jump | STEAM

AT HOME

DO TRY THESE AT HOME!

MICROSCOPY 101
SEEING IS BELIEVING

THINK LIKE A SCIENTIST!

Have you ever wondered whether wall color affects moods, why your dog prefers one food over another or whether bread molds faster in a paper or plastic bag? What's the best way to answer these questions?

Scientists turn wondering into a formal process called the **scientific method** to get logical or empirical answers to their questions. They conduct **experiments** that are **repeatable** until answers can be confirmed with the same predictable results each and every time.

Did you know that YOU were born a scientist?!

Babies are great at observing, trying and learning until they get predictable results.

Follow the link to watch a video about "baby Scientists"

SIX STEPS OF THE SCIENTIFIC METHOD

1 **OBSERVE:** *Notice something that makes you wonder.*

2 **QUESTION:** *Open your mind to ask, "What if...?"*

3 **HYPOTHESIS:** *Make an educated guess to answer your question.*

4 **EXPERIMENT:** *Make a plan and test your hypothesis.*

5 **COLLECT, ANALYZE AND REPORT DATA**

6 **MODIFY AND REPEAT**

Ever wonder, why you stink?!?

Armpits, sweat socks, and morning breath…its not just you…

Follow the link to read an article about how a doctor solved a medical mystery.

HAVE THE RIGHT TOOLS!

The most important scientific tools are not expensive or fancy. And they are something you already possess! We're talking about your natural curiosity, your sense of exploration and your love for the unknown. With these tools, you can turn your world into your very own science lab every day.

- Jump STEAM at Home experiments are designed to spark your curiosity in Science, Technology, Engineering, Arts and Math with an emphasis in health care.
- At the end of your experiment, **DO keep exploring** a topic.
- Think about it! Try to apply what you've learned to other things.
- Look it up! Search bold words online for connections.

MICROSCOPE SAFETY

- Always work within shouting distance of an adult
- Keep a trash can, sharps cup, and paper towels nearby
- Never eat or drink near your microscope
- Handle chemicals and specimens with care, if using potentially dangerous or infective agents wear gloves, glasses, and mask.
- Keep two hands on the arm and base at all times
- Keep the scope covered when not in use
- Always start with the stage the furthest from the lens
- Never take your microscope apart
- Only use LENS CLOTH on the lenses

Your microscope is a precision TOOL, take care of it and it will last forever.

YOUR LAB .

- ❑ Microscope
- ❑ Lens set
- ❑ Phone Mount
- ❑ Prepared slide set
- ❑ Blank slides
- ❑ Slide Covers
- ❑ Transparency paper
- ❑ Ring stickers
- ❑ Vial - Stains
- ❑ Vial - Yeast
- ❑ Vial - Brine shrimp
- ❑ Vial - Sea salt
- ❑ Vial - Gum Media
- ❑ Specimen Dish/Hatchery
- ❑ Lens Tissue
- ❑ Tweezers
- ❑ Pipette
- ❑ Paint brush
- ❑ Spatula
- ❑ Pick/probe
- ❑ Pencil
- ❑ Marker
- ❑ Ruler
- ❑ Toothpicks
- ❑ Pencil sharpener/microtome
- ❑ Clear nail polish
- ❑ Clear Tape
- ❑ Microscope Cover
- ❑ 3 AA Batteries
- ❑ Lab Notebook/Guides
- ❑ Microscope Manual

DO NOT Jump Ahead.

Listen,

Watch,

Then Do

KEEP A NOTEBOOK

- It's your "cookbook" of science.
  - **ALWAYS document everything!**
- Science is about gathering information then using it.
- It's a recipe to repeat and experience.
- **DETAILS** are important, even (especially) things that go wrong!
- Number your pages with a table to find things easier.
- Make notes with page references as you go through this manual.
- Write down whatever comes to mind as you explore, even if it's not microscope-related.
- Keep a BROAD mind. You never know where it may lead.
- NEVER say, "I'll write it down later." It's like capturing a dream; the thought is most vivid NOW!
- Did you know Leonardo da Vinci had over 7,000 pages of notes with over 7,000 drawings in his notebooks?

Follow the link to watch the video "Great Minds: Leonardo da Vinci" to learn about his many talents.

Follow the link to watch the video "The Most Curious People: Leonardo da Vinci" to learn about his notebooks.

COLLECTING AND CULTURING EXPERIMNTS

Some thick specimens must be sectioned or cut into very thin slices to allow light to pass through and see under light microscope. However very small cells or organisms require little preparation n order to see.

As we move through different experiences, you will be given new tools and develop new skills to make the best decisions for the specimens you will observe on your own (away from the course).

Always consider the life of the organism when observing. Live catch and release is preferred unless the learning experience requires otherwise. Always look up and take precautions when finding and collecting a specimen

SPECIMNES TAKE TIME TO PREPARE

- Catching Live specimens, bacteria, insects, pond water, moss, yogurt, air particles etc.
- Rehydrating fruits, vegetables, animals, fungus, etc.
- Making agar plates , traps, cultures, etc.
- Growing yeasts, shrimp, molds, bacteria, and more

WHERE TO LOOK

- Ponds , lakes, streams, rivers, oceans, ditches, standing water and rain puddles
- Refrigerator, bathroom, bedroom, vents, your lawn, school, everywhere

TIPS:

- Make sure your collecting jars are free of cleaning chemicals
- Test different sections or depths of your collection spot
- Work quickly and Be patient some specimens have a short “shelf life,” but others need time to wake up or come out of hiding. Be willing to reexamine specimens on their time.

Follow the link to find a simple way to grow some specimens you already have in your home.

LIVE SPECIMEN EXAMPLES

HYDRATING MOSS, LICHEN, SOILS, ETC.

Microbes are abundant in and around plants and soils. Dry environments are home to many species of microbes including rotifers, tardigrades, fungus, bacteria, and other organisms.

- Cover your plant specimen or lichen scraping in enough warm water to nearly cover but not completely cover(microbes from dry environments need air like you) gently massage the plant to hydrate. Observe a drop of water from near the plant. Observe a sample of the plant.

Soil Ecosystems

Soil ecosystems are complex systems packed with great biodiversity, even in one teaspoon. When the environment is dry, some species will hibernate in stage called a cyst. When they are rehydrated the will wake up. Take the time to sample different areas of your back yard or house plants.

- Put a few tablespoons of soil in ¼ cup of water. Shake gently for 5minutes before letting rest, exposed to air. Take random samples over 2 days.

You should love dirt! How can bacteria in soil kill bacteria in you? Check out these links!

ACTIVATING YEAST:

Yeast are unicellular fungi that consume sugars and carry out fermentation, producing alcohol and carbon dioxide.

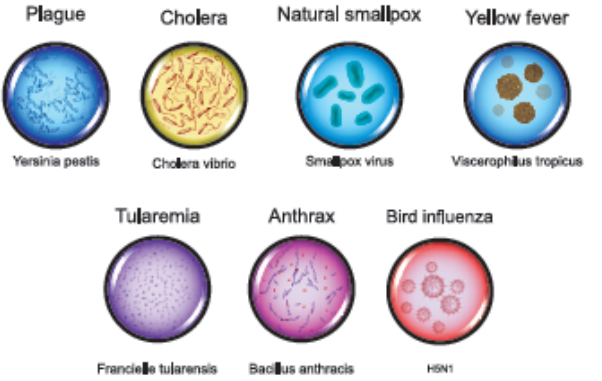
- Mix one sugar packet and equivalent amount of yeast to one cup of warm water, stir, then let it sit. Place a small drop of yeast solution to a slide with coverslip. Observe the yeast cells under magnification every 15 minutes
- Live trap slide
- Live trap wine glass, sugar water:

INVISIBLE WORLD

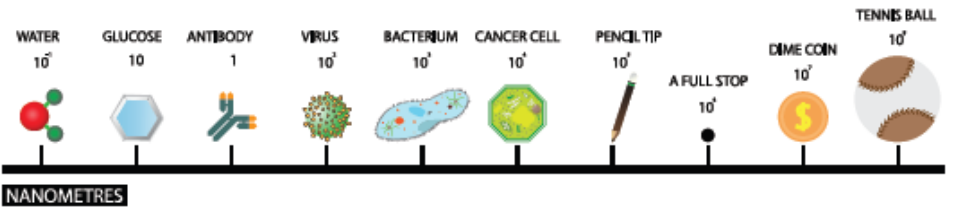
- Part of wisdom is understanding there is a lot of world that you haven't seen.
- An open mind and imagination to ALL parts of the world are part of being a scientist or doctor.
- At one point in time, none of the world had ever seen what you'll be looking at today.
- Before microscopes, we didn't understand disease was debated by philosophy and the visible world. Microscopes PROVED that what you cannot see CAN hurt you!
    - Once upon a time, the smartest people in the world thought you got sick and died from stinky air. They were kind of right. It wasn't the air but the source of the stink that killed. Dr. John Snow was one of the most famous epidemiologists and fought to prove it.

Follow the link to read the story "John Snow and the Broad Street Pump on the Trail of an Epidemic."

DANGEROUS INFECTIONS



- Microscopes are fundamental to every science area to observe the living and non-living.
    - Scientists rely on it to study fine structures or even atomic structures
- Detailed observations and measurements of the LITTLE questions are critical in scientific process to support and prove your findings.
- Learning to estimate, compare or apply what you know to the unknown is an important critical thinking skill and a necessary skill in science.



Follow the link to compare your world to the microscopic world.

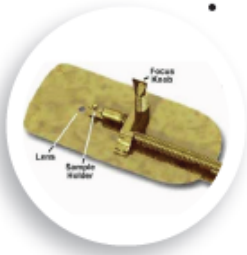
THE COMPLETE HISTORY OF MICROSCOPES

...well, maybe just a quick story of what you really need to understand to know more than most people

- Good to know: **Micro = small** and **scope = tool** for viewing
  - The underlying principle of a microscope is that lenses refract light which allows for magnification. Refraction occurs when light travels through an area of space that has a changing index of refraction.
- 1200s: Magnifying glass with curved glass bends light

- 1595: First simple compound microscope invented by the Janssens
  - 10x mag
  - Now we get 50x-1000x or 2000x
- 1665: Robert Hook
  - cork = "cells"

- 1683: "Animalcules" discovered
  - Anton van Leeuwenhoek
  - Single polished lens (noticed 2 lenses at right distance amplify)



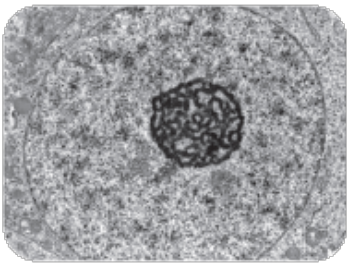
***Do you think you could build a scope like this with what's in your toolbox?**

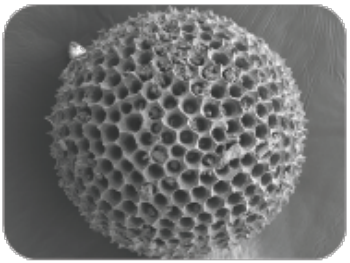
- Curiosity leads to discovery, discovery leads to knowledge and knowledge leads to creativity

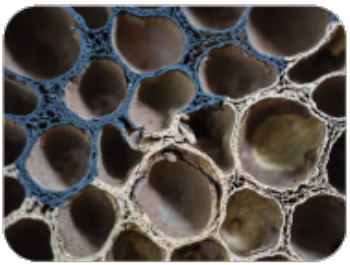
Follow the link to read the article "The Merchant who Discovered Microscopic Life."

OTHER TYPES OF SCOPES

- 1860: Binocular scope- one scope, same image, comfortable
- 1880: Multiocular scope
- Stereoscope: pair of microscopes – low magnification, but 3D
- Field scope: very light, portable
- Digital scope
- 1933: Electron microscope
- Magnetic field bends light
- 250k x -1millx





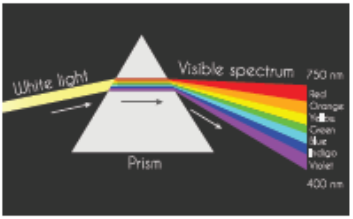


PRACTICAL USES AND CAREER FIELDS

- Medicine
- Food and environment
- Materials research and industry
- Geology
- Forensics
- Archeology
- Microbiology
- And many more!

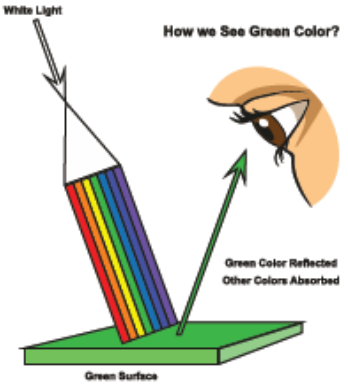
Follow the link to view the MicroWorldArchive of free microscopic images.

HOW VISION WORKS



LIGHT

- We see because light changes as it bounces off of things or moves through things.
- We can only see certain types of light.



REFLECTION

- Overhead light
- Some light absorbed
- Other light bounces

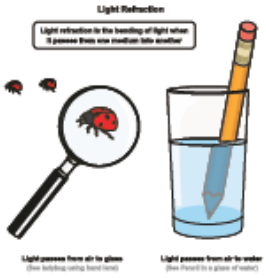
REFRACTION

- Underneath light
- Different materials bend light differently.
- Refraction occurs when light travels through an area of space that has a changing index of refraction.
- Plastic, glass, water, biological materials like blood and cell parts

HOW IS THAT POSSIBLE?

TRY IT! Pencil - Water - Glass

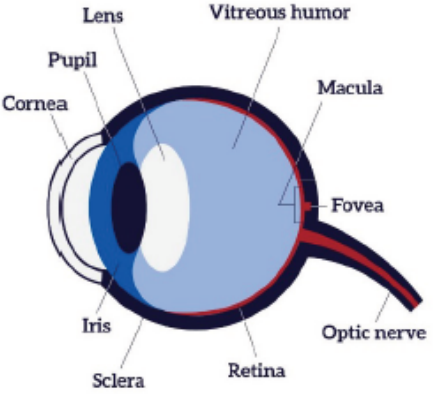
*It's important to remember that the change in medium makes a big difference. Air also refracts. In a slide, we want to eliminate changes in medium.



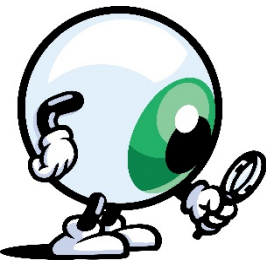
Follow the link to watch a video of "Oil Immersion Microscopy Animation."

YOUR EYE REFRACTS LIGHT

- All the different parts of your eyes refract light and work together to help you see.
- First, light passes through the cornea (the clear front layer of the eye). The **cornea** is shaped like a dome and bends light to help the eye focus.
- Some of this light enters the eye through an opening called the **pupil** (PYOO-pul). The **iris** (the colored part of the eye) controls how much light the pupil lets in.
- Next, light passes through the **lens** (a clear inner part of the eye). The lenses works together with the cornea to focus light correctly on the retina.
- When light hits the **retina** (a light-sensitive layer of tissue at the back of the eye), special cells called photoreceptors turn the light into electrical signals.
- These electrical signals travel from the retina through the **optic nerve** to the brain. Then the brain turns the signals into the images you see.



***Why do you think your eyes need tears to work correctly?**



MAKE A WATER LENS

Lenses can be made out of almost any transparent material if it is clear enough and shaped correctly. Fill up a Ziploc baggie with water. Look at text on this page while making the baggie rounded or flatter. Which magnifies better?

Why do you think it would be dangerous to look at the sun with a round lens?

COMPOUND LIGHT MICROSCOPES

Compound light microscopes are still the most common microscope in use today. understanding the contributions of each art of the microscope and the relationship of the microscope to the eye is very important if you want to maximize your skills.

PARTS TO KNOW

A. Ocular Lens (eyepiece)
B. Revolving nosepiece
C. Objective lens
D. Top illuminator
E. Arm
F. Course adjustment knob
G. Fine adjustment knob
H. Stage
I. Condenser lens
J. Diaphragm/ Filters
K. Bottom Illuminator
L. Rheostat
M. Power/Illuminator Switch
N. Base

Practice your skills on the go. Try out the virtual microscope simulator practice lab.

FIRST LOOK

Ever stopped to think about the advantages of having two eyes?

What "eyed" are you??

1. Make a circle with your thumb and first finger.
2. With both eyes open look at an object on the wall or in the distance, and center it inside the circle.
3. Close one eye, and then the other.

Closing which eye made the object "jump" from the center?

If the object seemed to move when you closed your left eye, then you have left eye dominance. If the object moved more when your right eye was closed, then your right eye is the dominant one.

What other times would this be useful?

FIRST USE Setting up your microscope

1. Locate a flat surface
2. Turn on light
3. Rotate the nosepiece to the SCANNING objective to lowest position
4. Position your slide in the center of the stage light
5. Adjust the course focus knob
6. Re-center specimen
7. Adjust fine adjustment knob
8. Adjust the diaphragm
9. Change objective lens and readjust

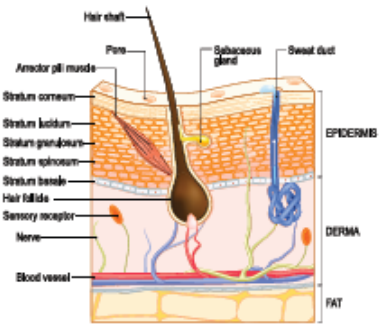
Cleaning your microscope

Your microscope is a precision tool and even the smallest flaws are magnified. It important that you clean it properly to prevent dirt or scratches

SIMPLE SPECIMENS:
PRACTICE WITH THE EYEPIECE

Sometimes you can use the microscope for just casually looking at everyday objects or things you just want a closer look at. Let's take a peek at the details of a few everyday items you may not have considered.

SKIN ANATOMY



Analyzing Skin

- Observation: different parts of your skin feel different.
- Try it:
  1. Look at your fingertip skin for ridges and glands.
  2. Turn finger over and compare.
  3. Can you find hair on either side?

EXTRA: Look at insect hair on a prepared slide.

DON'T FORGET your Notebook!!

- What do you see?
- What strange things didn't you expect?
- How clear did you get the image (resolution)?
- Were you able to see whole thing clearly at once (depth of field)?
- How big do you think these things are in millimeters (field of view measuring)?
- Did things move like you expected when you tried to get them where you wanted?

GOOGLE…knows everything!

ANALYZING PICTURES

- Observation: pictures look different on different paper.
- Try it: compare microscopic differences of photos on different paper types.

The orange part of the tiger and purple of the butterfly are not "pure" colors. What do they look like under the microscope? BTW, neither is the green in this box!

EXTRA: Try looking at pictures on plastic.

Pointillism is a technique of painting by applying small strokes or dots of PURE colors to a surface, so that from a distance they visually blend together in the viewer's eye.

- **EXTRA:** check out how your eyes trick you by using "hybrid images" in the link below. If you have photo negatives, check them out under the microscope.

Follow the link to view the MIT Hybrid Image Gallery.

NAVIGATING THE SPECIMEN

Have you noticed things don't seem to move where you want them to when you move the slide on the stage? Let's look at something you are familiar with to learn how to find what you're looking for.

HUNTING FOR "E"

- Rip a 2-3" square section of print out of a newspaper magagine and bottom corner of this booklet.
- Grab an ink pen and fine tip marker.

Set up

1. Follow the procedures for "setting up your microscope" (be sure to start at scanning power furthest from the stage).
2. Without a slide, put the newspaper under the scope and center over the light until you see a letter "e" in the middle.
3. Record by drawing how you see the "e" with your naked eye.
4. Look through the eyepiece, and focus until you can see letters clearly WITHOUT ROTATING THE PAPER.
5. Find the "e" and center it. DRAW what you see.
6. Repeat with the next two objectives.

What you should record

- The kind of paper you are observing.
- Four drawings of "e"
  - With the naked eye
  - 4x
  - 40x
  - 100x
- Strange movements
  - When you try to move a slide in one direction, does it move to match your hand movement?

TEXT ANALYSIS

Look closely at the text on the newspaper, magazine and this booklet. Have you noticed that text seems crisper on some paper and not so crisp on others?

1. Reset your microscope
2. Repeat "Hunting for 'e'" with other paper types
3. Draw ONLY the image from the objective that gives the best detail

PAPER ANALYSIS

Close your eyes and feel each of the paper types. Is there a noticeable difference? Try rubbing your finger on your pants or shirt in between each paper.

1. Tear the edge of each paper type.
2. Look closely at other papers under each objective
3. Select the objective that gives you the best detail
4. Draw what you notice that is unique about the papers

INK ANALYSIS

What makes the difference in the print, the paper or ink? On each type of paper, write an "e" with the marker then the pen.

1. On each paper, Under each objective, look at the ink then the marker.
2. Record what you notice is different between the papers, inks, and objectives that showed the best detail.

Career Link

Archeologists analyze historical items to verify authenticity and expand our understanding of history

Hmm...for real?

A man purchased a decorative picture frame from a Pennsylvania flea market for $4. when he got it home he took the back off to replace the picture inside. He found a folded up paper that appeared to be an original copy of the Declaration of Independence. How could they prove it was real?

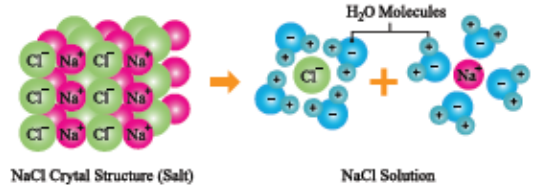
CRYSTAL CHEMISTRY ANALYSIS

- ***Chemistry*** is the study of matter, its properties, how it reacts to different environments, and how and why substances react with each other to combine or separate to form other substances.
- ***Crystals*** are made of molecules or atoms that stack neatly like building blocks to form special shapes with special properties.

THE SCIENCE...

- ***Dehydration*** is the process of removing water from substances. The more water you remove, the stiffer a substance typically becomes until it is considered a solid.

WATER SOLUBILITY



- ***Crystallization*** is the process of removing all of the water from (dehydrating) molecules and ions, allowing the structure to form as a solid.
- ***Ionic compounds*** are made of atoms that have stacked based on alternating positive and negative charges like magnets. The positive and negative ends attract so strongly that they hold tightly together. They tend to form symmetrical cubes and break perfectly along flat planes leaving a sharp, smooth and shiny surface. Interestingly, the strong positive and negative charges easily conduct electricity.
- ***Polar covalent substances*** have weaker interactions and do not stack as neatly or conduct electricity well.
- Imagine different types of dice and how they would stack to form larger structures. Which would look most like an ionic compound?

- **OBSERVATION:** if you see salt and sugar spilled, they are both crystalline structures that are indistinguishable with the naked eye. But it's a difference you definitely don't want to mix up on your breakfast!

DESIGN AN EXPERIMENT

Yesterday, you were baking cookies and accidentally grabbed an unlabeled jar off the shelf and added it to your cookies. Bad move!

At the microscopic level, crystals give away clues to how the molecules that build them form, so we should be able to design an experiment to identify the difference with a microscope.

- How do we set up our slides to observe the substances?

Make **macroscopic** observations of the samples in your notebook. Can you tell the difference between the samples?

- Shoot a digital photograph, if you can.
- Describe and record the physical properties of the samples in words.
- Make a data table that indicates the similarities and differences between the types of crystals.
- Record all of your drawings, data and notes. You can tape your digital images of the crystals in your lab notebook.

Let's look at a man-made artificial sweetener and an alternative sweetener. Are they more like the sugar or salt in structure?

- What would you predict?

On your own: you can examine various kinds of crystals and powders in your house like baking soda, corn meal, MSG, spices, bath salts and sugar scrubs.

- Research the chemistry of whatever substances you look at.
  - How are they similar to each other in chemical structure?
  - How are they different chemically from each other?
- What else did you see?
- What are your conclusions?
- Can you think of another way to test if the crystal is salt or sugar? Think outside the slide.

LOOKING FOR MORE JUMP STEAM OPPORTUNITIES FOR HOME?

About Me App

Rube-E App

Go to **jumpsimulation.org/PNC** to learn more about STEAM education and order a copy of the Jump Simulation PNC "About Me" Activity Book and app.

The "About Me" Activity Book and app are interactive tools that give kids the opportunity to learn about the body by coloring 3D models that pop off the page, defend against invading germs in a short video game and watch fun videos! The Rube-E Educational app allows young people to better understand their bodies as they build a 3D Rube Goldberg machine using augmented reality elements.

ABOUT JUMP STEAM

Jump Simulation created its STEAM program to spark the curiosity of our youth in health care careers. Designed to give middle and high school students hands-on opportunities, Jump STEAM offers experiences in everything from learning what it takes to be a doctor to understanding how engineers are working with clinicians to transform health care. Learn more and sign your kids up at **jumpsimulation.org/STEAM**

OSF HEALTHCARE

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THE UNIVERSITY OF ILLINOIS COLLEGE OF MEDICINE
PEORIA CHICAGO ROCKFORD URBANA

Made possible through the generous support of PNC