A Comparison of Scale Assessment
Instructor Guide

Notes to Instructor

This is the final assessment for *A Comparison of Scale: Macro, Micro, Nano Learning Module*. It assesses the participants on their knowledge of three scales (macro, micro, nano) and the challenges faced working within these scales after having completed the learning module and all activities.

The *Comparison of Scale Learning Module* consists of the following.

- A Comparison of Scale: Knowledge Probe (KP) Pre-test
- A Comparison of Scale: Macro, Micro, Nano (PK)
- Scale Inquiry Activity: Cut to Size
- The Scale of Biomolecules Activity
- Scale Activity: Zoom in / Zoom Out
- **A Comparison of Scale Assessment**

This companion Instructor Guide (IG) contains both the questions and answers for the assessment questions. Answers to each question are indicated in red.

Assessment

Now that you have completed the *Comparison of Scale Learning* Module and all of its activities, let's see what you have learned. This assessment determines your knowledge of three scales (macro, micro, nano) and the challenges faced when working within these scales.

There are 12 assessment questions below. Answer each to the best of your knowledge.

1. **What is the microscale range?**

Answer
100 micrometers to 100 nanometers

2. **What is the nanoscale range?**

Answer
100 nanometers to 1 nanometer

3. **Explain why the following statement would be unacceptable in a design summary about a microarray?**
"It is important that the width of the cantilever be very narrow in order to fabricate 10 cantilevers in one microarray."

Answer

"Very narrow" is a relative term and "one microarray" needs to be more specific. What is the size of the microarray? The widths of the cantilevers could vary considerably depending on the overall width of the microarray. A microarray of 500 microns could use 40 micron wide cantilevers; where as a microarray of 50 microns would require cantilevers approximately 4 micron wide.

4. **Cite an example of a microsystems device that requires components sized within the micro AND nanoscales. Indicate which components would be micro-size and which components would be nano-size.**

Answer

Answers will vary, but here are a few examples:
Microcantilevers with nanosize probes for read/write storage systems
Microcantilevers with monolayer (nano) coatings for sensor arrays
Microelectrodes connected with nanotubes as wires
Drug delivery (micropumps and nanoneedles)

5. **Micro and nanosize devices are always fabricated using the same methods.**
    1. True
    2. False

Answer

False. Nanosystems and some nano-components are build from the bottom-up, one molecule or atom at a time. Microsystems and microdevices are normally fabricated from the top-down.

6. **What size devices use a "bottom up" fabrication (macro, micro, nano)?**
    1. Macro
    2. Micro
    3. Nano
    4. Both micro and nano

Answer

Nano-sized devices

7. **Describe or cite an example of finished product or object that was constructed using a "top down" fabrication or construction method. (*It does not have to be a microsystems or nanosystems devices)***

Answer

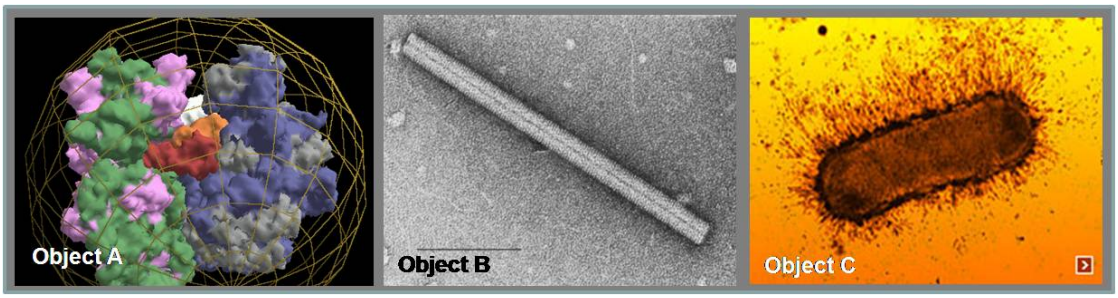
Answers will vary. Here are a couple of possible answers:
Description of "top down": Applies a layer, adds a pattern, etches (removes) select material. This may be repeated several times to end up with a microsystem.
Examples of "top down": Totem pole, Mt. Rushmore, cliff dwellings, fancy cakes with carved layers, sand blasting glass.

8. **Describe or cite an example of a finished product or object that was constructed using a "bottom up" fabrication or construction method. (*It does not have to be a microsystems or nanosystems devices)***

Answer

Answers will vary. Here are a couple of possible answers.
Description of "Bottom up": A structure is made by building it atom by atom or molecule by molecule. Each individual atom or molecule is manipulated or controlled for correct placement.
Examples of "bottom up": Cells of a seed multiply into a larger object (seed to plant, embryo to person), mold growing on a surface, a crystal or diamond.

9. **Which of the following objects has the largest diameter?**



a. Object a.
b. Object b
c. Object c
d. You need a scale to answer this question

Answer d.

You need a scale
(Actual sizes: A = 30 nm (ribosome), B = 250 – 1000 nm (Bacterium), C = 18 nm (Tobacco Mosaic virus)

10. **What has attributed to the overlap of micro and nanotechnologies?**

Answer

The shrinking size of microdevices. The smaller a microdevices becomes, the smaller its components become.
Applications. For example, applications in the medical field such as blood testing, diagnostics and therapeutics have required that testing devices be small enough to be used within the human body or to analyze particles such as proteins, antigens, and even DNA.
Advancement in nanotechnology

11. **You have been challenged to design a MEMS diagnostic tool to replace the current "tube or endoscope" used in endoscopy procedures. Currently, an endoscopy requires that a long tube be inserted into the esophagus to view the interior walls of the throat and esophagus. Your challenge is to design a tool that would be less invasive and would not require any type of anesthesia. Briefly explain your design, its overall size, and the size of critical components.**

Answer

Answers will vary. Grade this answer based on the participant's understanding of the size of the technology needed and the size of the components. To become familiar with an actual device, do an Internet search on "camera pill endoscopy". You should find articles that describes a camera pill that performs this task.

12. **A human hair is 60 to 100 micrometers in diameter. How does this size relate to microsystem components?**

Answer

Microsystems components are between 100 micrometers and 1 nanometer. Therefore, a component the size of a human hair would be a "large" microsystems component.

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