

## Student Worksheet

### *Powers of Ten with the Morpho Butterfly*

#### **Introduction**

Nature is full of nanoscale materials and processes. Biomimicry is where scientists and engineers use ideas from nature to create new products and develop new solutions to problems. The *Blue Morpho* butterfly has iridescent blue colored wings when viewed from the top, but the wings look brown when viewed from underneath. You will investigate why it exhibits these colors. You will use images from a scanning electron microscope (SEM) to investigate and hypothesize the cause of this difference in color.

To see the features on a Blue Morpho butterfly wing, one needs a powerful microscope such as a Scanning Electron Microscope (SEM). An SEM operates by using electrons to create images of the objects being scanned. Nanostructures cannot be seen with light microscopes because they are smaller than the wavelength of visible light – the basis of optical microscopy.

**Make a Prediction: Why is the Blue Morpho such an iridescent blue?**

#### **Materials**

- Blue Morpho butterfly (mounted)
- SEM images of Blue Morpho

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#### **Procedure:**

1. Observe the top side of a *Blue Morpho* butterfly wing sample images at three different magnifications (100X; 1,000X; 10,000X). Sketch your observations at these three different magnifications in the boxes below.
2. Use the same three magnifications to observe the bottom side of a *Blue Morpho* butterfly wing sample. Sketch your observations at three different magnifications in the boxes below.
3. Propose a hypothesis to explain the difference in color that is seen from one side of the wing to the other based upon your observations.

#### **Observations:**

Sketches of wings at three different magnifications

| <b>Top side wing sample</b> | <b>Bottom side wing sample</b> |
|-----------------------------|--------------------------------|
| Magnification: _____        |                                |
|                             |                                |
| Magnification: _____        |                                |
|                             |                                |
| Magnification: _____        |                                |
|                             |                                |

## Top View of the Blue Morpho Butterfly Wing



Photo credit: Johan J.Ingles-Le Nobel  
<http://www.flickr.com/photos/jingleslenobel/4370125469/>

## Bottom (underside) View of the Blue Morpho Butterfly Wing

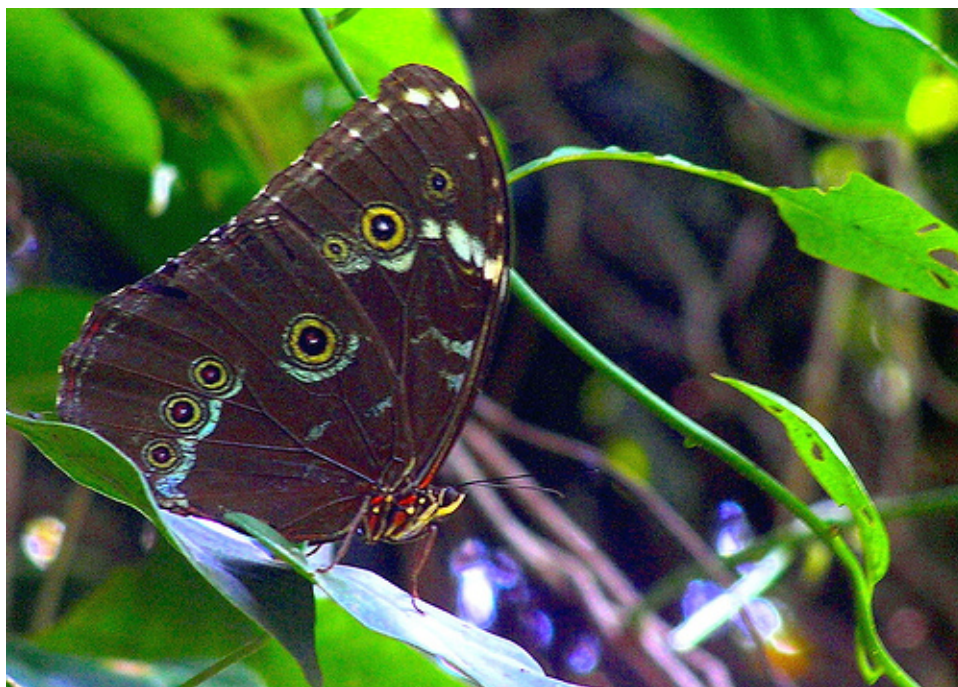


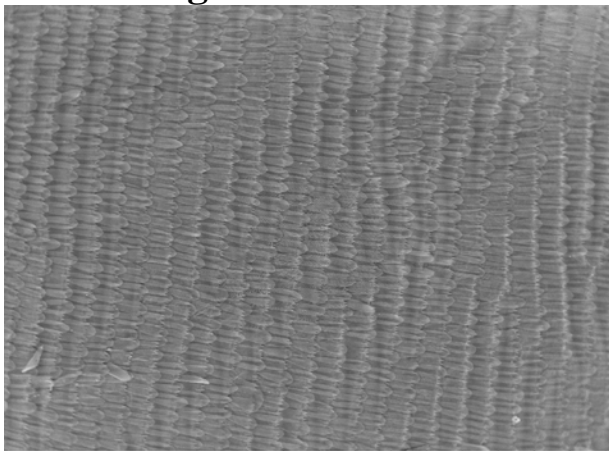
Photo credit: Pierre Pouliquin  
[http://www.flickr.com/photos/pierre\\_pouliquin/482340646/](http://www.flickr.com/photos/pierre_pouliquin/482340646/)



**Description:**

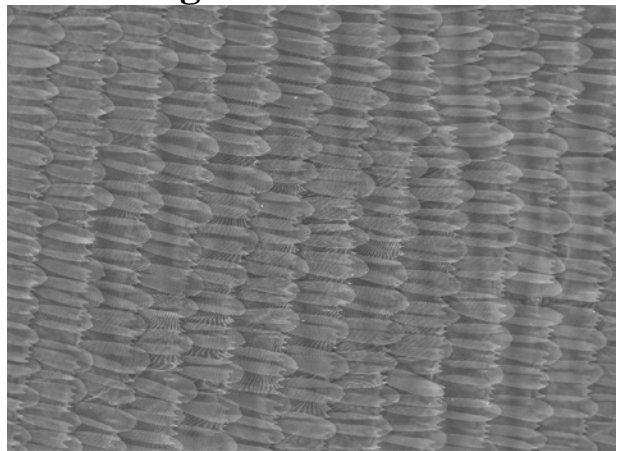
The object is a part of a wing of a blue Morpho Butterfly. The top part is an iridescent blue while the underside is a brown shade. These are SEM images of the blue side at four magnifications.

**Magnification: 10 X**



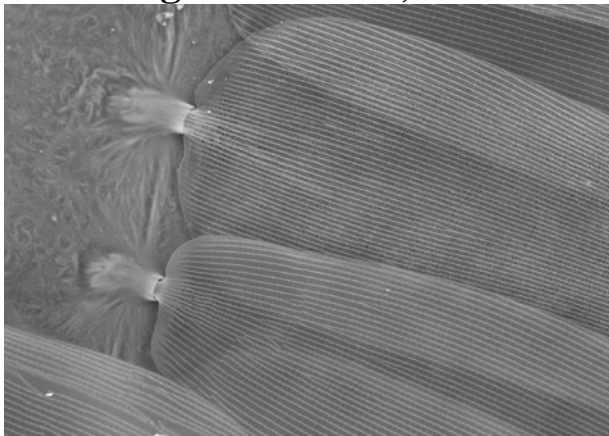
TM3000\_0190 2013/05/09 14:35 NL D3.9 x50 2 mm  
blue side morpho

**Magnification: 100 X**



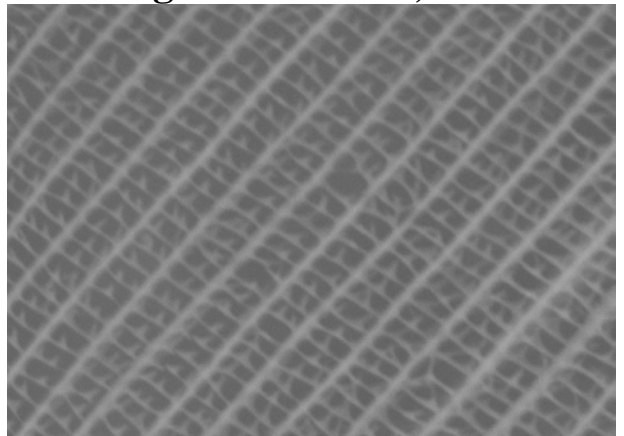
TM3000\_0191 2013/05/09 14:37 NL D3.9 x100 1 mm  
blue side morpho 2

**Magnification: 1,000 X**



TM3000\_0192 2013/05/09 14:45 NL D3.9 x1.0k 100 um  
blue side morpho 3

**Magnification: 10,000 X**



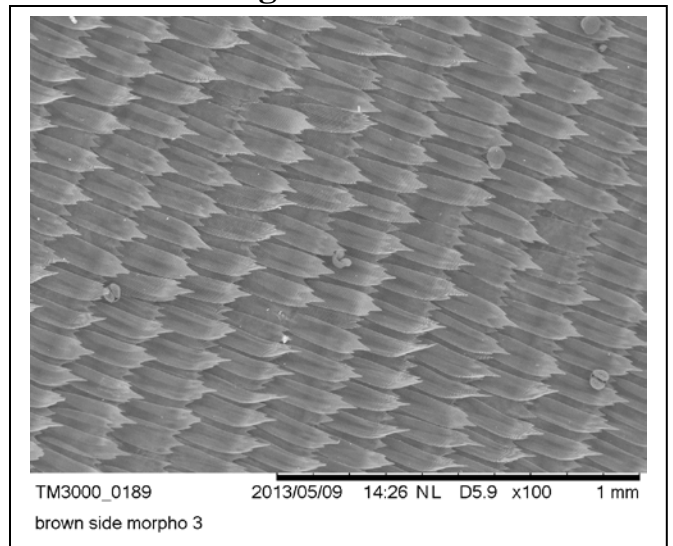
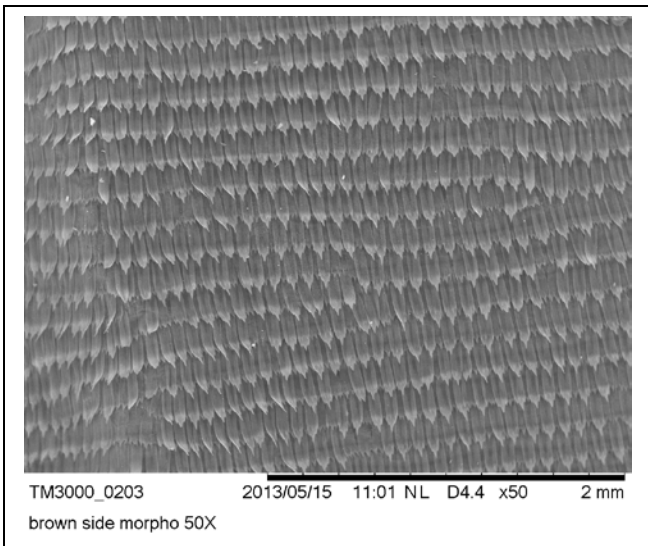
TM3000\_0199 2013/05/09 15:27 NL D5.9 x10k 10 um  
blue side morpho 9



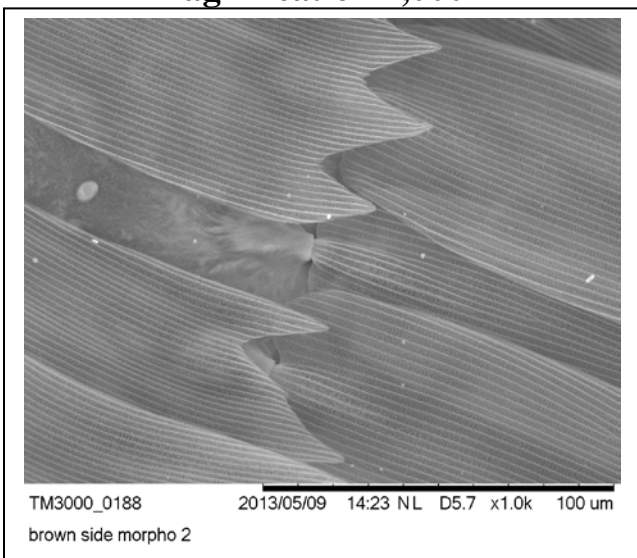
**Description:**

The object is a part of a wing of a blue Morpho Butterfly. The top part is an iridescent blue while the underside is a brown shade. These are SEM images of the brown side at four magnifications.

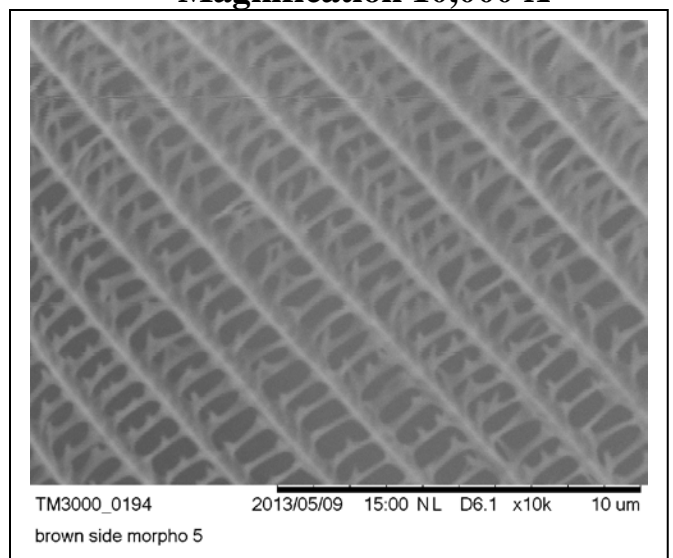
**Magnification 100 X**



**Magnification 1,000 X**



**Magnification 10,000 X**



NAME \_\_\_\_\_

SEM and the Blue Morpho butterfly

1. Why do scientists and engineers use a scanning electron microscope (SEM) to observe nanoscale materials? \_\_\_\_\_  
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\_\_\_\_\_
  
2. How does an SEM differ from an optical microscope? \_\_\_\_\_  
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\_\_\_\_\_
  
3. How do the magnified images of the butterfly differ from the macro-size image? \_\_\_\_\_  
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4. What are some of the unique features that you could see with the SEM that were not visible with the unaided eye? \_\_\_\_\_  
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5. How did the brown side of the butterfly differ from the blue side? \_\_\_\_\_  
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6. What do you think causes the brilliant blue color of the Morpho Butterfly? \_\_\_\_\_  
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