Subject Area-Biology, Nanotechnology, Engineering
Associated Unit-
Associated Lesson-
Activity Title-Drug Delivery Nanobots

Grade Level-AP Biology
Time Required: 45-75 minutes
Group Size: 2-4
Expendable Cost per Group: $5

Summary
The students are introduced to amino acids, functional groups, binding sites and nanomedicine. They are also constantly exposed to drug advertisements via television and made aware of concepts such as risks and side effects. This activity enables them to learn more about specific diseases as well as cellular activation sites. In groups, they design a robot that can travel through the bloodstream and deliver a drug directly to specific cells.

Engineering Connection
The developing field of nanotechnology is extremely multi-disciplinary, including various forms of engineering as well as medical professions. This activity demonstrates the collaboration of engineers with professionals from other fields to solve problems that neither could solve independently. One important niche of nanotechnology has been in the treatment of cancer, drastically less invasive and with less side-effects than conventional radiation and medication treatments.

Engineering Category
(1) relates science concept to engineering

Keywords: nanotechnology, cell activation, cancer, functional groups

Educational Standards
Texas Science

Learning Objectives
After this activity, students should be able to:
Identify functional groups of proteins
Describe the mechanism of cellular activation
Understand the process of cancer treatment via drug delivery

Materials List
Each group needs:
Assigned or selected cancer type
Model building materials, such as:
Legos
Modeling clay
Paper and Markers
Ball and Stick
Etc

Introduction / Motivation

Living in the Houston area, cancer is an ever-present reality. Most of us know someone, friend or relative, who has or has had cancer. Due to the variety of cancer diseases and the toll on human health, world-wide efforts to curb cancerous disease and its causes have been effected with much greater support than most other diseases. Many forms of treatment are available, but one unifying theme is the difficulty in targeting only cancerous cells and leaving non-cancerous cells unharmed. One method currently being developed incorporates a number of different research fields to expeditiously deliver medication to the cancerous cells using nano-devices. These nano-devices use chemoattractants to selectively attach to cancer cells and can deliver a payload, either medicinal or mechanically destructive.

In this lab, you will design and construct a model of a nano-device to selectively attach to a cancer cell of your choice. The device must meet the following requirements:

1. The device must be trackable (luminescence, radiation, etc.)
2. The device must be able to carry a payload
3. The payload must reduce the cancer, either chemically or mechanically
4. The device and its effects should have limited side-effects, and these should be noted
5. The device must be nanoscale (< 100 nm)

Procedure

Before the activity:

1. GK12 fellow presentation on the use of nanotechnology in oncological research.
2. Distribute 2-3 current research papers using nano-devices to reduce/eradicate cancerous tissue.
3. Teacher describes the purpose and logistics of this activity to the students as well as the rubric for assessment.
4. Students break up into their respective lab groups and decide on a specific form of cancer to target.
5. Students also decide who will research the cancer and who will research the nanotechnology (2 for each).
6. Teacher and GK12 fellow make suggestions to individual groups on methods of research, more effective web searching, etc.

One week from start

1. Students bring 2 research articles each to their lab group on their selected form of cancer and the nanotechnology currently being researched.
2. Students discuss findings and decide on nano-device to recreate/modify and how they will represent it (food items, styrofoam, etc.).
3. Students distribute responsibility to bring items for the next week when they will construct the model.
4. Teacher and GK12 fellow comment on groups individually and aid in model design.

Two weeks from start

1. Students bring construction materials to class and build their model.
2. Teacher and GK12 fellow assist groups individually.
3. Outside of class, groups generate a presentation on their cancer/nano-device for the following weeks.

Three weeks from start

1. Students present their models and their findings on the cancer.
2. Teacher assesses their presentations, depth of investigation, etc.
3. Students rate each group providing constructive criticism to hand in. Teacher will distribute later.

Assessment
Students will be graded individually based on a provided rubric.