**Final Assessment: Build-A-Particle**

**Teacher’s Guide**

INTRODUCTION: In this assignment, students will combine their knowledge of surface area, size and nanotechnology to design a novel nanoparticle that addresses a current medical problem. These are authentic issues that nanoparticles are being used to address today. Students will read a short description of each problem, including information vital to designing an appropriate particle. Then, they will assess the functions and benefits of a variety of auxiliary molecules, currently used to functionalize nanoparticles for specific purposes. Students should identify characteristics that are useful to a given problem, design a particle that emphasizes these benefits and support their design with reasoning. Lastly, they will create SuperNano card that creatively discusses the design, function and “powers” of their particle.

OBJECTIVES:

Students will-

* Identify key components of a given problem
* Assess a variety of traits for usefulness in a given application
* Design a particle based on a desired function
* Support a proposed design with reasoning
* Demonstrate that nanoparticles are customizable for many uses

TIME: 75 min or 45 min + additional at home

MATERIALS:

* “Build-A-Particle” Student sheet

PROCEDURE:

1. Explain to students that they will now use their understanding of nanoparticles and their many uses to design their own.
2. They will analyze a chosen problem (1 out of 4 options), identify its key features, and design a nanoparticle that addresses these key features. Point out that all these problems are real problems that scientists are trying to use nanoparticles to solve.

1. Explain that they will need to combine 1 base nanoparticle with any necessary accessory molecules to accomplish this task. Stress that only 1 base particle may be chosen, but any number of accessory molecules may be necessary. You may chose to print Table 1 (Base Particles) and Table 2 (Accessory Molecules) on different colored paper and have students cut out. This will allow for easy maneuvering and clarify the difference between the two types of Nano-pieces.
2. Point out to students that they must be able to explain their use of every piece of their new nanoparticle- every part should have a specific purpose and reason for being there. There is more than one solution for each problem, but their reasoning is what matters.

ANSWER KEY and RUBRICS:

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| --- | --- | --- | --- |
|  | **Key Features** | **Possible Nanoparticles** | **Explanation** |
| **Cancer Detection** | - Detected through tumor markers- Must detect small concentrations of compounds- Use MRI for detection | Base Particle: SPIOAccessory Particles: APTES, HerceptinPossible inclusions: Raman detector, PEG, Calcein Probe | - SPIO must be used to function with MRI due to its magnetic properties- Herceptin must be added to bind to tumor markers-APTES is a linker that allows other molecules to bind to nanoparticles |
| **Multiple Sclerosis** | - Attacks nervous system- Treatment must cross Blood Brain Barrier (BBB)  | Base Particle: LisosomeOther Possible Particles: Silica, ChitosanAccessory Particles: APTES, Prednisolone, PEG | - Lisosome particles are ideal because of their ability to cross biological barriers and formation of vesicles- APTES = linker- Prednisolone, the MS medication, should be enclosed within the nano-lisosome- PEG allows the molecule to cross the BBB |
| **Asthma** | - Causes inflation of airway tissue and production of mucus- Results from low levels of Interferon-gamma-Altered gene expression is a potential therapy | Base Particle: ChitosanAccessory Particles: None required, but could add APTES and PEG | - Chitosan interacts with Interferon, an important factor in Asthma- Attaches to Mucus  |
| **Antimicrobial Resistance** | - Microbes develop rapidly to combat chemical antibiotics- Microbes have negative membranes | Base Particle: NanopolymerAccessory Particles: None Required, but could add APTES, PEG, Raman Reporters or Calcein AM | - Nanopolymer is ideal for its positively charged surface- Additional molecules could either be to mask the positive charge until necessary or for detection purposes |

SCORING RUBRIC: SuperNano Card and Activity Analysis

*Overall Scoring may be adjusted by weighting specific categories more than others, such as accuracy and reasoning.*

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| --- | --- | --- | --- | --- | --- |
|  | **0** | **1** | **2** | **3** | **4** |
| **Accuracy** | Student provides no accurate information | Student provides some information, but with several major inaccuracies or misconceptions | Student provides mostly accurate information, but may have 1 substantial inaccuracy  | Student provide mostly accurate information with only minor inaccuracies | All information is accurate- no mistakes or misconceptions.  |
| **Reasoning** | Student provides no rationale for their design.  | Student briefly explains 1 or 2 aspects of design.  | Student explains most aspects of design, but is missing an entire component.  | Student explains all aspects of design, but may lack some depth on 1 or 2 features.  | Student explains all features completely and thoroughly.  |
| **Clarity** | Student writing is in-comprehensible  | Student writing is understandable, but with major weaknesses in organization and clarity.  | Students writing is mostly clear, but may contain 1 large problem in either organization or clarity.  | Student writing is clear and organized, with few minor problems in clarity or organization. | Student writing is clear and organized with no problems.  |
| **Creativity** | Student shows no creativity- no drawing, color or descriptions.  | Student shows limited creativity, but little to no effort.  | Student demonstrates moderate effort and creativity. Includes color.  | Student creates a visually clear, colorful, informative presentation, but the ad is not exceptionally unique or creative.  | Student creates a visually clear, colorful, informative presentation that is also exceptionally creative and unique.  |

**Total: / 20**

POSSIBLE EXTENSIONS: Get Creative!

* Have the students build 3-D models of their nanoparticles.
* Conduct a *Shark Tank*-like competition where students make pitches to convince each other to “invest” in their particle.
* Make a commercial selling their product.

**Example SuperNano Card:**

**(for Silica Nanoparticle from Lesson 3.2)**

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**SuperNano Card Master:**

**(can be resized as needed)**

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