explanations and elaboration
LANGUAGE APPROPRIATE	Too many unexplained technical terms, or language at a very young level	Most technical terms explained; language within a few years of appropriate	All technical terms explained; language age- and grade-appropriate	Technical terms explained in context; language appropriate
DELIVERY (PRESENTATION STYLE)	Mumbling, incorrect pronunciation, too quiet to hear; transition between presenters chaotic	Incorrect pronunciation; audience may not hear presentation; transition between presenters rough	Clear; few stumbles with the information; transitions between presenters smooth	No stumbles; clear voice; transitions between presenters appear seamless
MECHANICS	Lots of spelling and grammar mistakes	A few mistakes	Fewer than 5 mistakes	No mistakes
ORGANIZATION	No sequence of information	Student jumps around through information	Information presented in a logical sequence	Information presented in a logical and interesting sequence

<http://www.albertatechfutures.ca/nanoAlberta/AlbertaNanoAssetMap.aspx>

<http://www.wisc-online.com/objects/ViewObject.aspx?ID=NAN405>

Dr. Ted Sargent's *The Dance of the Molecules* is a good source of information on the possibilities of nanotechnology.

A slide show on nanotechnology as it is applied to cancer and health. This slide show can be modified as needed, as long as the National Cancer Institute logos are not removed.

<http://www.cancer.gov/cancertopics/understandingcancer/nanodevices/allpages>

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STUDENT SHEET

Biomarkers, Quantum dots, and nanoshells

Adapted from <http://www.cancer.gov/cancertopics/understandingcancer/nanodevices>

Every cell whether animal, plant, bacteria or virus covering has a distinct membrane that identifies the organism. The make-up of the membrane is a lipid boundary (like a wall) with proteins that act as gatekeepers to allow materials to flow in and out of the cell. To attract material to the cell, the cell membrane also has other unique proteins that connect to the cell wall. These proteins identify the unique nature of the cell. Biomarkers are chemicals that bond to these unique proteins.

Proteins on the surface of cancerous cells are different in some ways to the proteins on the surface of healthy cells. Being able to identify the cancerous cells proteins and bind them to antibodies, drugs, or other agents will kill the cancerous cells. There are a number of different approaches that can be taken to identify and bind them.

Identification for surgical removal (using quantum dots)

A minuscule molecule that can be used to detect cancer is a quantum dot. Quantum dots are tiny crystals that glow when they are stimulated by ultra-violet light. The wavelength (or colour) of the light depends on the size of the crystal. Latex beads filled with these crystals can be designed to bind to specific DNA sequences (or proteins). By combining different-sized quantum dots within a single bead, scientists can create probes that release distinct colours and intensities of light. When the crystals are stimulated by UV light, each bead emits light that serves as a sort of spectral bar code, identifying a particular region of DNA.



Quantum dots can be bound to cancerous cells so that all of the cancerous cells can be identified during surgery and the surgeon will only remove the cancerous ones—not the normal ones.

Binding of diseased/cancerous cells with nanoshells

Nanoshells are miniscule beads coated with gold. By manipulating the thickness of the layers making up the nanoshells, scientists can design these beads to absorb specific wavelengths of light. The most useful nanoshells are those that absorb near-infrared light, which can easily penetrate several centimetres of human tissue. The absorption of light by the nanoshells creates an intense heat that is lethal to cells.

Researchers can already link nanoshells to antibodies that recognize cancer cells. Scientists envision letting these nanoshells seek out their cancerous targets, then applying near-infrared light. In laboratory cultures, the heat generated by the light-absorbing nanoshells has successfully killed tumour cells while leaving neighbouring cells intact.

STUDENT SHEET

Membranes for water purification, desalinization

A large percentage of the Earth's water is contaminated with dissolved salts and minerals or pathogens.

Osmosis

The passage of water from a region of high water concentration to a region of low water concentration, through a semi-permeable membrane. The cell membrane is a semi-permeable membrane. This process allows the cell to stay filled with water, which is important since cell activities go on in a water-filled (aqueous) solution. This activity occurs naturally in a cell.

Reverse osmosis

To move water from a region of lower concentration to one of higher concentration (such as a region where water is contaminated with dirt, viruses, bacteria, or salts to a region of pure water), a semi-permeable membrane can again be used. The process does not occur naturally, however—energy must be used to force the water through the membrane. The membrane must prevent contamination from passing through it, and nanotechnology can be used to help develop membranes that can do that.

Types of nanotechnology membranes

While cell membranes are made of lipids with protein-controlled openings to let resources in and waste out, non-organic membranes that behave similarly can be made of many different materials. A nanotechnology tool that can be used for this purpose is a carbon nanotube.



Carbon nanotubes

The nanotubes (sheets of graphene rolled into a tube) are arranged so that they are closely packed together, which allows water to flow through them as if traversing a pile of straws. The opening of the nanotubes is only a few nanometers wide, so that water molecules can pass through them, but bacteria, biological material, and other impurities cannot. Thus, the water obtained after passing through the nanotube is clear of impurities.



Traditional membranes capture the impurities within the membrane, so it requires cleaning or back flushing. But the impurities are kept out of the nanotubes entirely, so that cleaning is more easily done.

Another possible application of such filters is water desalination

<http://www.nanobugle.org/2009/09/carbon-nanotube-membranes-for-water-purification/>

Polymers and engineered nanoparticles

At the following link, there is a description of an engineered membrane that uses carefully-designed nanoparticles to attract and retain water while repelling salts and impurities. By developing membranes that are porous and hydrophilic, a more efficient reverse osmosis process could be achieved.

<http://nanotechnologytoday.blogspot.com/2006/11/nanotech-water-desalination-membrane.html>

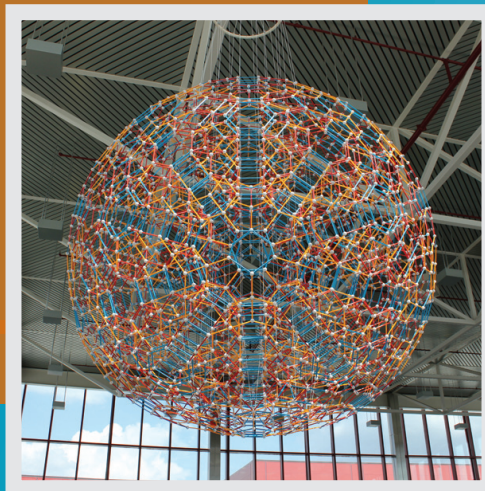
WHAT YOU'LL FIND HERE

- a “pick-up-and-go” lesson plan that will add science currency to your science program
- activities that meet science curriculum learning outcomes
- interesting subject matter that is engaging to teach
- easy to implement experiments (no specialized training needed)
- a quickly adaptable lesson with worksheets and rubrics for your class needs

Nano is... the scientific term meaning one-billionth (1/1,000,000,000). It comes from the Greek word meaning “dwarf”.

Nano Science is... the discovery, research and understanding of all things nano.

Nanotechnology is...
the application of science at the molecular level.



Nanotechnology

is revolutionizing medicine, energy production, environmental protection, bioindustries and more!

Government
of Alberta