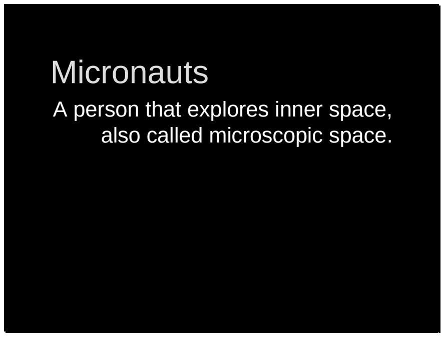
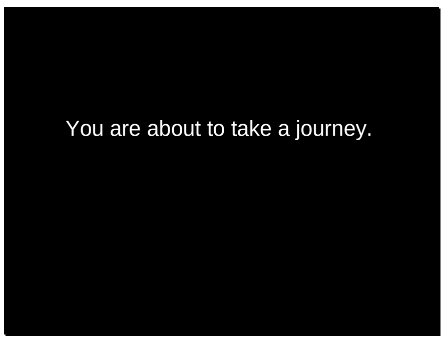
Slide 1



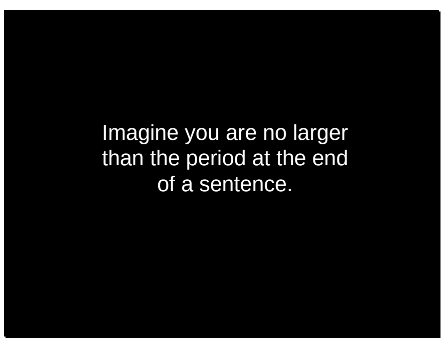
My – crow – s – cop – ic
People that explore microscopic worlds use different kinds of instruments called “microscopes” that let them see things that are just a little smaller than we can see with our eyes to things as tiny as an atom.

Slide 2



So where are we going? We are going to explore a very, very tiny world.

Slide 3



We are now going to shrink down to the size of a period. (I sometimes make a fun shrinking sound as we all “shrink.”)

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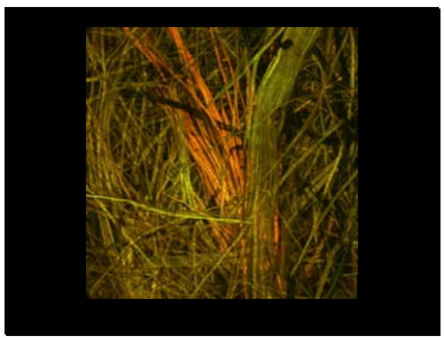
Slide 4

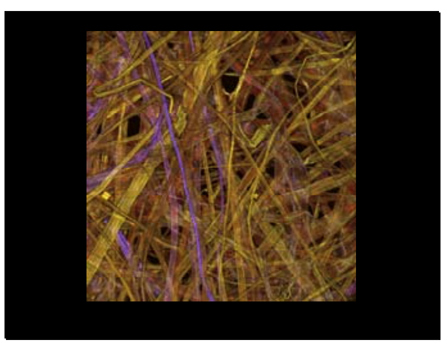
Now that we have shrunk down to the size of a period, let's see where we are going and what we will see.

Slide 5


Cattail fibers

Where have we gone?

Slide 6


Taiten fibers

What could these shapes be? Think about what we can see now that we are the size of a period.

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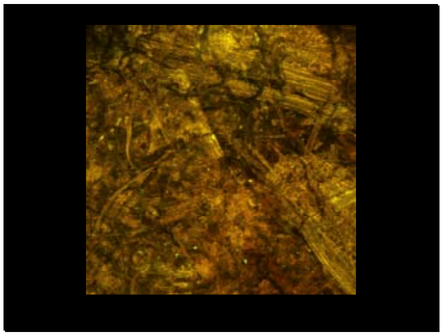
Slide 7

Chauke Heavy – Japanese paper

Look at all the different colors.

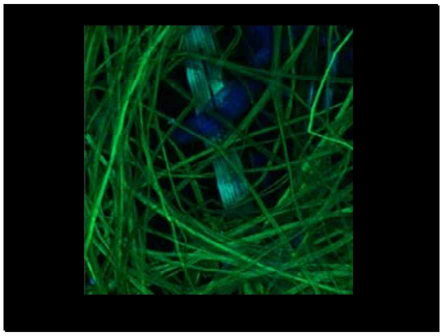
Slide 8



Cornhusk fibers

This one looks like maybe someone very small painted it. Kind of a very, very tiny finger-painting.

Slide 9



Sugikawa & Tenjyo – Japanese paper

Any guesses what we are looking at? (some will say carpet or fabric, or cloth)

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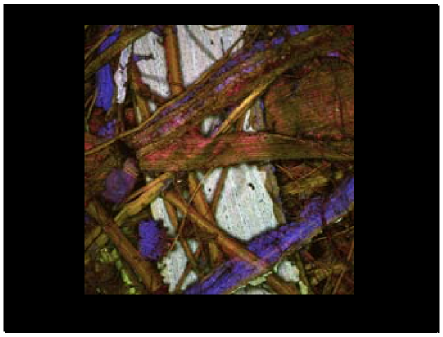
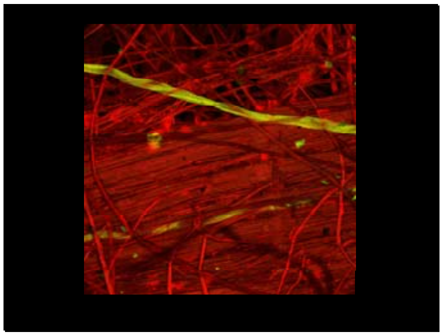
Slide 10



Australian plant fibers (Juncus sp.)

Wow, look at all those colors. Any more guesses? (This looks like some of the stained glass you see in churches.)

Slide 11



Taiten fibers

Any more guess? (Carpet, cloth, string, fibers, these are all good guesses.)

Slide 12

Gampi and Daffodil fibers

Now this looks different.

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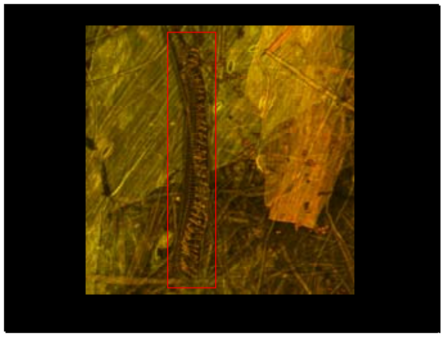
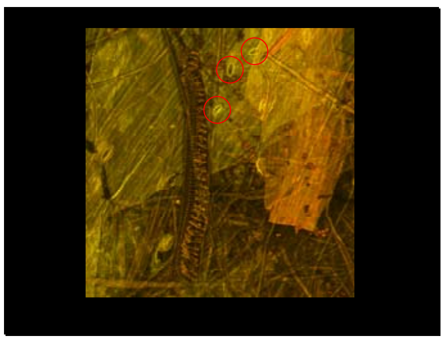
Slide 13



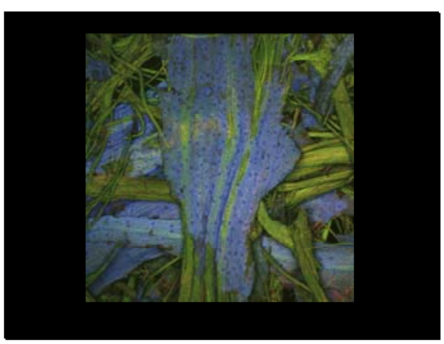
What does this look like? (It is part of a plant called xylem). Xylem moves water and nutrients around the plant. So now we know that we are looking at parts of a plant, but why are there just parts?

Slide 14



What do these look like? (Eyes? Tiny mouths). These are called stomata and are where gases are exchanged. Anyone know which gases? (take in CO2 - carbon dioxide and expel O2 - oxygen). Does anyone know what plants use CO2 to do? (photosynthesis). What gas do animals, like you and I need? (O2 oxygen). Okay, we breathe in oxygen, but what do we breathe out? (CO2) Can anyone see an how plants and animals are important to each other.

Slide 15



Australian Fan Palm fibers

So we know these are parts of plants, but do you know what we are looking at? (paper) Sometimes students will have already figured this out, but often they have not. You can also emphasize this point by holding up a sheet of paper when you let students know what they are looking at.

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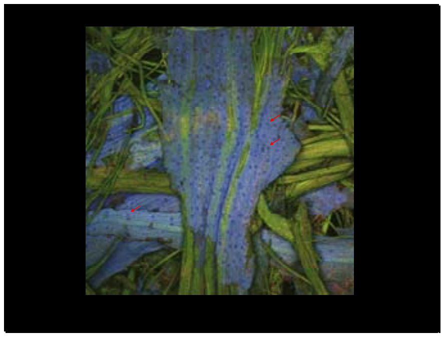
Slide 16



Notice that here are more stomata.

Slide 17

Australian Flat Drain Sedge fibers

Can you find any more stomata in this picture?

Slide 18

Here are two, but there are more. It seems that there are a lot of stomata in plants and one might think a lot of CO_2 and O_2 (gases) moving in and out of the plant. (You can then go into more detail about the role of CO_2 in photosynthesis.)

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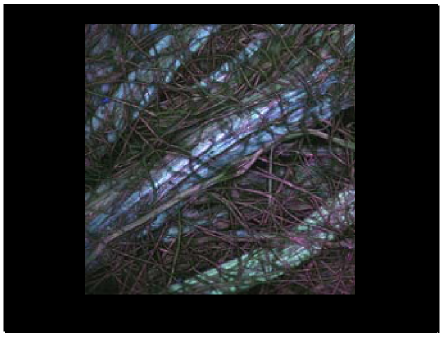
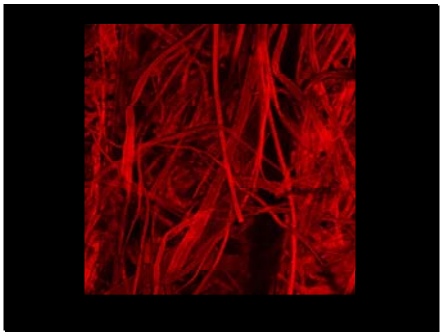
Slide 19



Australian Spiny-head mat rush fibers

Does anyone know how we can see all these tiny things? (microscope – you can visit the “History of the Microscope” section on the Paper Project web site for more information.)

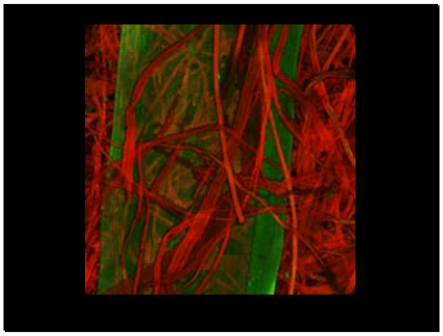
Slide 20



Taiten fibers

In this case, a very special microscope is used called a “Scanning-laser confocal microscope.” (see notes on web site for more details).

Slide 21



This microscope can see through transparent and translucent materials. Anyone know what transparent and translucent means? (you can move back and forth between slide 20 and 21 to add or remove the fiber)

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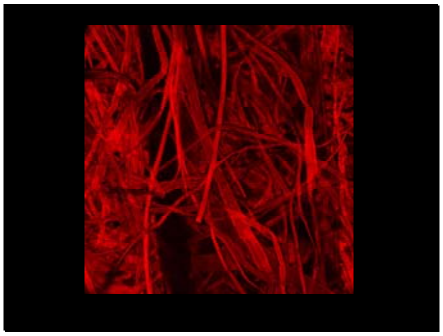
Slide 22

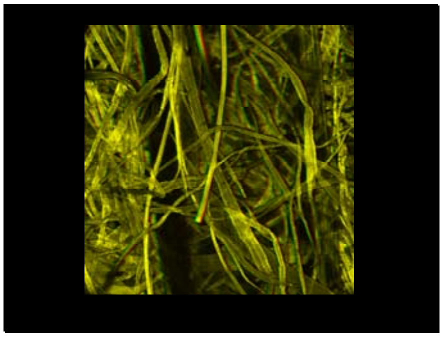
Here is the special microscope. The man in the funny glasses is part of the Paper Project group that made these images. Notice that a computer is connected to the microscope. (You can make your own 3-D glasses using the "Make Your Own 3-D Glasses" web article on the Paper Project, or you can purchase set from http://www.3dglassesonline.com. In some cases they have cut-outs they will sell to you for the cost of shipping and handling.)

Slide 23



Does everyone have their 3D glasses on? Do you see 3D? No, I forgot to press the 3D button. (go to next slide)

Slide 24



Now, do you see 3D? (this is the "wow", "cool", or lately "tight" moment for the students)

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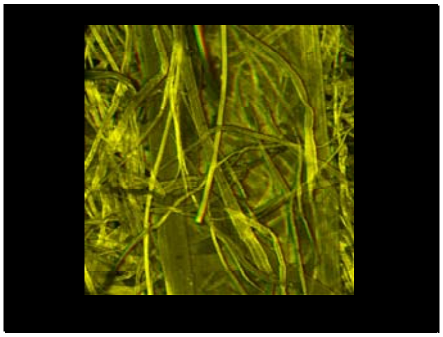
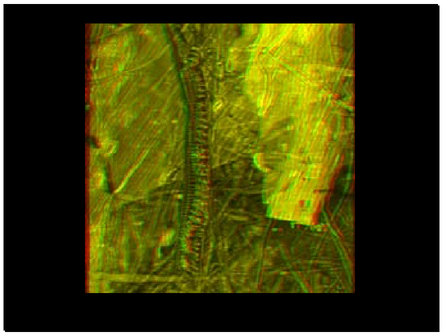
Slide 25



Remember that green fiber that we just saw earlier? Here it is again. (You can also insert and remove this fiber by going back and forth between slides 24 and 25)

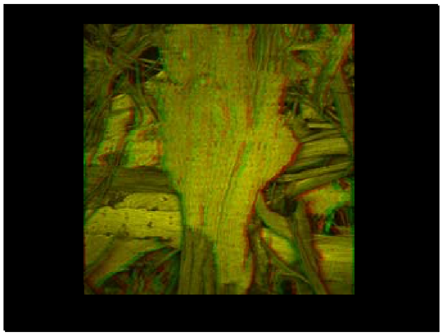
Slide 26



Gampi and Daffodil fibers

Here is the picture of the xylem and stomata we saw earlier. Doesn't the xylem look like a backbone from some creature? Maybe the creature from the movie "Alien." (later you will show students another picture of paper made from another plant that has a lot more xylem)

Slide 27



Australian Fan Palm fibers

Look at how much depth there is in these pictures. You would never think that plain old paper could have such wonderful color and so much space. (here you can also hold up a sheet of paper to emphasize the fact that what seems to be flat really has a lot of depth.)

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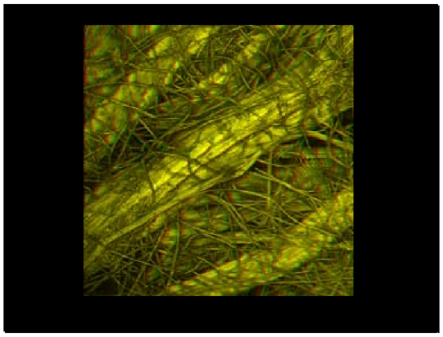
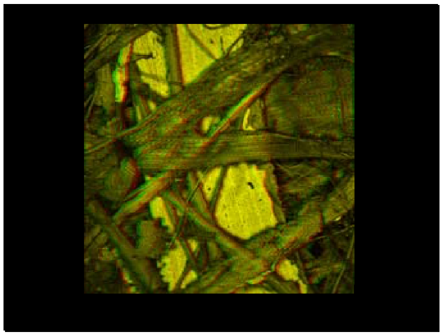
Slide 28



Australian Spiny-head mat rush fibers

Has anyone wondered, or does anyone know how paper is held together? In other words, what's the glue? (Yes, the fibers help to hold paper together, but there is also another force at work here – hydrogen bonds – (see the "Cookbook for Papermaking at Home and in the Classroom" for more details) The key is that hydrogen bonds are weak chemical bonds, but since there are literally billions and billions of them they help to give paper strength. (pop and tear a sheet of paper to demonstrate)

Slide 29



Australian plant fibers (Juncus sp.)

So between all these fibers there is a microscopic amount of water that helps to hold the paper together. It is important that there is only a tiny amount of water so that the hydrogen bonds can work. If there is no water, there can be no hydrogen bonds and if there is to much water – well does anyone know what happens when paper gets wet or is soaked in water? Yes, it falls apart. The extra water does not allow the fibers and hydrogen bonds to stick together.

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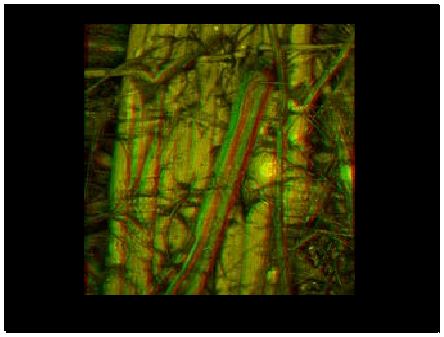
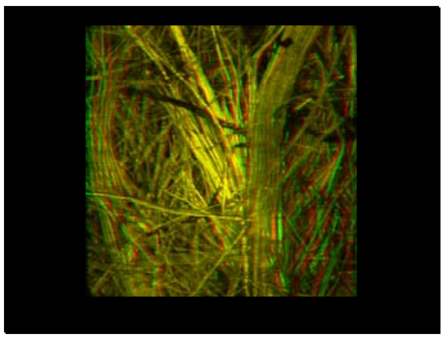
Slide 30



Australian Flat Drain Sedge fibers

Notice that if you move your head that parts of the image move. (I have students move their head side-to-side to see this effect.)

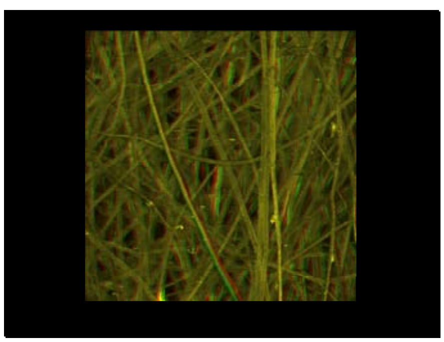
Slide 31



Cattail fibers

It is amazing how much detail and depth "3D" there is in paper.

Slide 32



Kinwasi - Japanese Paper

Some pictures look like you could just walk into them. Does anyone know how we see 3D? (use the "3-D Anaglyph Images" web section for details including a simple test students can do to prove that each eye sees a slightly different angle of view.) This also links to the position of eyes in animals. Some have them side-by-side like humans to provide binocular vision to see depth. Other animals have them on the sides of their heads. Why are they in different positions? (I use an example of a hawk and a

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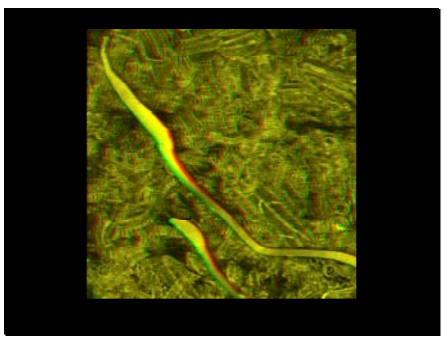
pigeon. Both have eyes in different positions. Hawks are predators and need to see depth to hunt. Pigeons do not hunt and are instead the prey of many other animals so they need to be able to see if they are being hunted. For Pigeons, it helps to have the eyes on the side of their head so that they can see almost 360 degrees. Predators give up this wide field of vision to gage depth. Most predators have about 180 degrees of vision. No, teachers cannot see out the back of their head).

Slide 33



Barrel Cactus fibers and unknown worm-like fiber

Wow, this looks different. What do some the shapes look like to you? (snake, springs, slinky) This is actually another picture of xylem, but from a plant that not only needs to move water and nutrients, but also store water. Can anyone tell me what plants might need to store water? This is paper made from barrel cactus. The tiny springs actually have coiled hollow tubes, like having tiny coiled straws. The helps to move the water up through the plant by taking advantage of one of waters properties called adhesion (literally, "sticking") between a water and the sides of the tiny xylem tubes.

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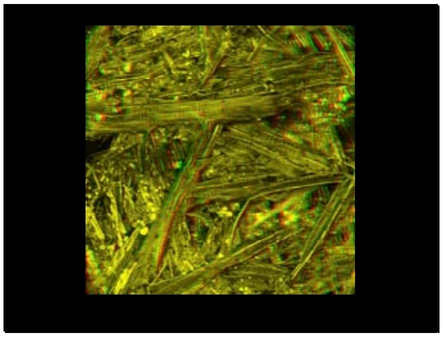
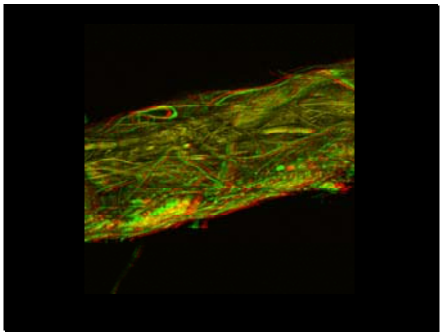
Slide 34



Paper wasp nest

This paper was made by a master paper maker. Can anyone guess who or maybe what made this paper? (paper wasp nest – wasps predate dinosaurs) So humans are really very late to the paper making process.

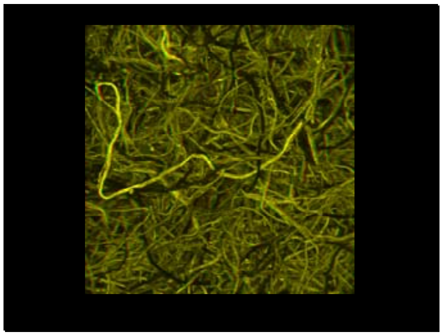
Slide 35



Australian Porcupine Grass

We often see pictures on the surface of mars and in some cases in 3D, but how about walking out on the surface of paper?

Slide 36



Silk fibers

This is what started the Paper Project. This is paper made not from plant, cellulose, material, but instead it is paper made from protein-based material – silk. Does anyone know where we get silk from? (most from silk worms, spiders also make silk)

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Slide 37

These are the colors of the silk paper when we look at it under the scanning laser confocal microscope.

Slide 38

To see and learn more about how these images were made and to explore and learn about paper, you can visit the Paper Project on the web.

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