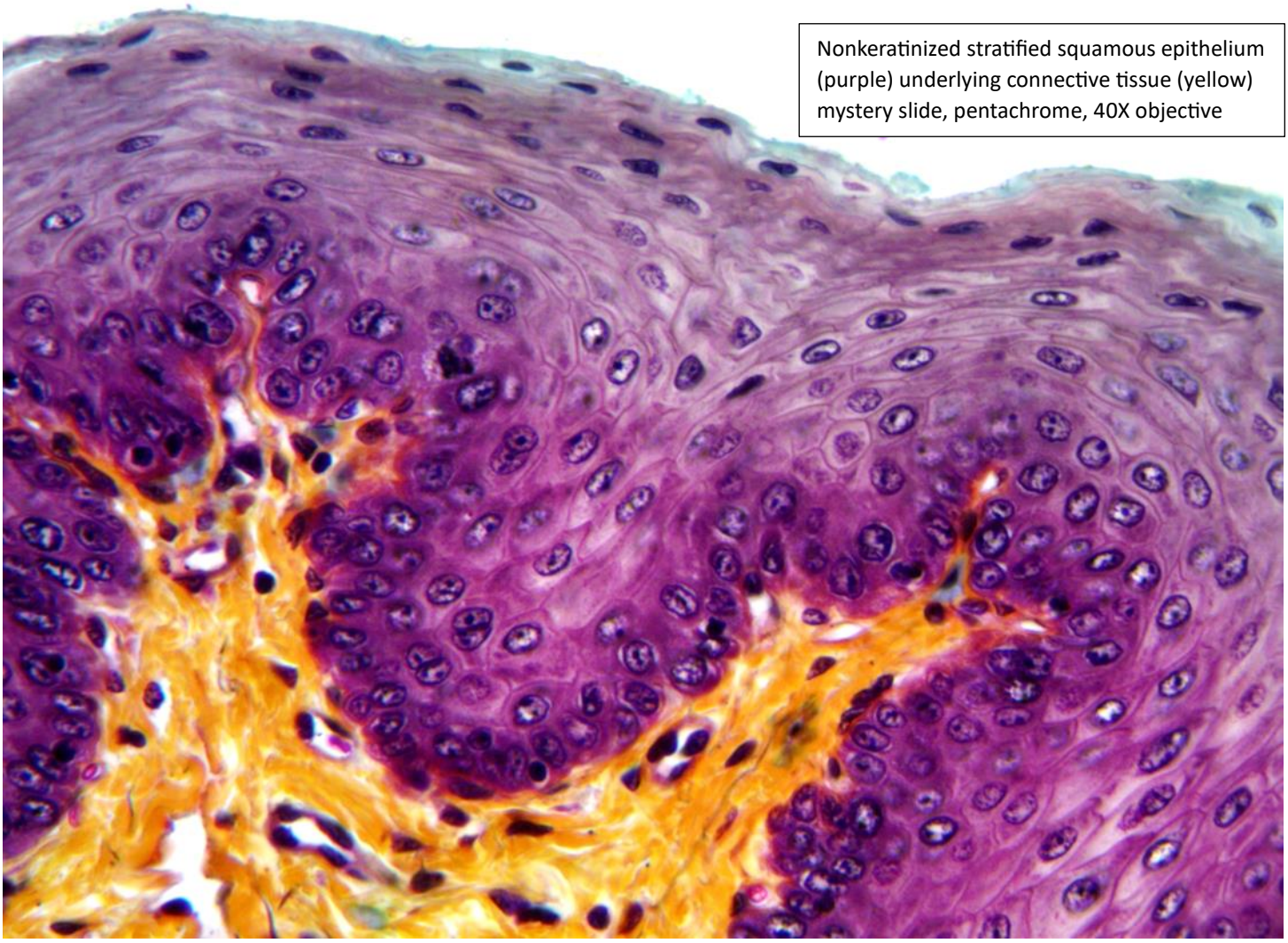
An introduction to Histology and Pathology slides



Nonkeratinized stratified squamous epithelium (purple) underlying connective tissue (yellow) mystery slide, pentachrome, 40X objective

Trash or Treasure?

for Micscape Magazine August 2023

by Ed Ward MD, Minnesota, USA

Medical Disclaimer:
I'm a real doctor, but I'm no pathologist. My knowledge of histology and pathology slides is that of an amateur. Some readers will know more than I do, and I would be happy to have any errors pointed out. Microscope hobbyists should not diagnose or treat disease.

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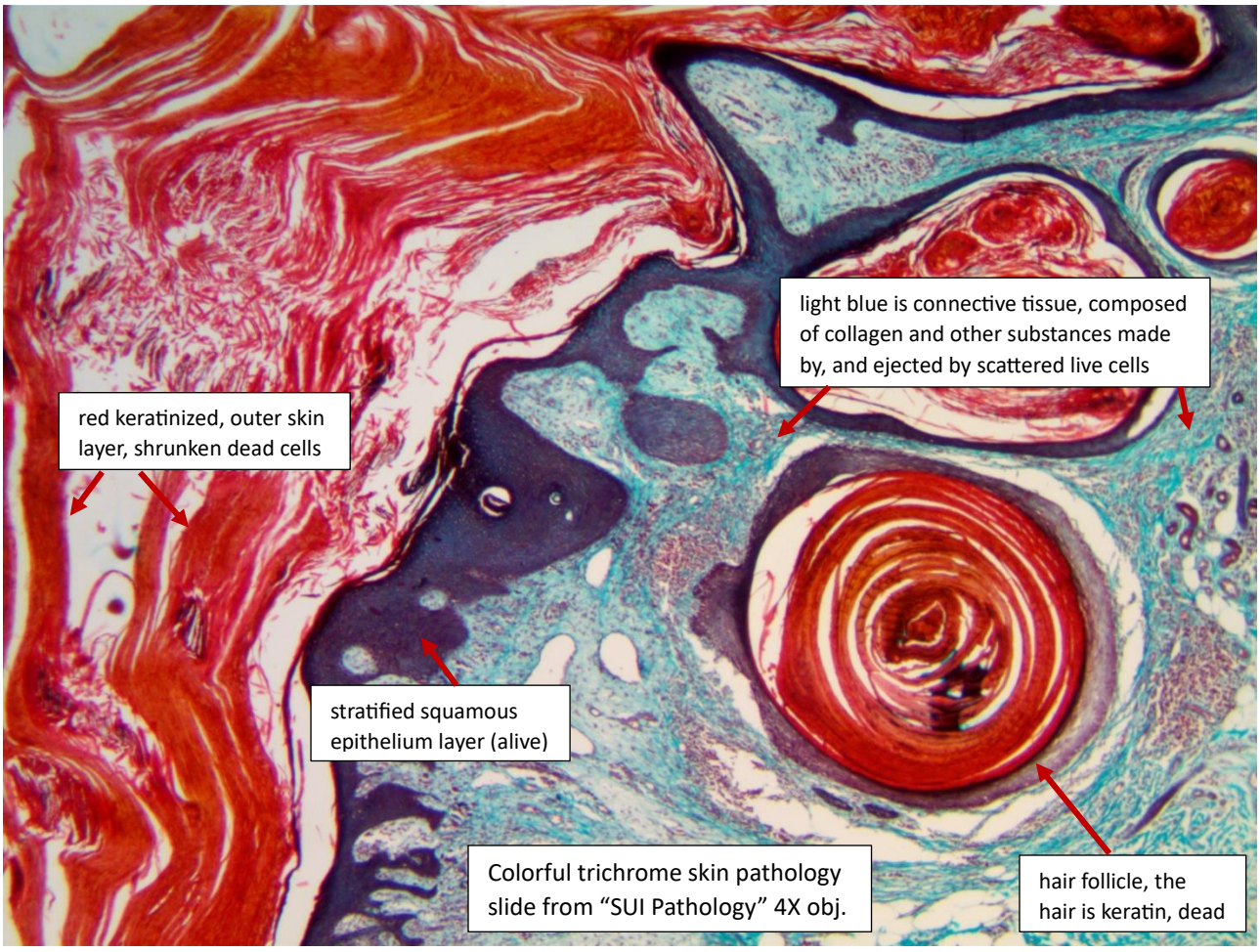
An introduction to histology and pathology slides for amateurs and collectors

The inside of a human body is a mysterious and wonderful place. Within the past two centuries science discovered that you are multitudes, made up of maybe 70 billion cells, jostling together like people in a thriving city. If you have a microscope and some quality prepared slides, then you can see some of the wonder for yourself. Unfortunately, the world is full of bad histology slides that have turned some people away from the wonder. Those crummy slides are like a bad 1960's toy microscope. Don't give up. Obtaining truly great histology and pathology slides without paying a small fortune is quite possible with repeated efforts, luck, a little basic histology knowledge and some used slide tips I'll share.

First, some definitions. **Histology** is the study of healthy tissues, and **pathology** is the study of diseases of cells, tissues and organs. One of the first histologists was Xavier Bichat in late 18th century Paris, who identified 21 different tissues, bits of bodily "stuff" that he distinguished by "gross" dissection (without a microscope). Thanks to Schwann, Schleiden and Virchow's microscopic observations in mid 19th Century Germany we now know living bodies have a hierarchy of structure with cells making up tissues, which in turn are arranged to make the organs comprising the body. At the same time, Johannes Müller and Rudolph Virchow in Berlin used autopsy and preparation of microscope slides from diseased tissues to establish the modern, cellular understanding of pathology: diseases result from the dysfunction of cells.



A great histology slide reveals an intricate wonderland. What are you looking at? Is a hidden order or a disease present? Maybe start with a low power scanning objective like 4X to look over the slide, then zoom into the most interesting areas with 10 and 40X objectives. Sometimes you may then bring out the 100X objective and the immersion oil. Cells vary greatly in size and shape; a red blood cell is about 5 microns across. Good slides preserve details even smaller than the 0.2 micron limit of standard light microscopes. Searching carefully under a 22 mm square coverslip at 1000X is like looking for a needle in a 22 by 22 meter yard. You could waste a lot of time on your new hobby.

Histology methods

Modern methods of making microscope slides of animal tissue samples were developed during the late 19th century, at the same time the classical optical microscope was essentially perfected by Abbe, Zeiss and others. The usual multistep, multiday process for making slides from animal and human specimens includes:

Overall steps	Examples of required chemicals
1. Dissection and trimming of tissue specimen into small blocks	
2. Quick fixation to prevent decay/loss of microscopic detail	formaldehyde, Bouin's solution
3. Dehydration/clearing with a series of solvents compatible with the next steps	70-100% ethanol, xylene
4. Imbedding in wax	paraffin or special resins
5. Cutting 4 to 10 micron thin sections on microtome	
6. Fix the sections to slides, dissolve out wax, ready for stain	xylene, acetone, buffered saline
7. Stains (often a series of contrasting colors) to bring out particular details	H and E, Gram, trichrome
8. Fix stains with mordant and/or wash out excess stains	alum, acid fast techniques
9. Apply glass coverslip with permanent mounting medium and a slide label	Canada Balsam

A good tissue slide shows sharp, colorful details inside every cell and is a beautiful thing to behold under a microscope. The very best even look interesting just held in your hand. The technique required for great results is complicated, and very hard to do consistently well. Some steps take days. Bouin's fixes and mordants. Dehydration may involve soaking the block in 70% ethanol, then 90%, then 3 soaks in 100% before moving on to multiple soaks in xylene or acetone. The entire process of making slides takes a few days to a week or so. These multi-step processes were first worked out in the late 1800's, long before OSHA or other safety regulators. Many of the hundreds of previously used chemicals are now banned and many of those still allowed are potentially dangerous. Anything meant to fix, clear or stain tissue might do the same to tissues in your body if inhaled, ingested or spilled. Formaldehyde exposure greater than 1 part per 10 million (approximately zero) requires OSHA safety training for employees. Picric acid (also a fixer) and silver stain solutions can explode if they dry out or get old. Xylene can dissolve into your nerve sheaths and shut down nerve conduction when inhaled. If you cut yourself on a microtome blade after you sliced a sick liver, you might get viral hepatitis. Despite the risks of death and disability, a few amateurs make plant histology slides, sometimes with spectacularly beautiful results. It is even more rare for amateurs to make animal or human tissue slides, so you will likely be buying histology or pathology slides rather than making them. Still, knowing how they are made helps you evaluate your purchases.

Fixation, slicing and other physical steps also affect the end results, but many of the colorful qualities of a great histology slide come down to the staining used. For 150 years the most common general purpose staining for animal and human tissues remains hematoxylin and eosin, usually called simply "H and E". Hematoxylin is basic, so is attracted to "basophilic" nucleic acids in the nucleus and ribosomes. Eosin is acidic and stains "acidophilic" basic proteins (opposites attract) in the cytoplasm and extracellular matrix. Over 400 "biological" stain variations can be used in histology, each highlighting some subcellular structure or substance based on chemistry. Wrights stain is often used for blood smears. Gram staining distinguishes monoderm (gram positive) vs diderm (gram negative) bacteria. Ziehl Nielsen stains acid fast bacilli (mycobacteria). Silver stains neurons and some pathogens. Giemsa stain is useful for blood and bone marrow, helping to differentiate certain cells and also to sometimes show chromosomes or pathogens. Periodic Acid Schiff (PAS) stains carbohydrates purple-red, including glycogen, glycoprotein, mucin and basement membranes (useful in some kidney diseases). Sudan Black and Oil Red both stain lipids such as triglycerides and lipoproteins. Perls' Prussian Blue stains iron (to check liver biopsies for hemochromatosis). Masson's trichrome stain shows connective tissue or fibrosis related collagen blue, and cell components in beautiful contrasting colors. Congo Red can stain amyloid protein orange, turning apple green when viewed with polarized light. Modern histology required the development of a dizzying array of hundreds of different stains, fixation solutions, solvents, and mountants (use of Canada Balsam was discovered in 1851) as well as microtome machines with special knives to precisely cut slices less than 10 microns (1/100 of a mm) thick.

The other histology

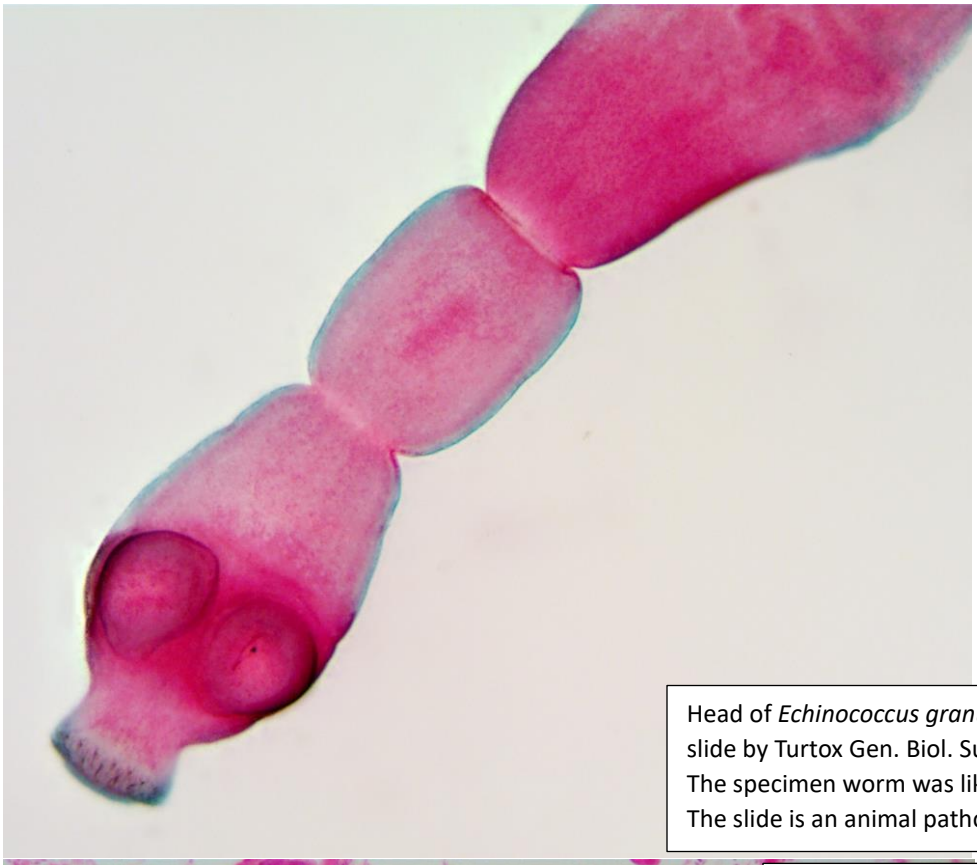
Plants have tissues and diseases too, so botany slides are histopathology slides. Some amateurs here at Micscape have made these and some at the Microbe Hunter and Photomacrography sites are doing masterful botany work. My experience is mostly animal and human histology and pathology slides, so the rest of this article will focus there.

grass stem longitudinal section, unknown researcher, 1953, 40X obj.

grass stem cross section 1953 slide, 4X objective

Thank plant relatives for making your food and oxygen. All plants, animals, fungi and protists had a last eukaryotic common ancestor (LECA) born about 2.2 billion years ago when an archaeal cell started using an engulfed bacterium as a battery pack (mitochondria). About 1.6 billion years ago a LECA descendant merged with a cyanobacteria and got chloroplasts to make food from sunlight. Photosynthesis makes your life possible. Plant and animal cells all have a nucleus, and numerous internal compartments. Animal cells are usually squishy but plant cells have a stiff cell wall made of cellulose (a polymer of sugars, it forms wood and paper) and pectin. Hence many plant cells are boxy. The term “cell” was coined by Robert Hooke in 1665 when cork under a microscope looked like the tiny rooms in a monastery.

Both plants and animals have tissues and may get diseases. This article concentrates on animal (and largely human) histopathology slides that are stained thin sections. But technically not all pathology slides are histology slides. Most are painstakingly prepared thin sections of diseased tissue, but some signs of disease needing microscopic examination are not slices of tissue. Urine and blood are routinely examined microscopically for signs of disease. Pap smears are sloughed off epithelial cells, quickly stained. Microscopic eggs of a parasite seen in feces (poop) could be a sign of disease and so are considered by pathologists. Occasionally a mysterious worm gets submitted to the pathologist.



2 phyla (broad categories based on body plan) of worms can be common human pathogens:

1.Flatworms (phylum Platyhelminthes), specifically tapeworms (cestodes) and flukes (trematodes)
2. Roundworms (phyla Nematoda), including Ascaris, hookworms, whipworms (the most common 3) and the now rare (thanks to microscopes) Trichinella

Head of *Echinococcus granulosus*, the dog tapeworm, 10X objective slide by Turtox Gen. Biol. Supply Chicago USA. Mid 20th century
The specimen worm was likely passed or pulled from a dog.
The slide is an animal pathology slide, but not a histology slide.

Trichinella spiralis encysted in muscle, 10X objective slide by NASCO, Fort Atkinson, Wisconsin. Mid 20th century
This is a tissue slice, a typical histopathology slide

All photomicrographs* obtained with AO/Reichert Microstar (410) or Diastar (420) microscopes, with a 3Mp USB microscope camera and Toupview software. Unless noted, standard brightfield, sometimes with a touch of oblique. Didymium filter with a few slides, but digital color adjustment can have similar effects. Brightness digitally adjusted after capture on some slides.

*as opposed to microphotos, which are small spots on a slide that reveal a photograph when viewed with a microscope

3 cheap, relatively safe, do it yourself histology possibilities

- Onion skin epithelial cells

- Human cheek mucosa epithelial cells

- Human blood smears

The humble onion is a source of a plant histology slide. The thin translucent "onion skin between layers can be carefully pealed off and mounted in a drop of water under a coverslip. The cell walls around the large plant cells will be obvious even at low power, although everything else is harder to see.

A flat toothpick or small spoon scraped along the inside of your cheek will pick up hundreds of epithelial cells (don't worry, they are meant to fall off and will soon be replaced). These can also be smeared onto a slide, with a tiny drop of water and a coverslip. Like the onion skin, they will be colorless and hard to see until you use tricks.

If you aren't squeamish, you can look at your own blood cells. Wash a sewing needle in soap and water and/or soak it in rubbing alcohol to sterilize it. Wash and rinse and dry a few microscope slides to make sure they are extra clean. Now wash your hands with soap, rinse and dry them. Prick a finger tip with the needle and put a tiny drop of blood towards the end of a slide. Hold a second slide at an angle and pull or push the blood drop into a thin film. If it still looks red it's likely too thick; a good smear will look just slightly pink, and even. Again, you'll see little when you at first look at the smear. Also remember that objectives over 10 power are usually designed for looking through a coverslip and won't see the finest details without one. Water might explode the fresh cells (remember osmosis from high school science?) but a tiny drop of vegetable oil (or isotonic saline if you have it) could work under a coverslip. The blood smear needs stained for best viewing. First et the smear dry completely and perhaps pass for a few seconds through a flame to "fix" the blood cells to the glass. Wright's is the stain used at hospitals but you can make do with methylene blue, liquid ink for fountain pens, or sometimes food coloring. Flood the slide with a few drops of stain, wait about 3 minutes, then rinse with clean water. If it looks too pale, try staining for 2 minutes more, or start over and try 5 minutes. Like everything technical some trial and error will be involved.

Without stains all three of these preparations won't look at much at first. But for that reason they can each be quite helpful in learning lighting tricks. Look at them first with standard brightfield. Optimize it with proper Koehler illumination (if your microscope is equipped with a field diaphragm and other components of Koehler). Adjust the condenser diaphragm for better contrast. Try oblique lighting if you know how (easily learned and done DIY; look at Micscape and other websites). Try phase contrast if your microscope is so equipped, and you'll appreciate how big of a breakthrough phase contrast was for looking at living tissue (leading to the 1953 Nobel prize for Frits Zernike).

Excessively Tricky Illumination of Human Blood

Blood cells can be seen with darkfield illumination. It is pretty, but the stained dry smears used in clinical labs give far more information. Amazon and others sell "2500X Blood Analysis" microscope kits with a trinocular microscope, darkfield condenser and digital camera for "live blood analysis" done by alternative practitioners (who are trained in different understandings of health and disease than MD doctors). The 2500X claim is exaggerated; Abbe's resolution formula for light microscopes means added magnification past about 1000X just makes things blurrier without adding detail. But often the ND digitally cranks the magnification of the blood crazy high, to 20,000X or more, resulting in a random, soothing, slowly moving screen pixelation. The natural doctor points out some vitamin molecules floating by, strokes his chin, and identifies a riboflavin deficiency. Then he sells you a bottle of $5 vitamin B2 for $50. Conventional doctors occasionally have scams too, but I suggest you find healers who respect the laws of physics and biology.

Each of the hundreds of chemicals used in histology labs has its own origin story, but consider a few important examples. Red carmine (from the cochineal insect) and purple hematoxylin (from the logwood tree) were both used as dyes by the Aztecs and eventually became histology stains. Spanish explorers in the New World rediscovered the dark heartwood of the logwood tree in the Yucatan in 1502 and being able to dye textiles blue, black or purple (by using different mordants or oxidizers with it) was a revelation. Logwood became so valuable English and French pirates often targeted logwood cargoes. The high value of logwood created the "Golden Age of Piracy" in Belize and the Caribbean from 1660 to 1726. The flag of Belize above shows logwood being harvested by white and black "baymen", with the national motto (translation "under the shade I flourish"). Some of the English were "casual pirates", living on the coast cutting logwood themselves but also raiding Spanish ships when they seemed easy targets, as a profitable and patriotic side business. History is amazing. Who would have thought the standard histology stain had a connection to pirates! Later, in the 19th century, it was discovered hematoxylin could dye nuclei and chromosomes blue, and in 1865 Heinrich Waldeyer used hematoxylin to stain human tissue. Perkin discovered the first aniline dye by accident in 1856 as a student in London, a deep purple that was a fashion hit. Soon German chemists discovered many dozens of other artificial aromatic (phenolic) dyes in multiple colors, again derived from coal tar, including eosin in 1874. Eosin stains cytoplasm red, a good contrast to hematoxylin. In 1877 Wissowzky described the hematoxylin and eosin (H&E stain) staining technique that is still the most common standard histology stain today, in several modern variations. From textiles to piracy to modern science, it all started from hematoxylin, a phenolic compound that a plant evolved to reduce insect predation.

Logwood cutters and tree, the source of hematoxylin dye, pictured on the flag of Belize

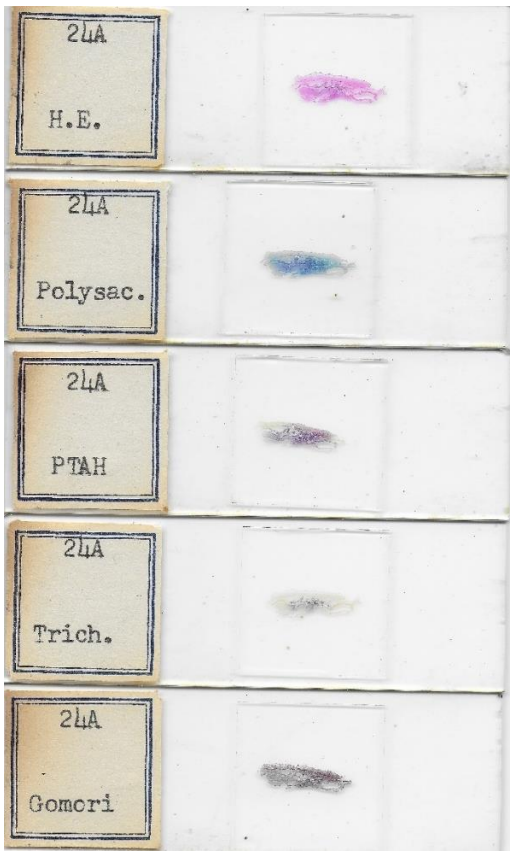
"Special Stains" usually refers to classical chemical stains beyond H and E, such as the list below. Today university and commercial labs now also have thousands of specially tailored immunologic stains (aka "immunohistochemistry") that pair an antibody against a desired target with an enzyme (such a peroxidase which will produce a color change) or a fluorescent dye marker. This is often combined with classical chemical stains, but requires additional steps to "expose" the antigens and apply the immunologic stain, and maybe a fluorescence microscope for the reading. Another modern technique is "in situ hybridization", using a labelled complementary DNA or RNA probe to find a particular gene sequence inside cells. Research labs often invent their own special immunologic or genetic sequence stains.

Special stains available at University of California Davis VMTH Histopathology Laboratory (as of June 2023)

AFB	**Acid Fast Bacteria**
ALB	**Alcian Blue**
ALB/PAS	**Alcian Blue Periodic Acid Schiff's**
BB	**Brown & Brenn**
CR	**Congo Red**
CV	**Crystal Violet**
FEUL	**Feulgens**
FITE	**Fites Acid Fast**
GIEM	**Giemsa**
GIM/PVK	**Gimenez/Pierce Vanderkamp**
GRAM	**Gram Stain**
GTRI	**Gomori's Trichrome**
HALL	**Hall's Bilirubin**
IRON	**Gomori's, Perl's Iron, Prussian Blue**
KIN	**Kinyoun's Acid Fast**
LIP	**Lipofuscin - AFIP**
LUNA	**Luna's - eosinophils**
MACH	**Machiavello**
MB	**Melanin Bleach**
METHBL	**Methylene Blue**
MUCI	**Mucicarmine**
MGP	**Methyl Green Pyronin**
PAS	**Periodic Acid Schiff's**
PAS/DIA	**PAS/Diastase**
PTAH	**Phosphotungstic Acid Hem.**
SAFO	**Safranin & O**
THIOT	**Thioflavin T**
AOG	**Acid Orcein-Giemsa**
BIEL	**Bielschowsky**
BM	**Basement Membrane, Methenamine silver**
BOD	**Bodian**
FM	**Fontana Massons**
GAF	**Gomori's Aldehyde Fuschin**
GCHROM	**Gomori's Chromaffin**
GMS	**Grocott's Meth Silver**
GRIM	**Grimelius**
HO	**Holmes**
G&S	**Gordon & Sweet**
LFB/B	**Luxol Fast Blue/Bodian**
LFB/CV	**Luxol Fast Blue/Cresyl V**
LFB/H	**Luxol Fast Blue/Holmes**
LFB/P	**Luxol Fast Blue/PAS**
MTRI	**Masson's Trichrome**
ORO	**Oil Red O - Lipofuscin**
RET	**Reticulin or Reticulum**
SNK	**Snook's Reticulum**
STI	**Steiner**
SDB	**Sudan Black (Paraffin)**
URATE	**Urate crystals**
UZ	**Uzman**
VHVG	**Verhoeff's Van Gieson**
WS	**Warthin-Starry**
TB	**Toludine Blue**

(There are many more stain protocols than these University of California examples. I note my Toupview camera software has built in digital filter settings for about 400 different histology dyes)

Examples of some common histology stains



Left: rat skin and subcutaneous tissue, serial slices with 5 different stains, 20th century teaching collection

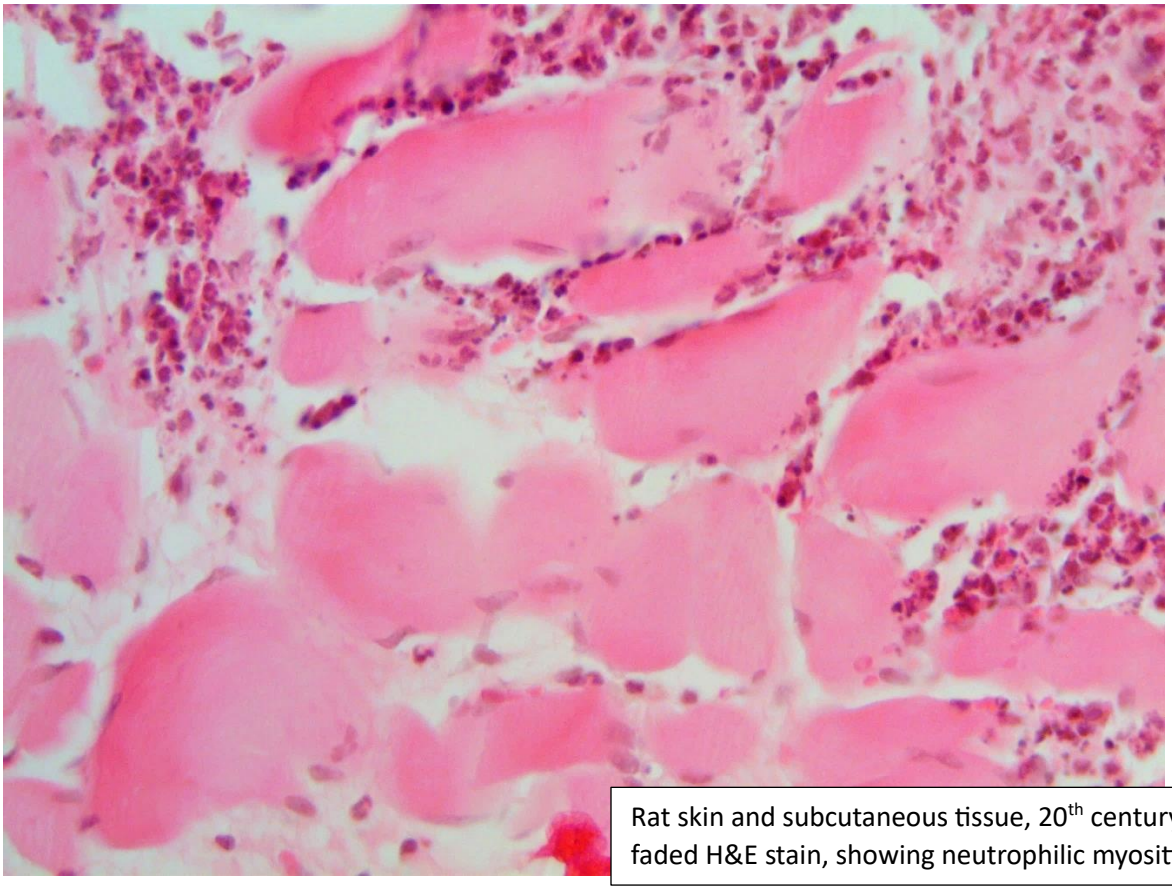
Hematoxylin and Eosin stain (H&E)
The workhorse of histology and pathology since the 1880's dark blue nuclei and chromatin, ribosomes, pink cytoplasm

Common special histology stains include:

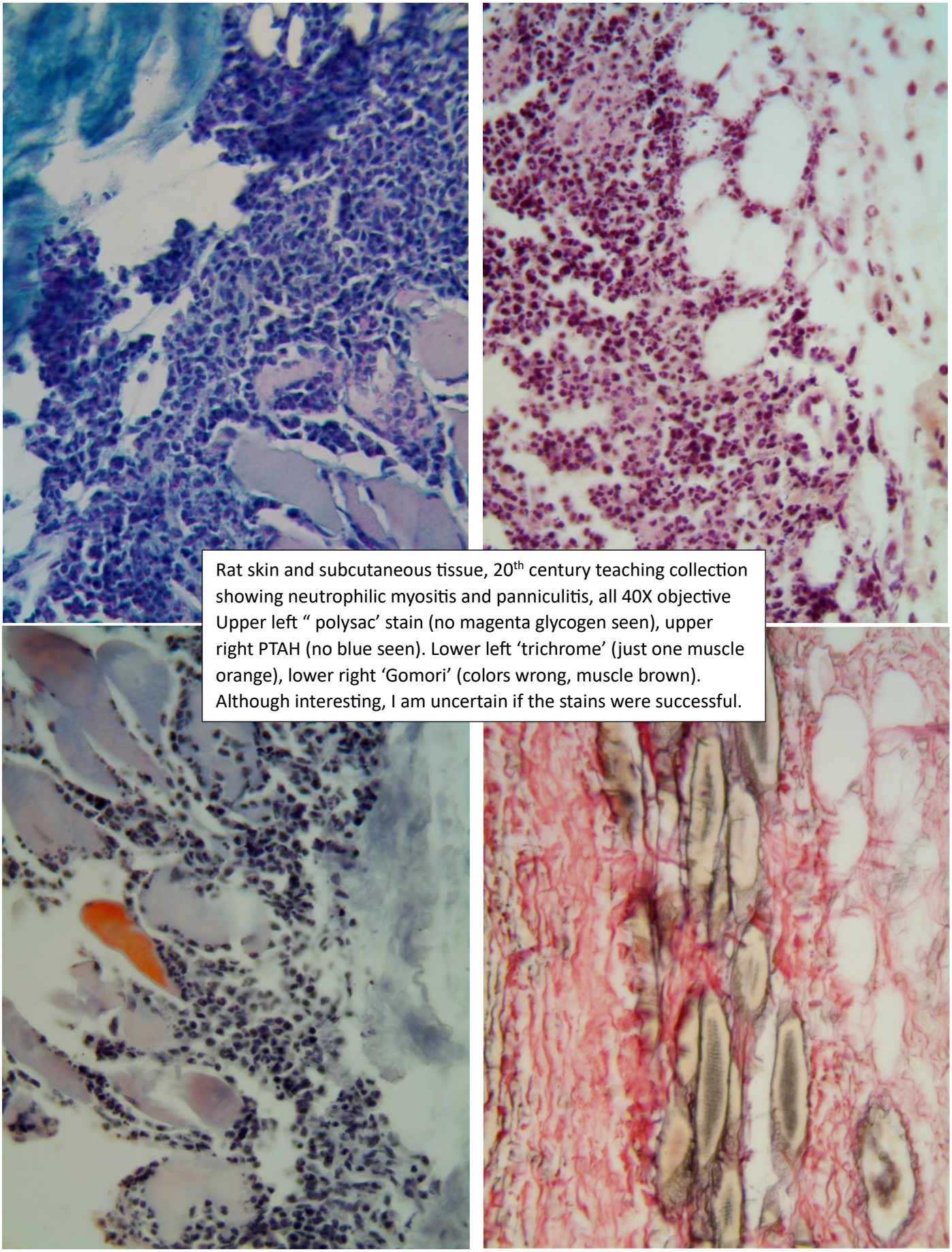
Periodic Acid Schiff's (PAS) or Alcian Blue "Polysac" stain
Magenta or blue carbohydrates, including glycogen ("animal starch") glycoproteins (sugars stuck on protein) and mucins

Phosphotungstic Acid Hematoxylin stain (PTAH)
Stains collagen and muscle tissue, resulting in purple glycogen, blue cross striations and nuclei, red-brown collagen, purplish elastic fibers. Optionally, added diastase turns glycogen to pink.

Trichrome stains: Masson's, Gomori, Mallory stains
Trichrome stains highlight connective tissues that glue the body together with sticky stuff outside cells. Trichrome stains can be very beautiful. Most stain collagen blue and muscles red.

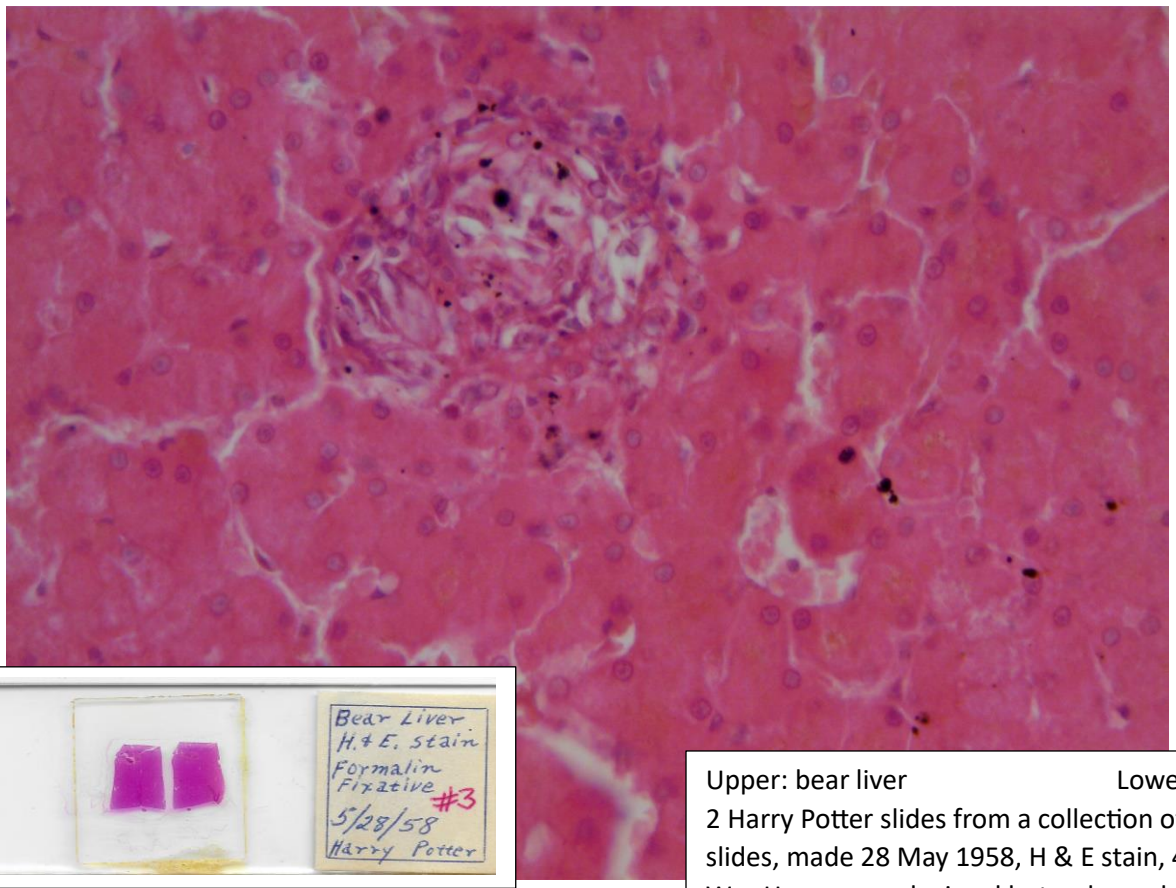


Rat skin and subcutaneous tissue, 20th century teaching collection faded H&E stain, showing neutrophilic myositis, 40X objective

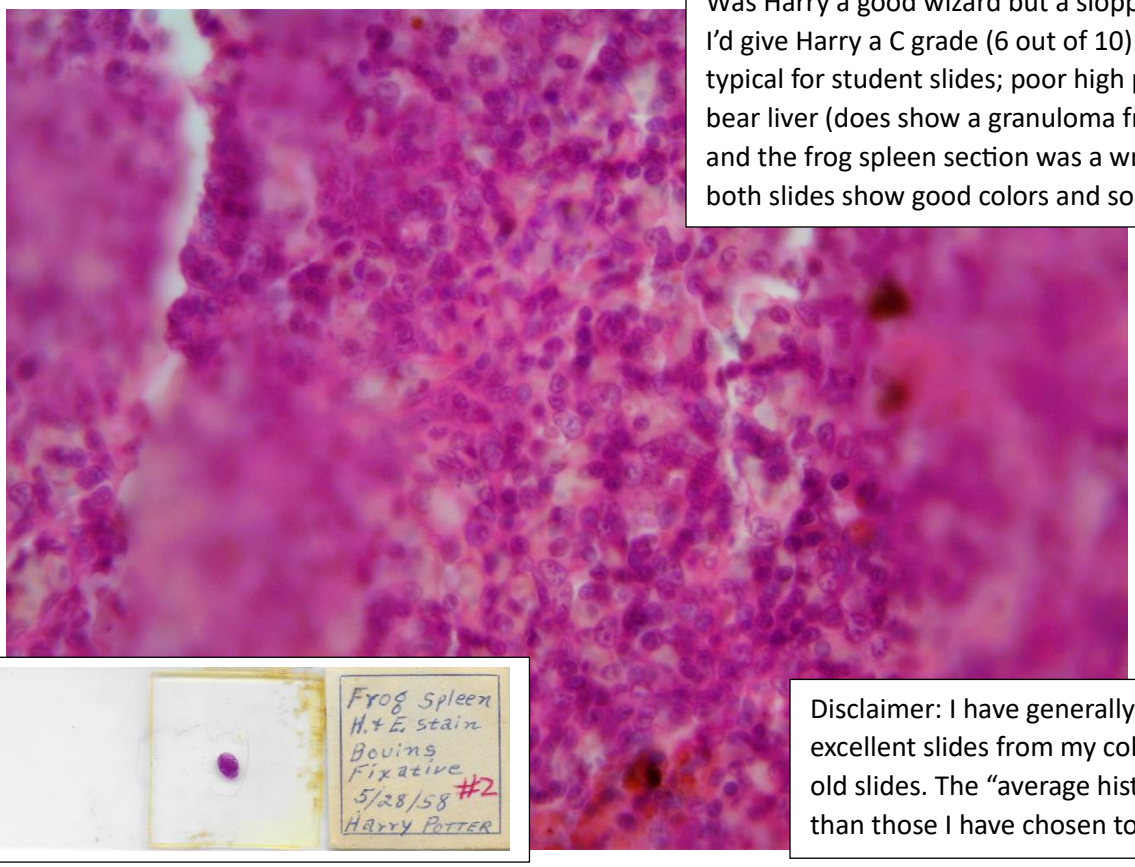


Rat skin and subcutaneous tissue, 20th century teaching collection showing neutrophilic myositis and panniculitis, all 40X objective Upper left " polysac' stain (no magenta glycogen seen), upper right PTAH (no blue seen). Lower left 'trichrome' (just one muscle orange), lower right 'Gomori' (colors wrong, muscle brown). Although interesting, I am uncertain if the stains were successful.

Example of mediocre student histology slides: Harry Potter's

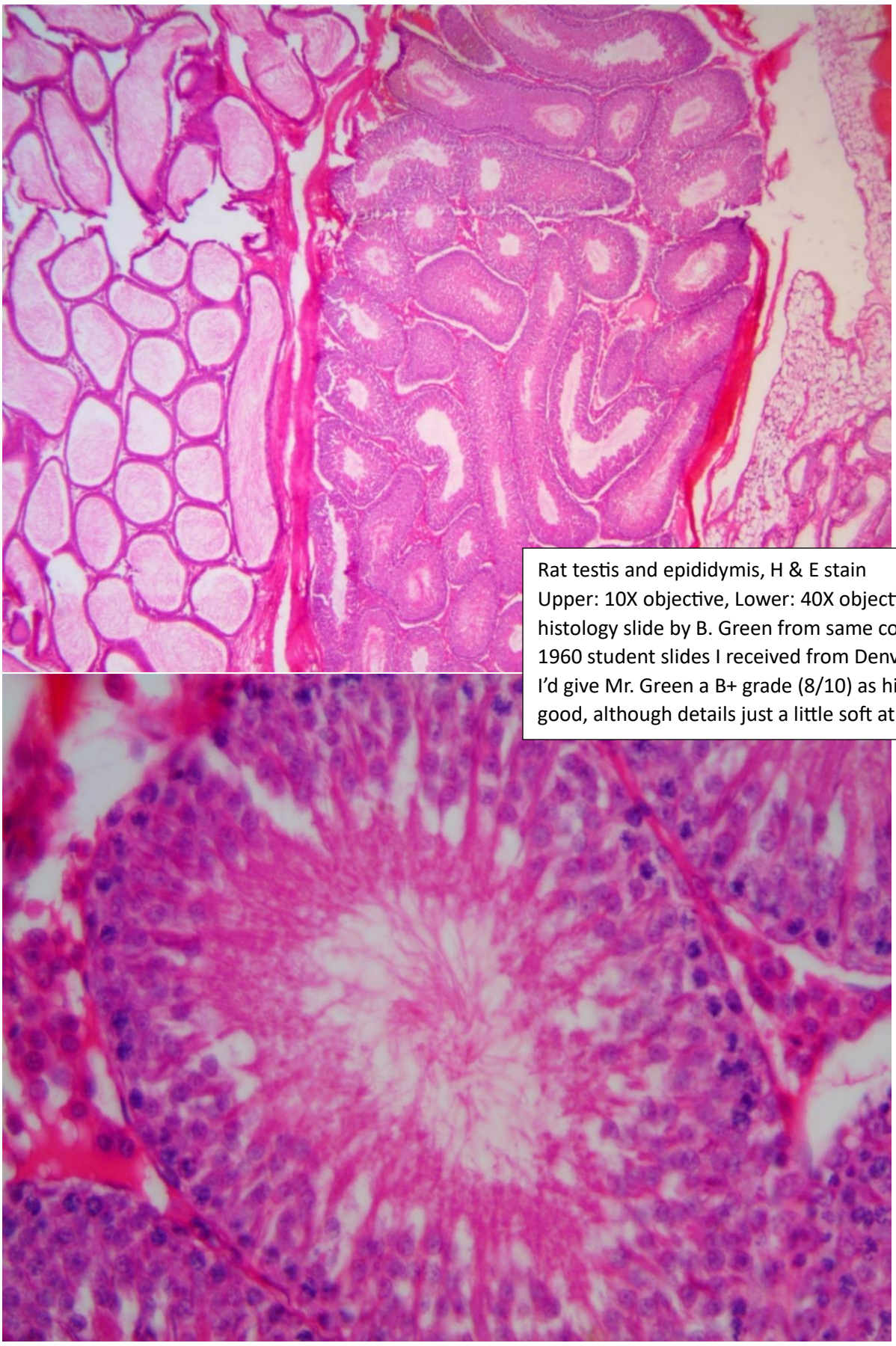


Upper: bear liver Lower: frog spleen
2 Harry Potter slides from a collection of student histology slides, made 28 May 1958, H & E stain, 40X objective
Was Harry a good wizard but a sloppy histology student? I'd give Harry a C grade (6 out of 10) as his results are fairly typical for student slides; poor high power cell detail in the bear liver (does show a granuloma from a chronic infection) and the frog spleen section was a wrinkled mess; at least both slides show good colors and some cellular structure)



Disclaimer: I have generally picked out good to excellent slides from my collection of thousands of old slides. The "average histology slide" is far worse than those I have chosen to try to inspire you.

Example of a good university student histology slide: by Harry's classmate, B. Green

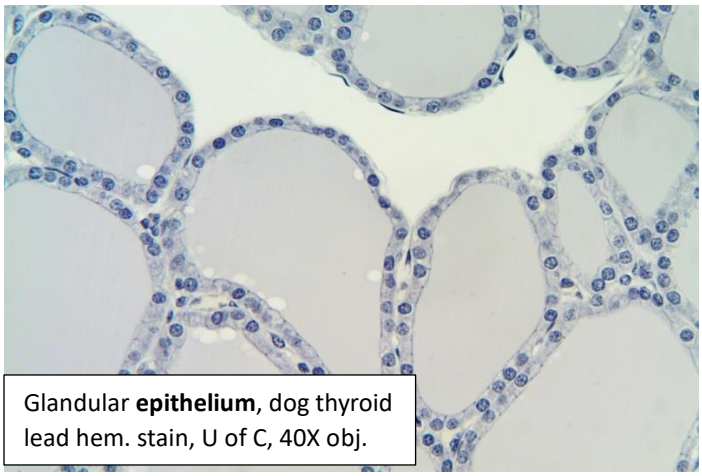


Rat testis and epididymis, H & E stain
Upper: 10X objective, Lower: 40X objective
histology slide by B. Green from same collection of 1952 to 1960 student slides I received from Denver, Colorado, USA
I'd give Mr. Green a B+ grade (8/10) as his results are quite good, although details just a little soft at high dry power.

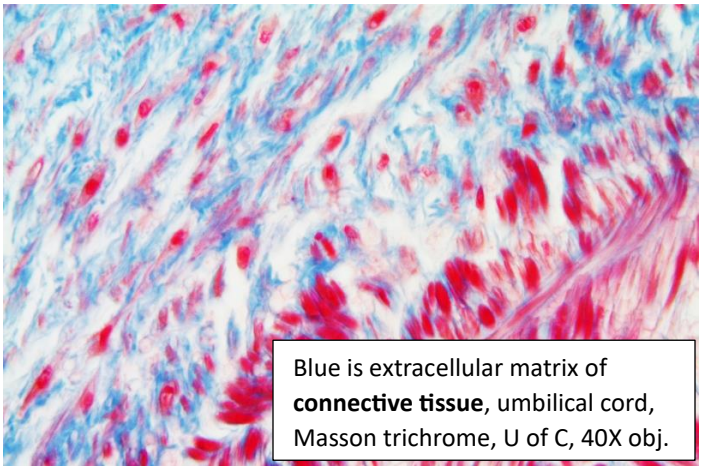
An extremely brief overview of histology and pathology

Animals have 4 basic types of tissue, with many subtypes:

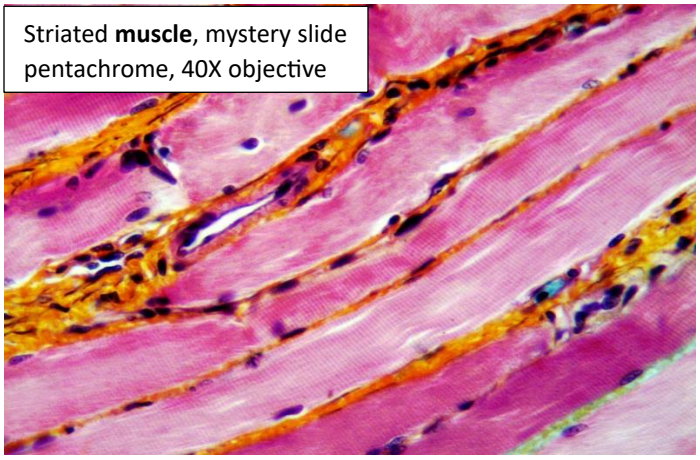
1. epithelial- simple, stratified, glandular	in skin, lining and parenchyma (main functional bulk) of many organs
2. connective- general and special	widespread, special types include bone and blood
3. muscle- smooth, striated, cardiac	in intestines, muscles, heart
4. nervous- neurons, glia	central and peripheral nervous system



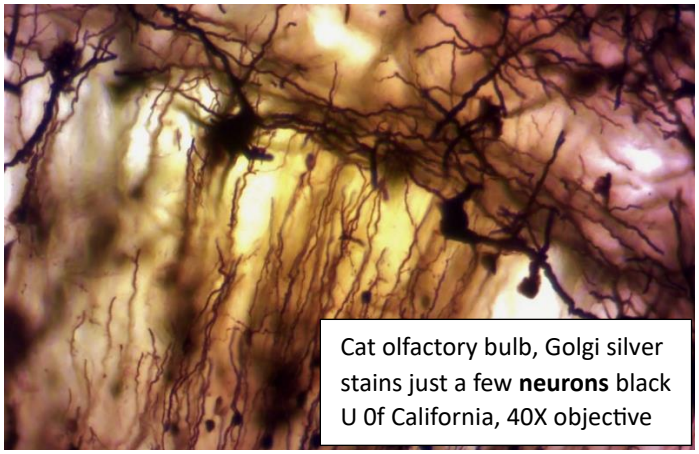
Glandular **epithelium**, dog thyroid lead hem. stain, U of C, 40X obj.



Blue is extracellular matrix of **connective tissue**, umbilical cord, Masson trichrome, U of C, 40X obj.



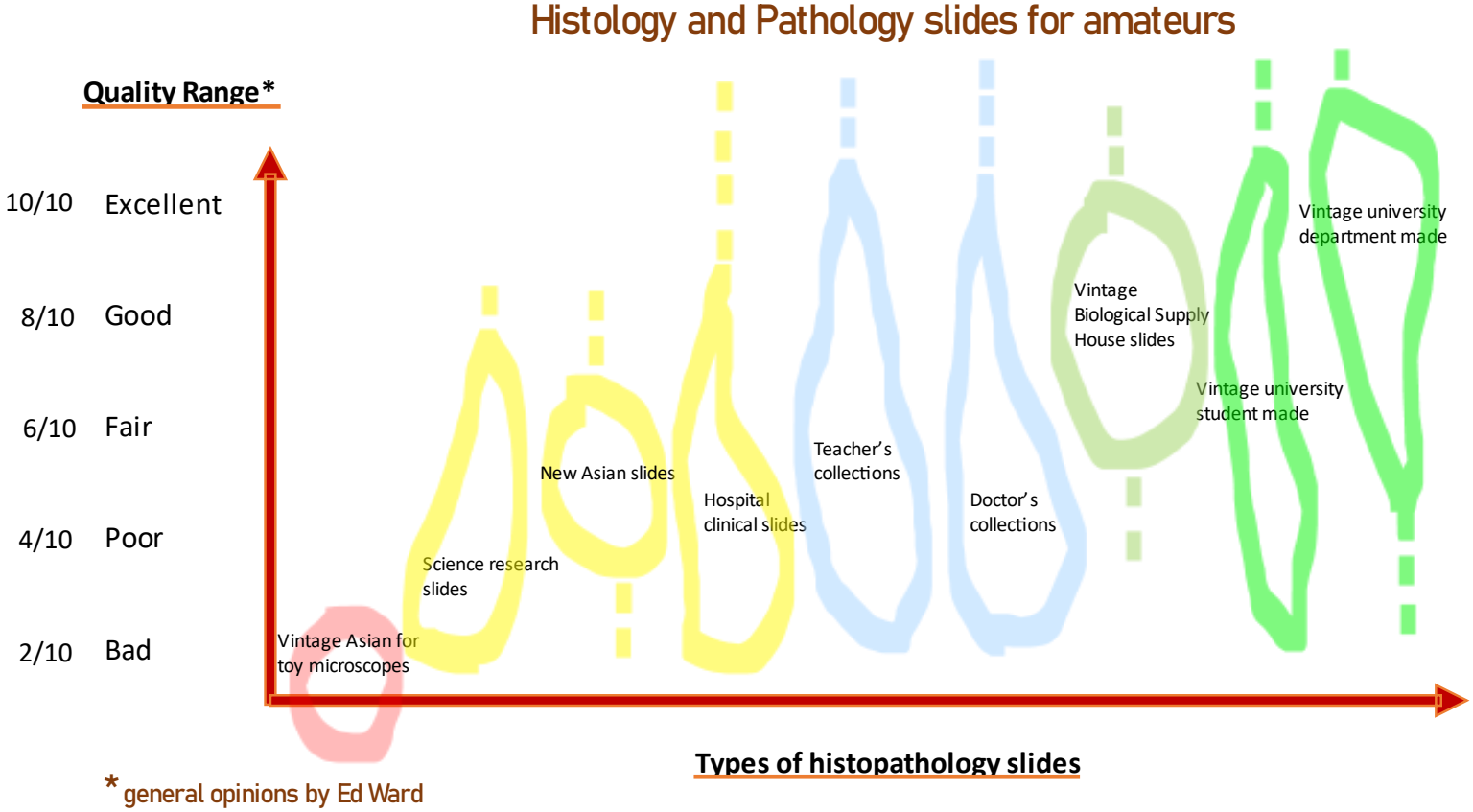
Striated **muscle**, mystery slide pentachrome, 40X objective



Cat olfactory bulb, Golgi silver stains just a few **neurons** black U 0f California, 40X objective

Most organs have all 4 types of tissues, as they are lined or covered by epithelium and supplied by blood vessels and nerves, with connective tissue holding it together. Many organs and glands are full of blocky celled epithelium layers, and looking for what is functional and special (goblet cells in places with mucous membrane, sinusoids in the liver, islets in the pancreas, glomeruli in the kidney, alveoli in the lungs) helps me to narrow the possibilities. Particular special stains are used more commonly for particular organs (silver or Nissl stain for brains, PAS for kidneys, iron stains for liver, etc.).

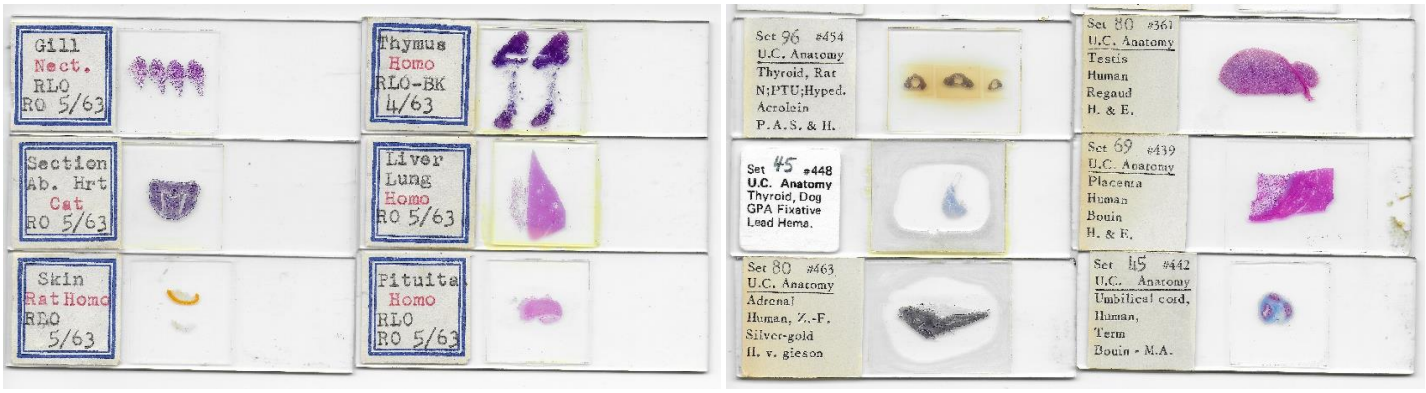
You shouldn't be doing amateur pathology at home (please leave pathology to trained professionals, as do I), but after you have looked at many slides and can identify normal tissues you might suspect pathology (disease) when you see something that shouldn't be there. Find one of the many YouTube videos on the kind of pathology slide you have. A blood smear packed with 20 times the normal number of white cells might be leukemia. An appendix with the usually empty spaces showing many neutrophils (a kind of white blood cell) might be appendicitis. Lung alveoli full of cells instead of air might be a pneumonia or pneumonitis. A section of skin or other organ with an out of place mass of odd, dense cells with multiple mitoses (dividing cells) could be a cancer, but any real diagnosis requires an expert.



The chart summarizes my overall opinions based on my own selection of good slides from several thousand used histology and pathology slides I have seen. Your opinions may be quite different, and I welcome them.

The pages that follow give more detailed advice regarding obtaining histology slides. Many slide sets for sale don't fit into any of the categories I created. Even collections that are mostly junk slides may have one great slide. Histology slides showing the full glory of cells woven into tissues are hard to make consistently well. Hence the average histology slide quality is near the lower end of the chart for most types of slides. Even though histology and pathology slides drastically vary in quality, I recommend you keep trying until you secure some magnificent examples.

Nothing is certain in life, but I have had good luck with histology and pathology slides made at universities. The 6 slides on left were made by a talented University of Cincinnati student in 1963. The 6 slides to the right were made by the University of California for its Department of Anatomy about a decade or so later.



Available histology and pathology slides

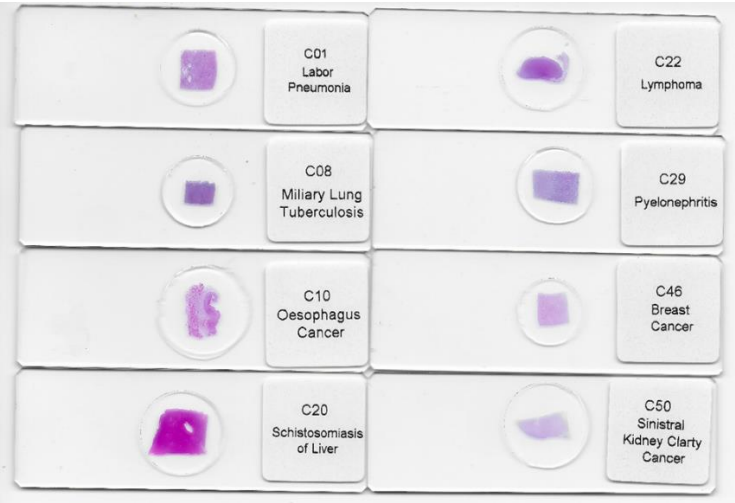
Histology slides vary greatly, from poor to excellent in quality, because the required hundred little steps over several days required to make them perfectly can be messed up in so many ways. Bad (old, contaminated) reagents, poor fixation, bad staining, warped sections, 1 minute too long with step #67, 1 minute too fast with step #68, air bubbles, bad mounting medium, imperfect cover slips and 101 other errors (Leica Biosystems helpfully published a list) can ruin the whole long process. To paraphrase Tolstoy, maybe all happy histology slides are alike, and each unhappy histology slide is messed up in its own unique way. I commonly find bad slides from poor staining with faded colors, or from poor fixation, thick sections or other issues leading to a complete lack of any clear fine details. I have seen far more unhappy than wonderful histopathology slides. But the good histology slides are so exquisite they are worth searching out.

Those of us without a home histopathology lab full of deadly chemicals and expensive antique precision machines have two basic choices for obtaining histology slides at a reasonable cost: new slides from Asia, or old slides from eBay.

1. Sets of new prepared histology slides, mostly from Asian suppliers including Amscope, Omax, Meade and others

As of June 2023 sets of human histology slides are available on Amazon for $45 to $414 for 50 or 100 slides in a good wooden or plastic box, free delivery. Pathology slides are more expensive. Some come from surgical specimens, but you likely have to find people dying with cirrhosis or cancer to get certain disease slides. Pathology slide sets listed by Amazon from Asian suppliers cost from $50 to $500 for 12 to 100 slides. The slides and photomicrographs look fine in the ad copy. However, there are few reviews, including several 1 star affairs. One respected authority recommends Indian over Chinese slides. I have acquired some of these sets used, looking like new, but the stains were generally faint and many of the slides lacked good contrast and detail with 40X objectives. Maybe fixation issues or sections were excessively thick, leading to 3 or 4 layers of overlapping cells making it hard to see fine detail. In some cases the mountant was also too thick. Overall I'd rate most of these Amscope type human histology slides poor to fair at about 3/10 average quality. I have a human pathology set sold by microscope dot com that is of fair quality, showing needed diagnostic details, about 5/10 quality. Useable, but not as inspiring or beautiful as a really great histology slide.

50 slide human pathology set from microscope dot com good or not so good?

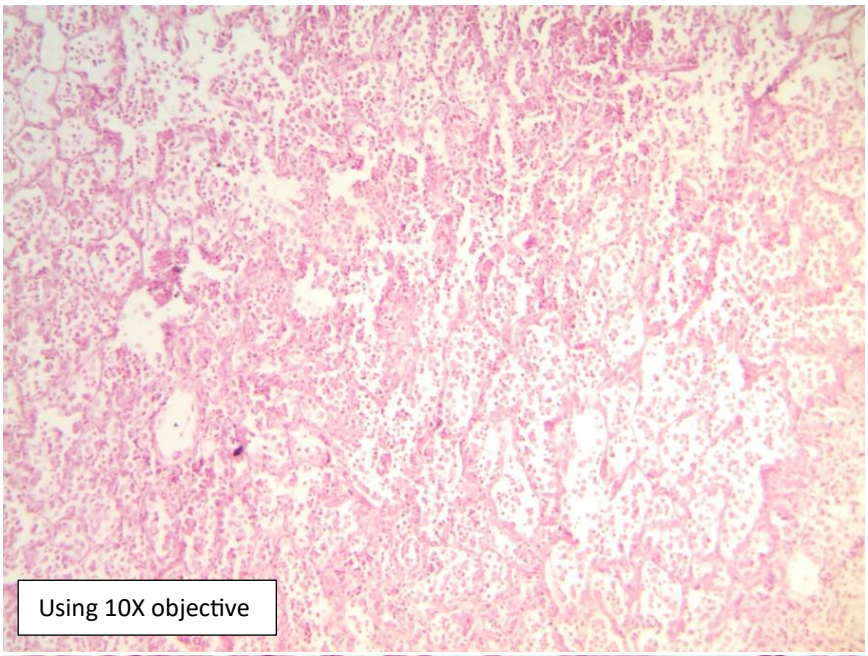


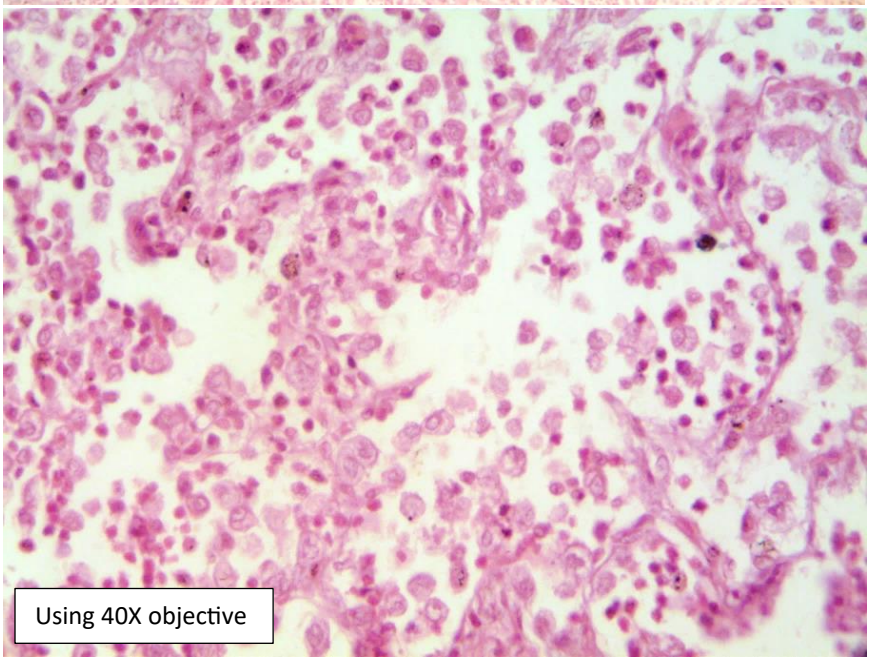
Recent pathology slides from Asia
Modern pathology slides from a set sold by microscope <dot> com. Specimens appear colorful, labels are neat, and slide corners are nicely beveled. The slides looked very promising, until they went under the microscope. I bought this set used, but it looked like new. It's possible slides from the company are better now, but quality appears similar to many other modern Asian slides I've seen.

'Labor Pneumonia' from a set sold by microscope dot com.
Misspellings are common on Asian slides; the correct term is lobar pneumonia. The stain is monochromatic and faint. High magnification details are somewhat lacking. This slide is typical in quality to others in the set. Some were a little better and some worse. You could learn from these slides but overall, they are much less inspiring than really good slides. I rate this slide and set about 4/10.

A sense of scale:
I designate which objective I used rather than stating an overall magnification. If used with a 10X eyepiece, a 10X objective would give 100X magnification through the eyepiece. Apart from those cropped or stitched, you can get a rough sense of size by knowing the 2.5X objective images are about 5 mm across, the 4X about 3 mm, 10X about 1 mm, 40X about 0.3 mm (300 microns), and 100X about 125 microns. Human red blood cells are about 5 microns across, and are smaller than most other human cells.

Metaphysical Disclaimer:
Cells don't "really" look like my photographs. The slides are specially stained. You can't focus your eye 0.1 mm from a slide; you see a projection from a system of lenses, enhanced by interference patterns. Only a tiny slice of the electromagnetic spectrum is visible to humans. Your brain makes up color and pattern. Yet the medical usefulness of the patterns seen has become lifesaving, proving the power of microscopes to help understand.


Using 10X objective


Using 40X objective

The biological supply houses Ward's Science supply (no relation to me) and Carolina Biological Supply still sell histopathology slides, seemingly of better quality (based on vintage examples; I have not seen their current slides). They do command a higher price. They sell 20 human histology slides in a paper box for about $155 or 15 human pathology slides in a plastic box for about $145. I'm not sure where these slides are made. I suspect Asia, but perhaps with better quality control. Triarch, an old Wisconsin based slide company (discussed further below as a source of used slides) sells some human histology slides from $5 to $19 dollars each. I believe they still make some of their nice botany slides in the US but for practical and economic reasons they might source the human histology slides from Asia. I have not seen new Triarch human specimen slides, but they might be better than average Amscope type slides. Most (usually decades old) Ward's and especially Triarch plant histology slides I've seen were clearly better than Amscope types, being perhaps about 8/10 quality on average.

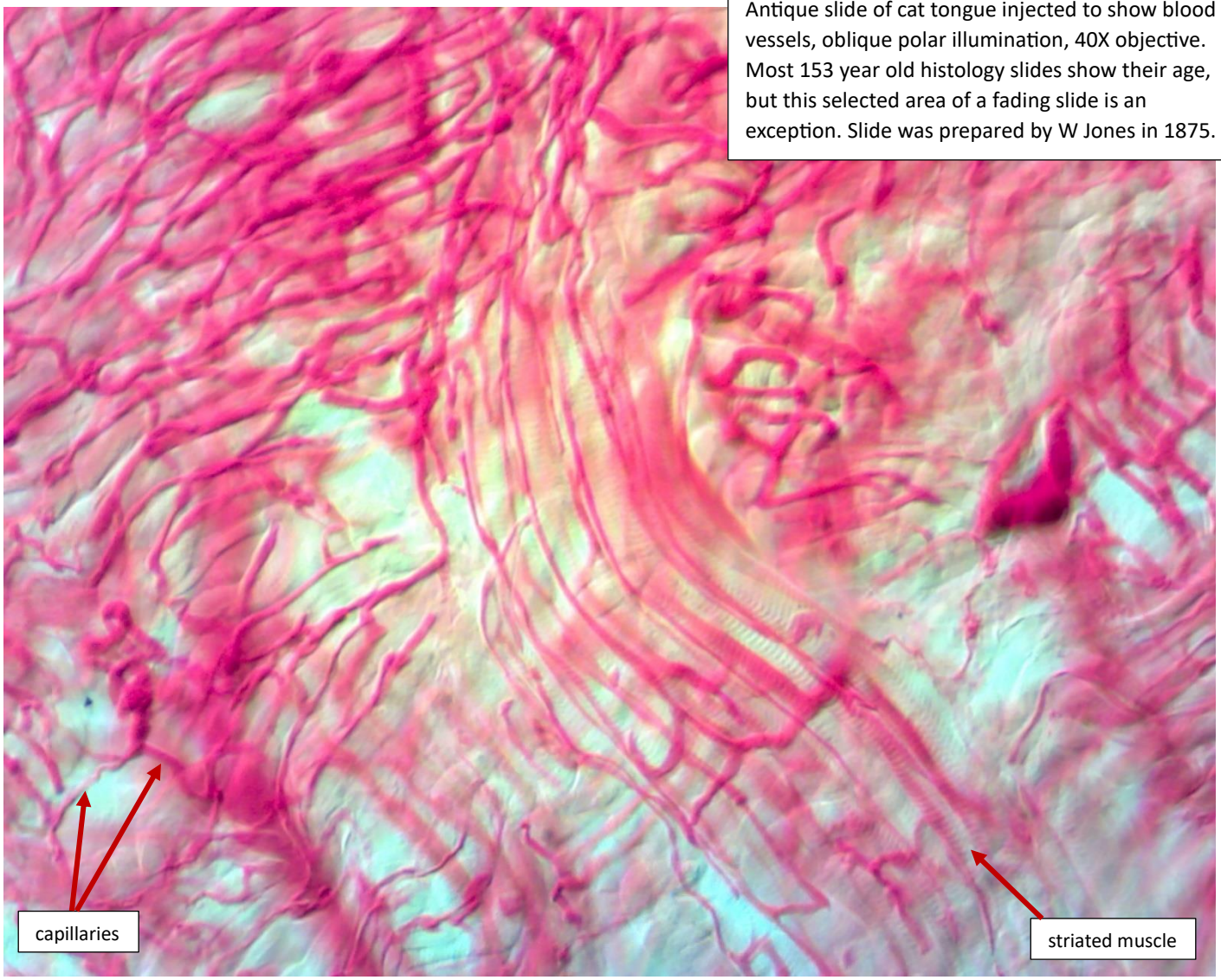
I have no experience with them, but a German company established in 1955, Johannes Lieder, says it makes its slides in Germany. Individual Lieder human histology slides are available for about $15 plus $10 shipping each, or in or sets of 6 to 25 slides for about $160 to $600 from Fischer, Frey, School Specialty and other science education companies. I have seen some good reviews on-line. They might be very good slides, but are too expensive for my taste.

2. Used sets of histology and/or pathology slides from eBay, my recommendation for histology slides

There are lots of used microscope slides on eBay (and rarely on the Goodwill internet site or at local estate sales). These sets are far more variable than the Asian commercial slide sets in theme and quality, often even worse than those commercial slides on average, but sometimes far better, including beautiful gems that are my favorite histopathology slides. These favorite slides show contrasting colors and interesting microscopic features with sharp subcellular details. I recommend you try some used histology or pathology slide sets. Results will vary from poor to great. With patience and luck, you can eventually get some great used histopathology slides for far lower cost than new commercial slides.

I describe mostly sets of slides because they are far more economical. When slides are sold individually the shipping costs can easily become prohibitive. A box of 100 slides comes with its own nice vintage organizer case and might have a $20 shipping charge which can seem high but really isn't. Consider that if you paid $6.95 shipping and handling each for 100 individual slides the shipping alone would total $695 and you'd still need to pay perhaps $1000 total ($10 each) for the 100 histology slides themselves and you'll still want a $20 case to hold them… ouch. Also a good set of used slides can be it's own organized collection by a particular person who made the slides or on a particular histology topic.

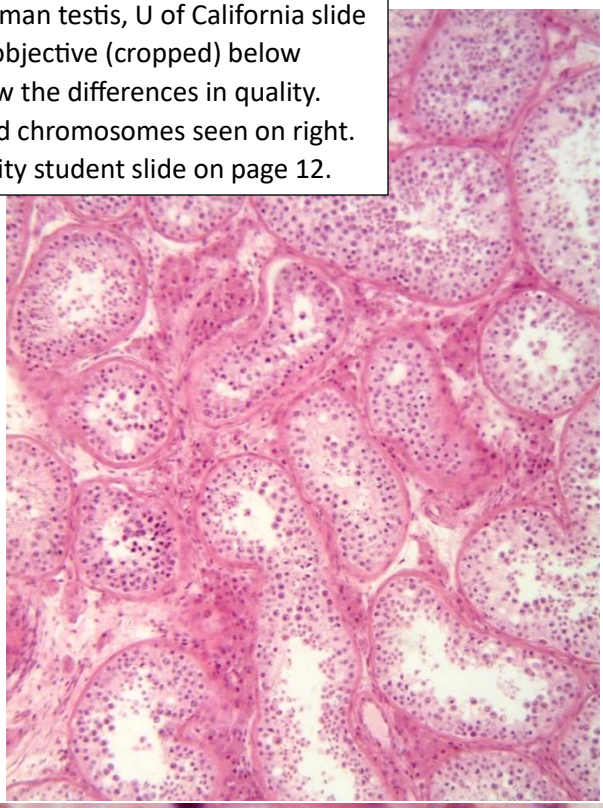
Shipping is just one reason I'm not going to talk much about **antique histology or pathology slides**, which are typically sold individually. Multiple famous early European commercial slide preparers like Topping, Norman and Wheeler sold histology slides along with insects, marine findings and everything else. Histopathology was only invented in the mid 19th century and the earliest slides were just hunks of tissue in a thick fluid mount. Perhaps historically interesting, but not much detail to see. I do have some interesting slides by AC Cole and others from the late 19th century. Some were stained OK, but not up to modern standards (or they faded badly after more than a century). Some antique commercial sides have the capillary blood vessels injected with red carmine, which illustrates how kidneys or lungs work. After 1900 the scientific resolution in medicine that started in Europe came to the United States and American Medical schools started making slides. Some histology slides I have from about 1900 to 1930 from various (non top tier) medical schools seem pretty badly done. This is not surprising as most US medical schools were basically nonscientific diploma mills "teaching" how to sell snake oil until about 1920 or later. After they embraced such innovations as cellular pathology and the germ theory of disease, they eventually learned to make decent histopathology slides. Old slides very in quality. Some well done 150 year old prepared slides with Canada Balsam as mountant still look fantastic today. But unless you prize these slides just for being antique, you are usually better off with more recently produced used histology slides.

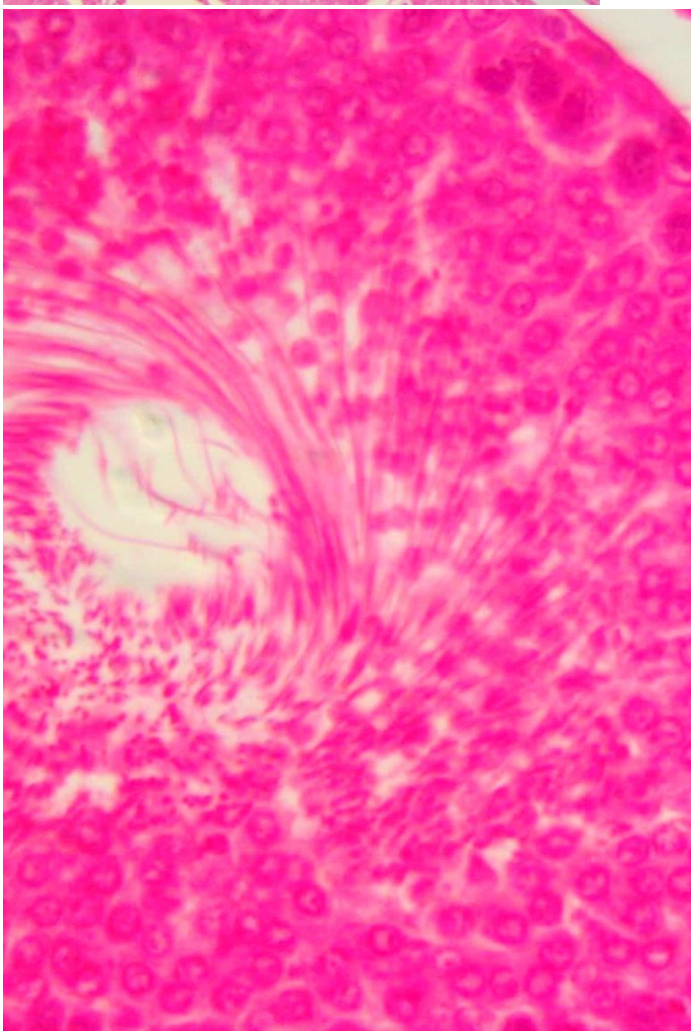


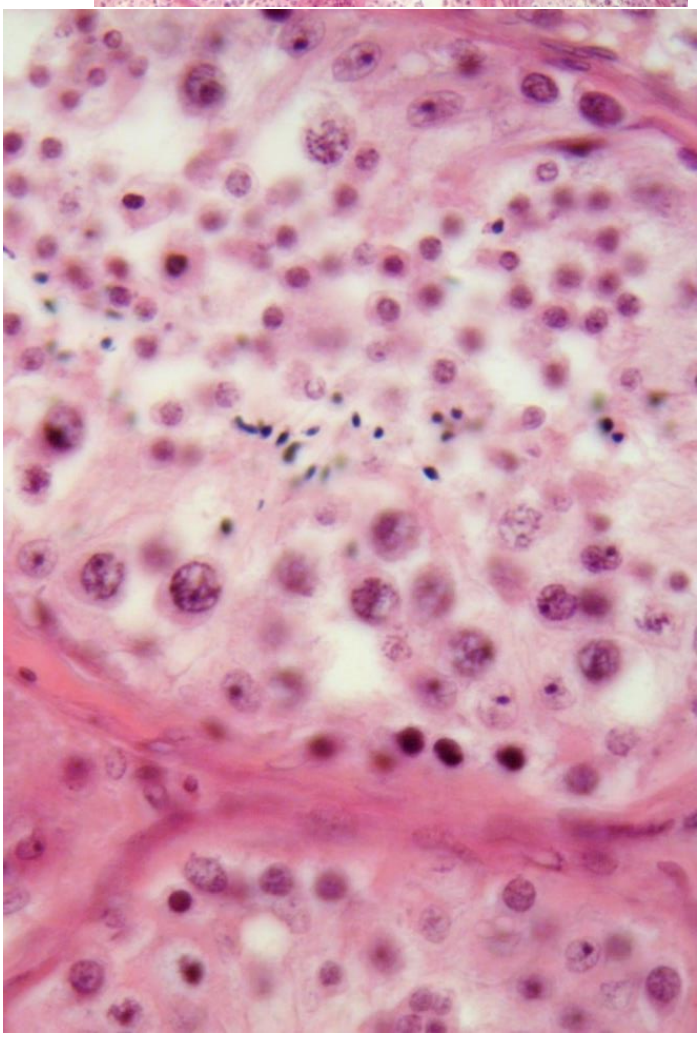
Many eBay sellers get slides at **estate sales** from sellers that don't know what they are. They might see "human" or the name of a hospital or university on a label and pass that on. A lot are in boxes of mixed subject materials. Sometimes it's part of an amateur's **collection of favorite slides from childhood**. I would not bother with a collection that was purely cheap imported slides for toy microscopes. But sometimes these collections extend up **to college age**, with a few human specimens thrown into a collection of mostly **Tasco "leg of honeybee" type cheap import slides**. Look carefully at the listing photos to see what you are getting, but some sellers don't even remove the slides from the box, so the photos aren't always helpful. These collections vary greatly in the subjects and in the quality of the slides contained. Many are from people who had one of the tiny imported Japanese hobby/toy microscopes of the 1960's. They often bought imported slide sets from Japan top go with them, labelled as Tasco, Milben (great yellow boxes with themes like "blood suckers"), Perfect, Skilcraft or Sears (among many other brands). The slides usually came in paper boxes. The quality of both microscope and slides were usually poor, far worse than Amscope type slides, perhaps 1-2/10 quality, with many unusable (sometimes no specimen is seen even with a good microscope). The rare imported cheap hobby histology slide sets were mostly poorly done blood and bacteria smears, mostly unusable with no cells present, even checking with phase contrast illumination. Yet, a few of the insect parts and other Tasco slides still look interesting today. Some students enjoyed and learned from their optically poor student hobby microscopes, but others tuned away from microscopes in frustration (myself included). Some slide collections are likely from people that started out with imported toy microscopes but persisted to move on to better microscopes and slides. Amazingly, even in sets of very good slides collected by medical professionals I still find two poor quality Tasco slides, which may have been childhood favorites.

Modern cheap Asian slide vs. Vintage USA University produced slide

Left: rabbit testis, Amscope slide Right: human testis, U of California slide
both H & E, 10X objective view above, 40X objective (cropped) below
Sometimes higher powers more clearly show the differences in quality.
Slide on left has poor detail; sharp detail and chromosomes seen on right.
Also compare to the rat testis, good university student slide on page 12.







Educational slides from smaller 20th century US based commercial makers: variable quality, some excellent

In the late 1800's the popularity of microscopes with lay people and scientists allowed a few persons to make a living preparing microscope slides, creating a confusing array of both famous and obscure mounters. My hat is off to Brian Bracegirdle of *Microscopical Mounts and Mounters* (1998) and Brian Stevenson at microscopist.net for their detective work elucidating hundreds of mounters of antique (over a century old) microscope slides. There is also a profusion of vintage mid 20th century vintage slides from well known companies like **Triarch** (now defunct), **Ward's Science** and **Carolina Biological Supply**. A number of less known mounters, including smaller companies and individuals also sold educational slides in the 1900's, including sometimes plant, animal and human histology slides. The upper Midwest was a hotbed of mid 20th century biological slide making, with big **Turtox** in Chicago, **Triarch** in Ripon, Wisconsin (both made excellent slides, see 'Golden Age') and smaller Ann **Arbor** Biological Center making similar slides in Michigan (slides I have are fair to good quality). Some employees may have defected and set up shop on their own. I have a few botanical slides from "**Ripon Microslides** Laboratory, John P. Limbach". 75 miles south is Fort Atkinson, home to **NASCO**, which made good histology slides. Some slides from "**BICO** Nat'l Bio. Supply Co., Chicago 10. Ill" are of simple specimens such as insect tracheae and squamous epithelium, choices somewhat reminiscent of Tasco style Asian slides. These company's slides don't usually say "made in the USA" and apart from some plant slides made in Wisconsin, I think all commercial "US" histology slides may now be from Asia.

Some probably smaller "US" makers of vintage educational and histology slides I have come across:

- "**Bioscope** Mfg Co. Tulsa, Okla." I saw some slides of fading botanical sections, a lung c.s. (cross section without mention of source animal) and a badly crazed animal trachea section. Quality and/or preservation fair to poor.

- "**Denner-Geppert** Co. Chicago Made in USA", was a 1916 to 1984 map and globe company that also sold anatomical models and some fair to very good histology slides, not all specified human (so some probably are animal)

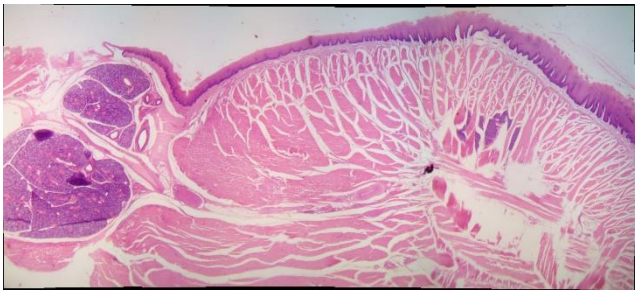
- "**L.E. Knott Apparatus Co.** Cambridge, Mass," blood smear (sold physics instruments, perhaps also hemocytometer)

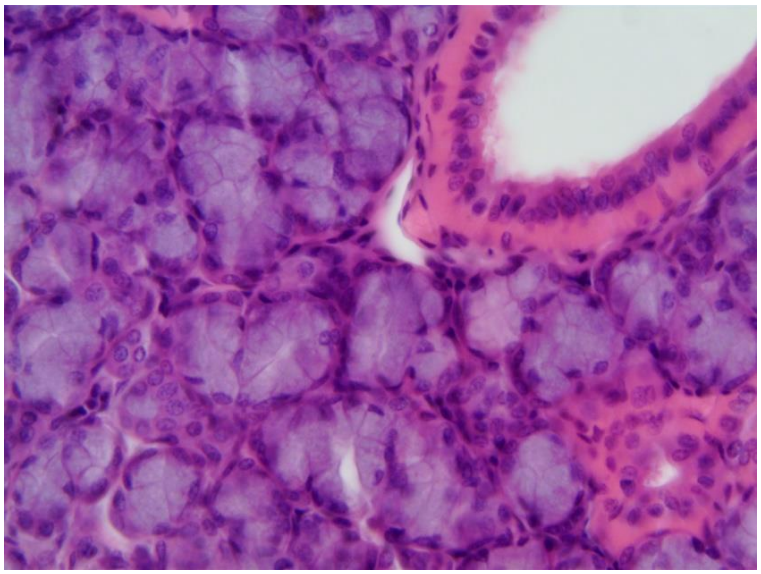
- "**Central Scientific Co**.", no other details, I saw a nice clover dodder slide, and a sloppy wing of "house mosquito"

- "**3B**" in a triangular graphic, no other details, several simple education slides of fish scales, feathers, might be Asian

- "**Albert Gallagher**, Berkley, CA," several histology slides including a good whole fetal mouse section (Gallagher was author of *The essentials of practical microtechnique in animal biology*, published in 1934)

- "**California Biol. Supply**, Pomona, CA", I've seen a fair to poor *Obelia* slide, unknown if they made histology slides

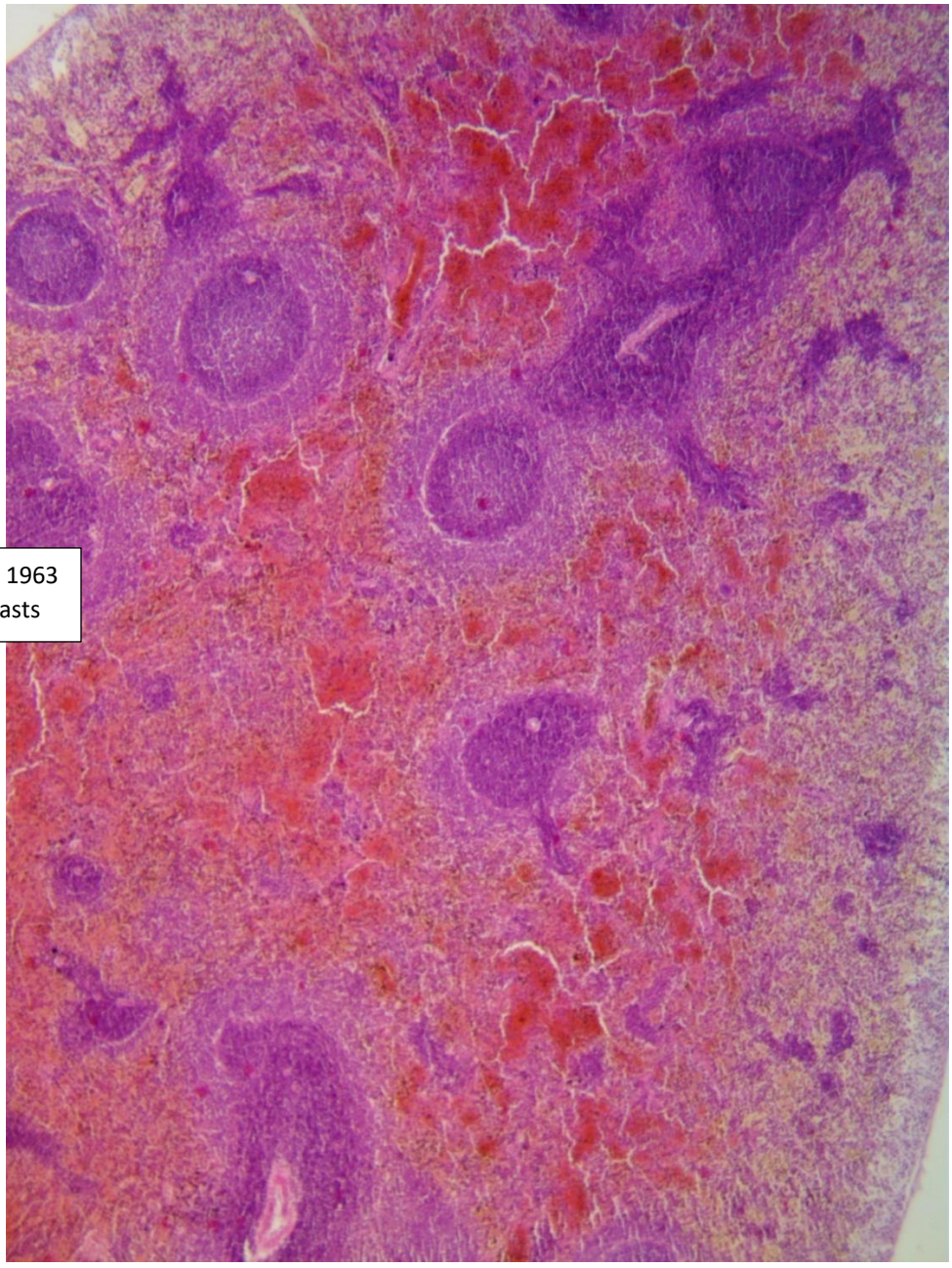




"Sublingual glands" unknown animal, H&E stain
Above: stitched from 2.5X obj., Right: 40X objective
2.5X panorama shows tongue and saliva glands
slide Denoyer-Geppert Co. Chicago, mid 20th century

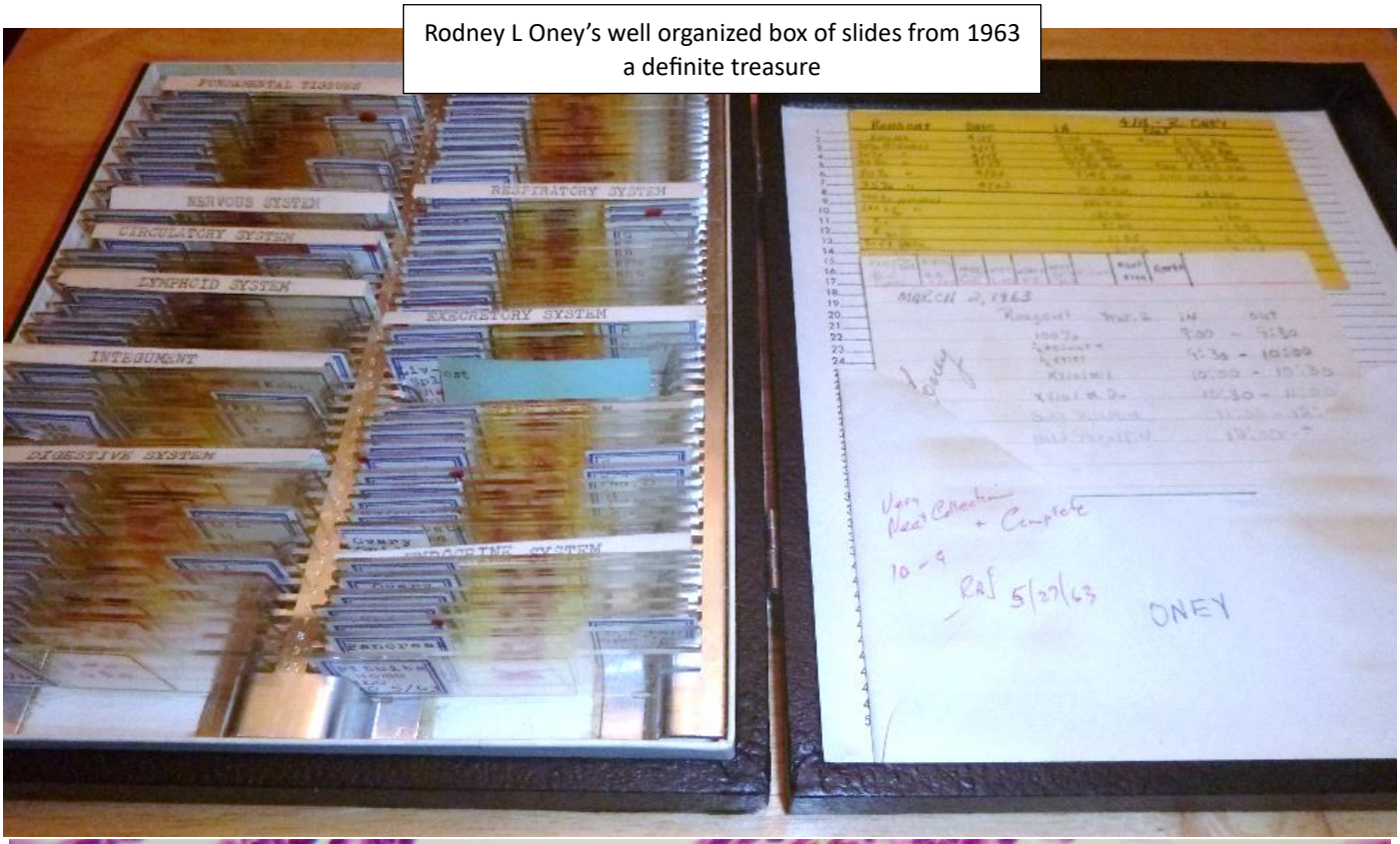
A fair number of the slide boxes that show up on eBay are vintage **university student histology collections**. Although variable in quality, some of these are quite good. In the mid 20th century pre-med and other college biology students learned histology by making their own sets of slides. Most of these sets have animal rather than human specimens and some have an assortment of both. Frogs, rats and dogs were the most common subjects dissected, and then slides were made of the most important organs. Don't dismiss the animal histology slides. Your gastric mucosa looks about the same as that of a rat or dog, and the similarities and differences in body plan between an earthworm (a hard slide to make well) and a human is instructive. If lucky you might get a big box of slides with the organs of a dog in various stains on one side, and those of a rat on the other. You could teach yourself a lot of histology with such a set. But be aware that university student slides vary incredibly in quality and condition, which I would rate from 1/10 (no visible detail at all) to 10/10 (superb). Some students appear to have flunked histopathology lab, and just a few deserved an A grade.

One student who should have earned an A grade was Rodney L Oney at the University of Cincinnati in 1963. His slide box is organized with organ system dividers and includes some protocols he used for tissue blocks, fixation, dehydration and wax embedding. Most of his results on a wide variety of animal and human organs are still stunning 60 years later.

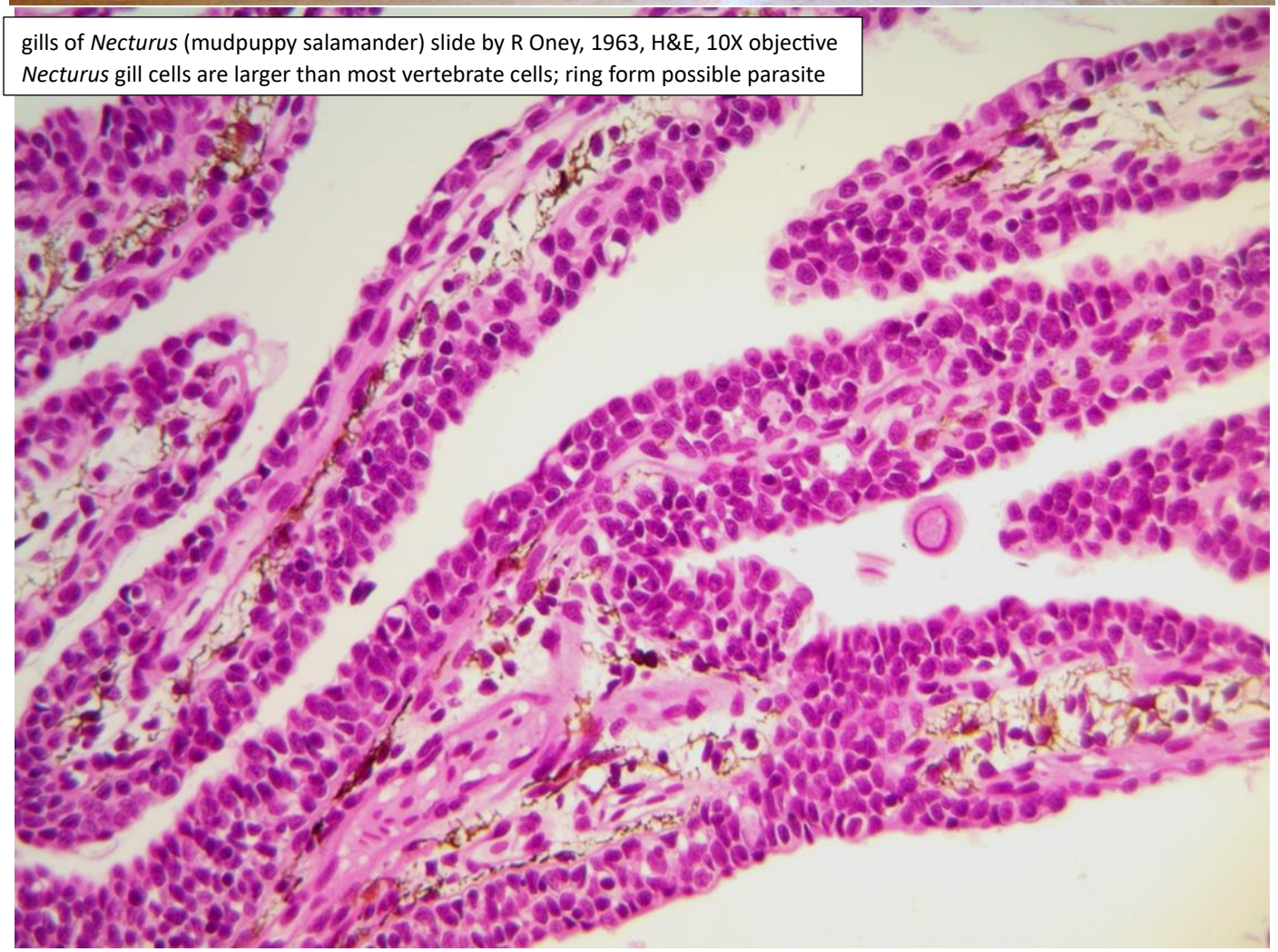


Spleen of rat, student slide by R Oney, 1963
H&E, 4X obj., stain has beautiful contrasts

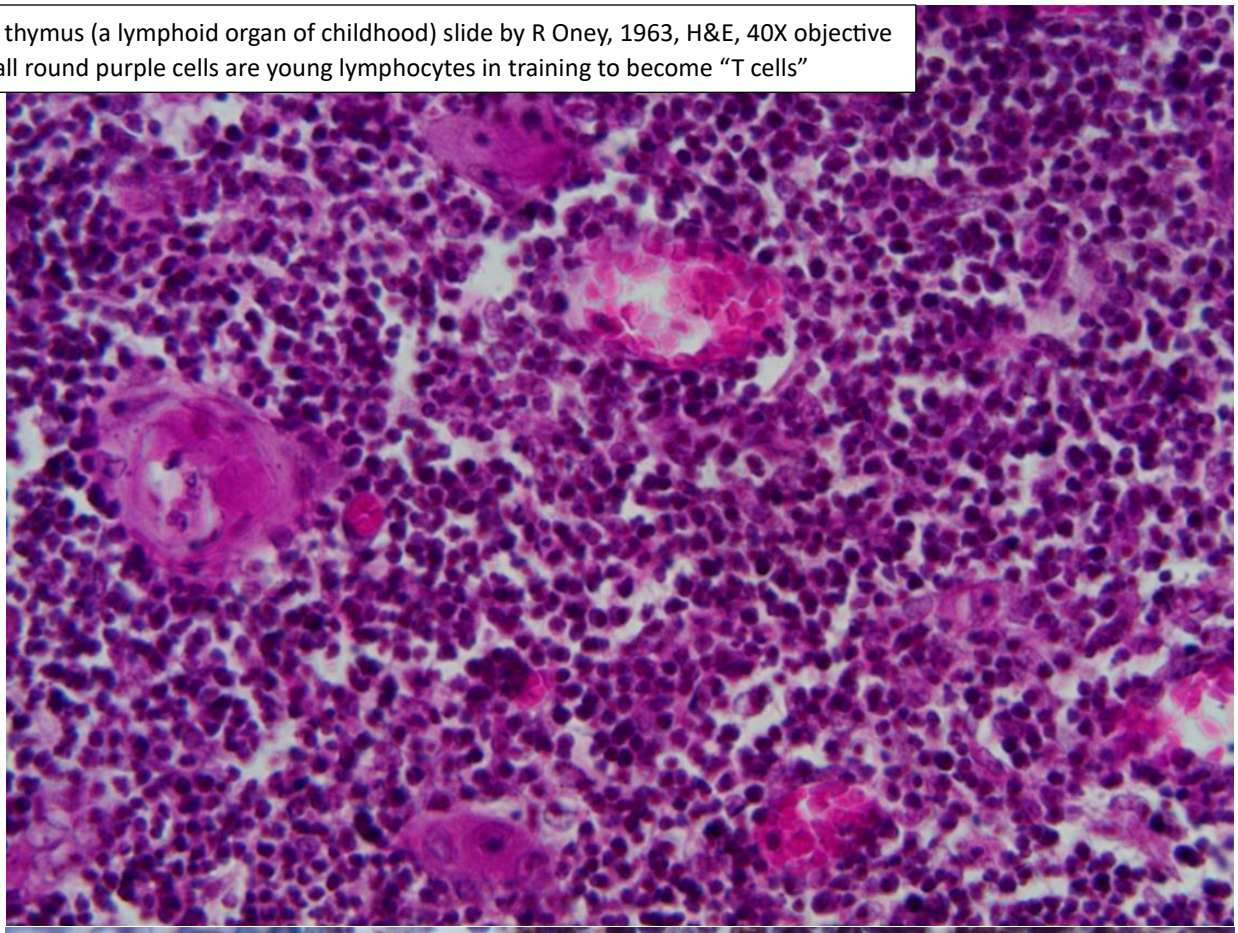
Rodney L Oney's well organized box of slides from 1963
a definite treasure

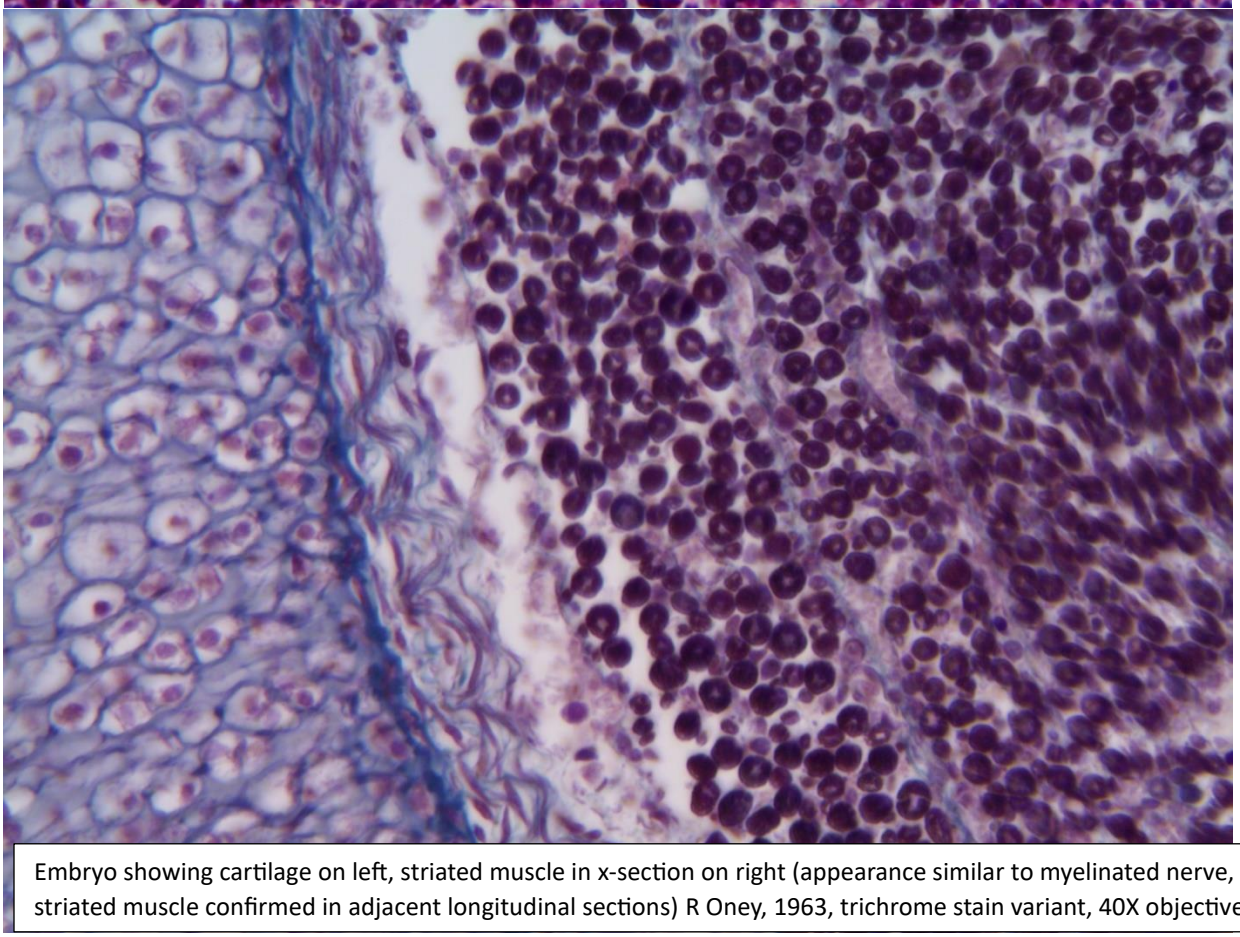


gills of *Necturus* (mudpuppy salamander) slide by R Oney, 1963, H&E, 10X objective
Necturus gill cells are larger than most vertebrate cells; ring form possible parasite



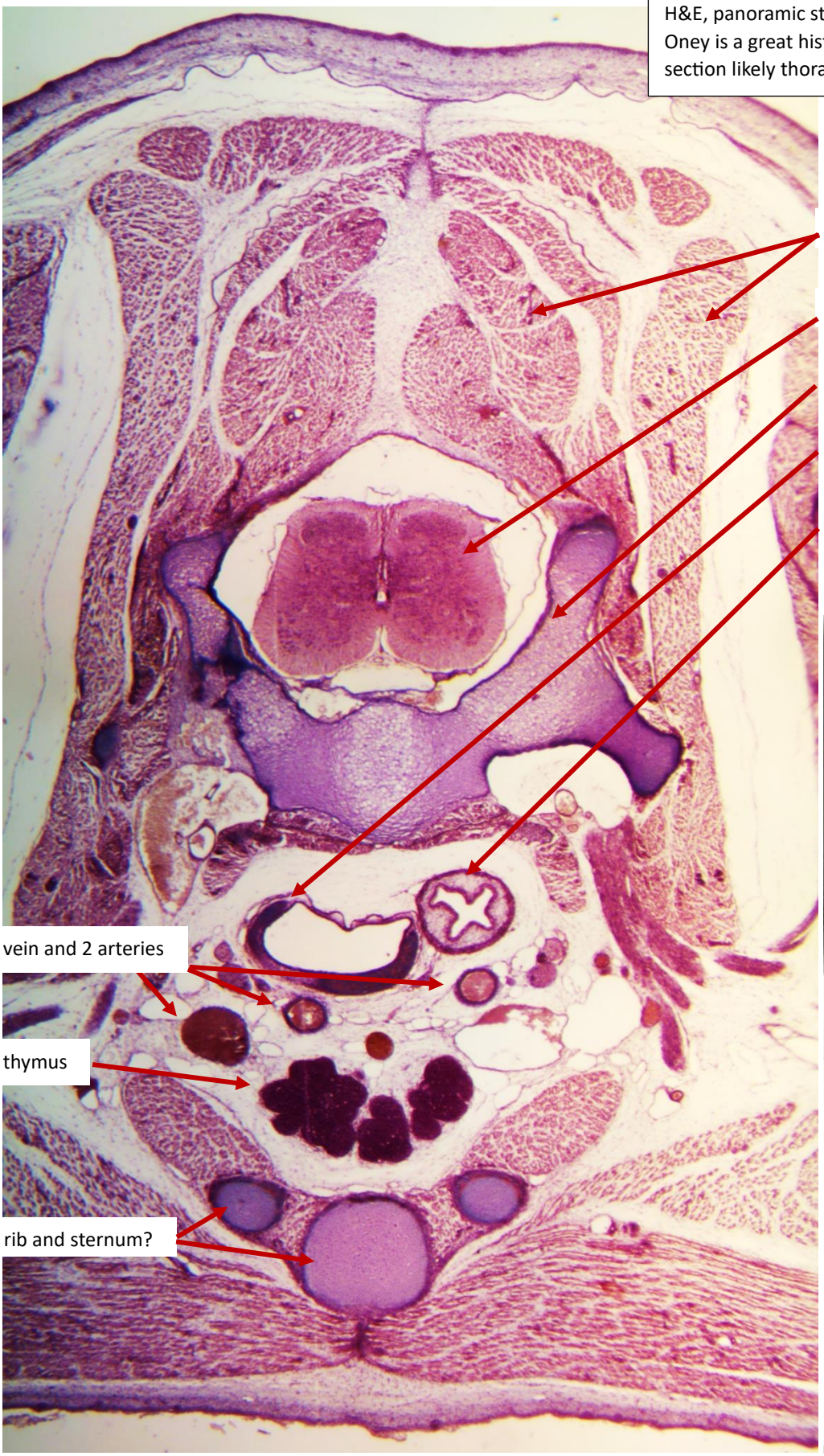
Human thymus (a lymphoid organ of childhood) slide by R Oney, 1963, H&E, 40X objective
the small round purple cells are young lymphocytes in training to become “T cells”





Embryo showing cartilage on left, striated muscle in x-section on right (appearance similar to myelinated nerve, but striated muscle confirmed in adjacent longitudinal sections) R Oney, 1963, trichrome stain variant, 40X objective

X-section fetal cat, another Rodney L Oney slide
H&E, panoramic stich of 5 shots with 2.5X objective
Oney is a great histologist but label may be wrong, section likely thorax/lower neck, not abd or heart



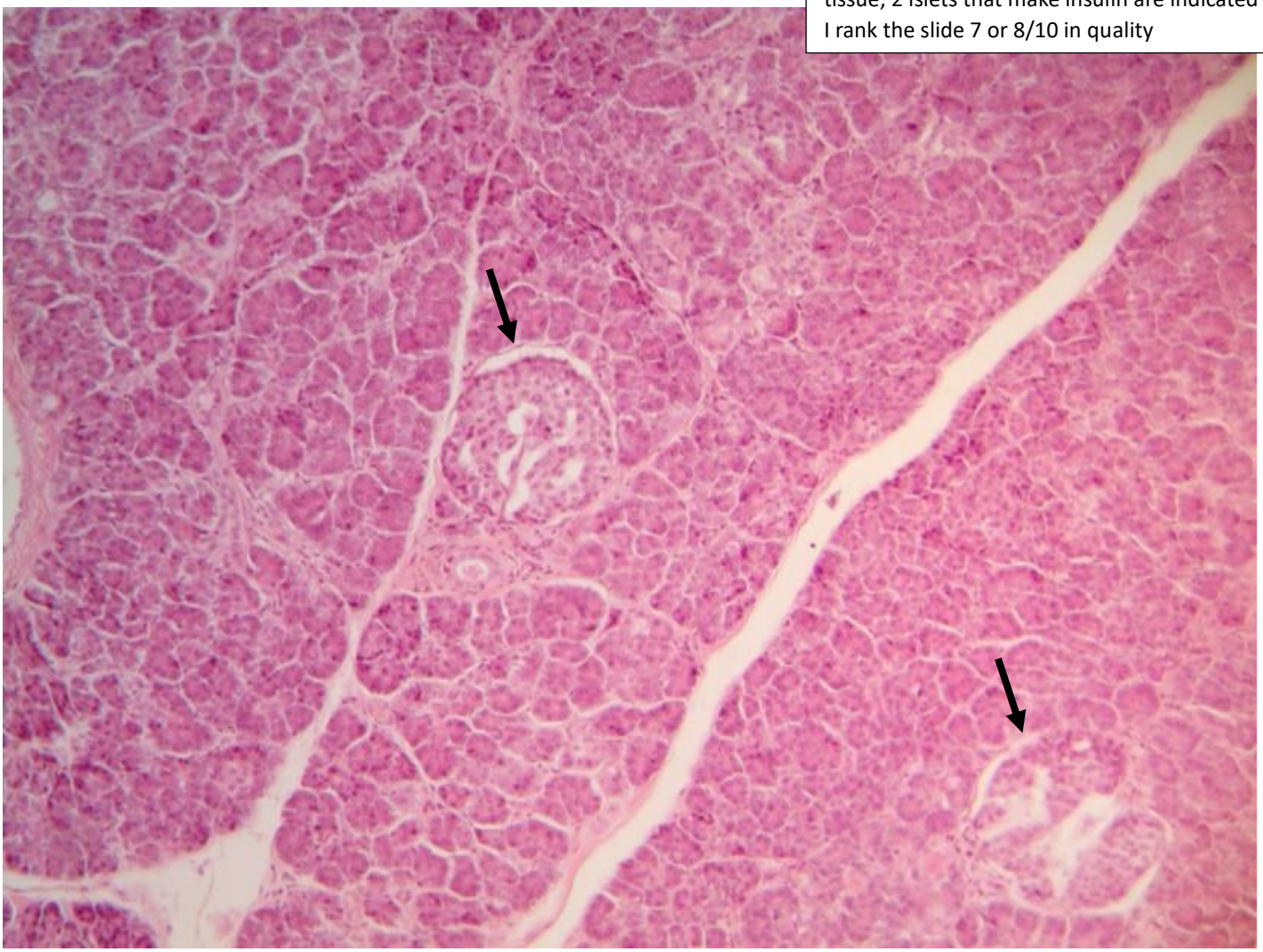
Look at the seller's photos to **<u>evaluate the condition of used slides</u>** as best you can before purchase. Some were stored in wet, cockroach infested environments. **Slide boxes** or hinges may be damaged. Labels may be faded or missing (without labels, nice slides may still be interesting mysteries). **Coverslips** may be broken or falling off. Some slide subjects have faded, crazed or otherwise deteriorated over time. If the seller provides pictures, **look for colorful and interesting specimens** on the slides. Special stains and trichromes can be nice if well done. Also **look for crazing**. Many fine mid 20th century histology slides are now ruined by innumerable fine cracks in the mountant. It usually starts at the edges of the coverslip then moves inward. Sometimes a clear area of specimen is still visible at the center of the coverslip, but I have seen hundreds of slides that were completely ruined by crazing over the entire specimen section. "Permount" is not always permanent and even the chemistry of Canada Balsam (the longest duration mounting medium known) can change when given a century plus to age, according to research on slides in natural history museums. But again, some of these eBay collections are really good, with motivated students learning from a master professor in a world class histopathology laboratory. Usually, if the slide is well done, **the slide label** also shows attention to detail. In those cases, the last name of the student is usually on the slide along with concise information about subject, fixation, preparation and date (such as "Rat, liver, Bouin's, H&E, 10 µ, J Smith, 9/23/61"). I am pleased when a female gendered first name is present. In my experience with old slides, young women often did especially excellent histopathology work (possibly self-selected to be the best, more patient, lacking male arrogance, better attention to detail?).

Macromolecules with attached sugars bind the aniline blue in this trichrome, including connective tissue and the brush border of the gut

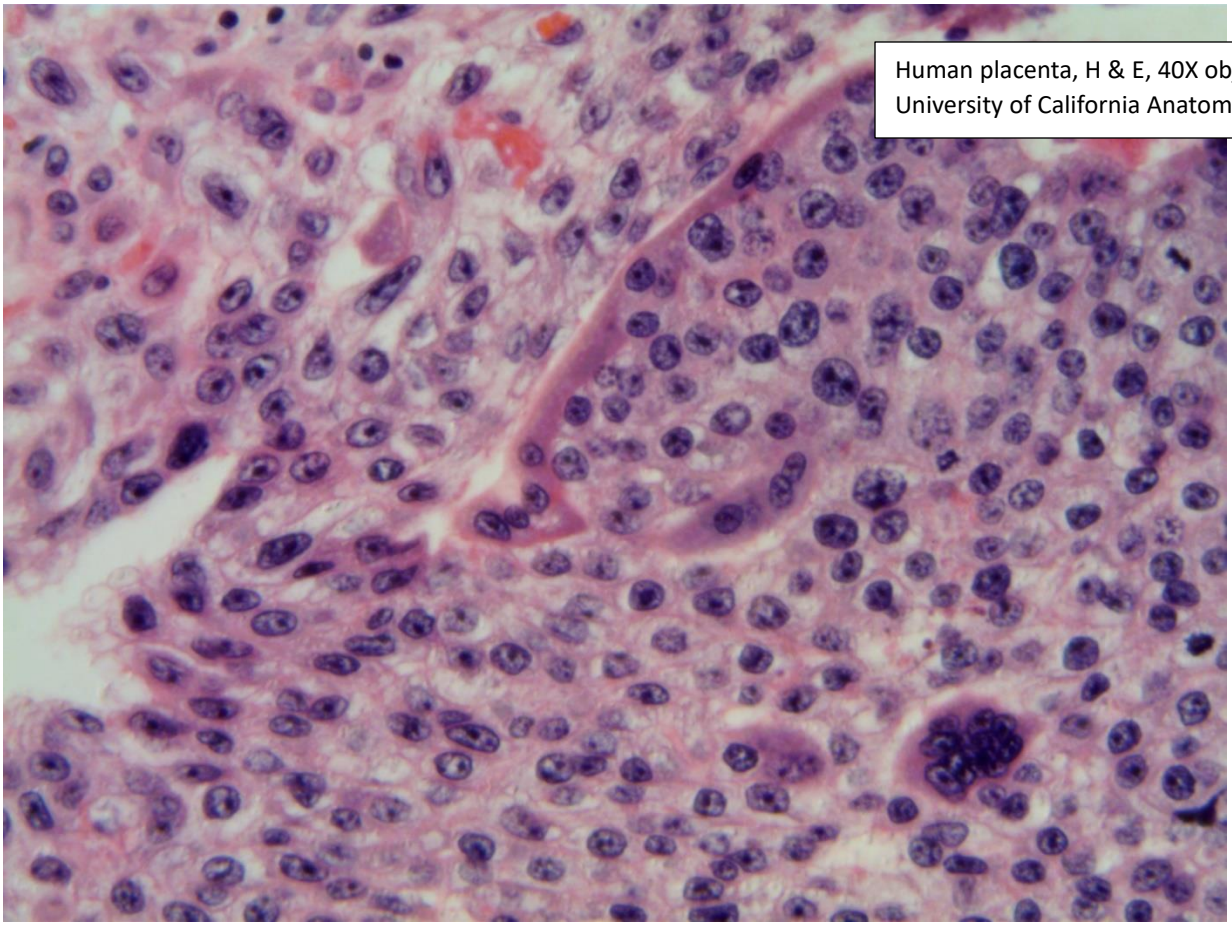
Guinea pig jejunum (small intestine) Zenker fixative, Mallory trichrome stain by "JR" at Wilson College, 1938, 10X objective
Beautiful staining by a female student; Wilson College is a private, Presbyterian university in Chambersburg, Pennsylvania and was a women's school from its 1869 founding until 2013

Some slides are from **teaching collections**. Some **high school teachers** made a collection of a slide or two or three each of many different science subjects. Sometimes some human histology slides appear in these collections. These slides are often of variable sources and quality including cheap Tasco or Perfect or Sears childhood slides, some homemade slides made in college, and some from scientific supply houses like Turtox, Ward's, Carolina Biological Supply or Triarch. The latter are often quite good in quality. Sometimes there are a few slides of ticks or tapeworms or other external or internal parasites, which many teachers must understandably have found interesting. The collection is usually broad including plant histology (a beautiful subject when done right) and maybe some non-biology subjects (the printed letter "e").

Human pancreas, H&E, 10X objective
Turtox Gen. Biol. Sup. House Chicago c1950
Pancreas is a fixation challenge because of contained digestive enzymes can self-digest tissue; 2 islets that make insulin are indicated
I rank the slide 7 or 8/10 in quality



Collections of **university teaching slides** are often excellent. The slides were often produced by the university, to a high standard, and often some good slides from biological supply houses are included. With a few exceptions, histology slides made by universities (in their own department labs, usually with nicely printed labels; not to be confused with hand labelled slides made by individual students during their education) are of high quality. Most rank 7-9/10 on my subjective quality scale, slightly better than average good Triarch, Ward's or Carolina commercial histology slides. A possible drawback is that some of these teaching collections have 20 or so duplicates of each slide, to allow multiple students to view them simultaneously during a lab session, and I have no use for so many duplicates.



Human placenta, H & E, 40X objective
University of California Anatomy Dept.

Rat pituitary, India ink vascular injection
40X obj., University of California Anatomy

The mid 20th Century Golden Age of biological supply house microscope slides

The quality of histology slides from big biological supply houses has been usually good to excellent in my experiences with many used slides. I enjoy the usual general biology slides (botanical subjects, marine invertebrates, primitive chordate *Amphioxus*) as well as the animal and human histology slides made by these fine slide makers. I'm most familiar with American slide making houses although I've seen great UK examples from Flatters and Garnett and NBS.

In the United States, Triarch, Ward's Science and Carolina Biological Supply still sell educational slides today including many plant histology and biology slides, and fewer animal and human histology slides.

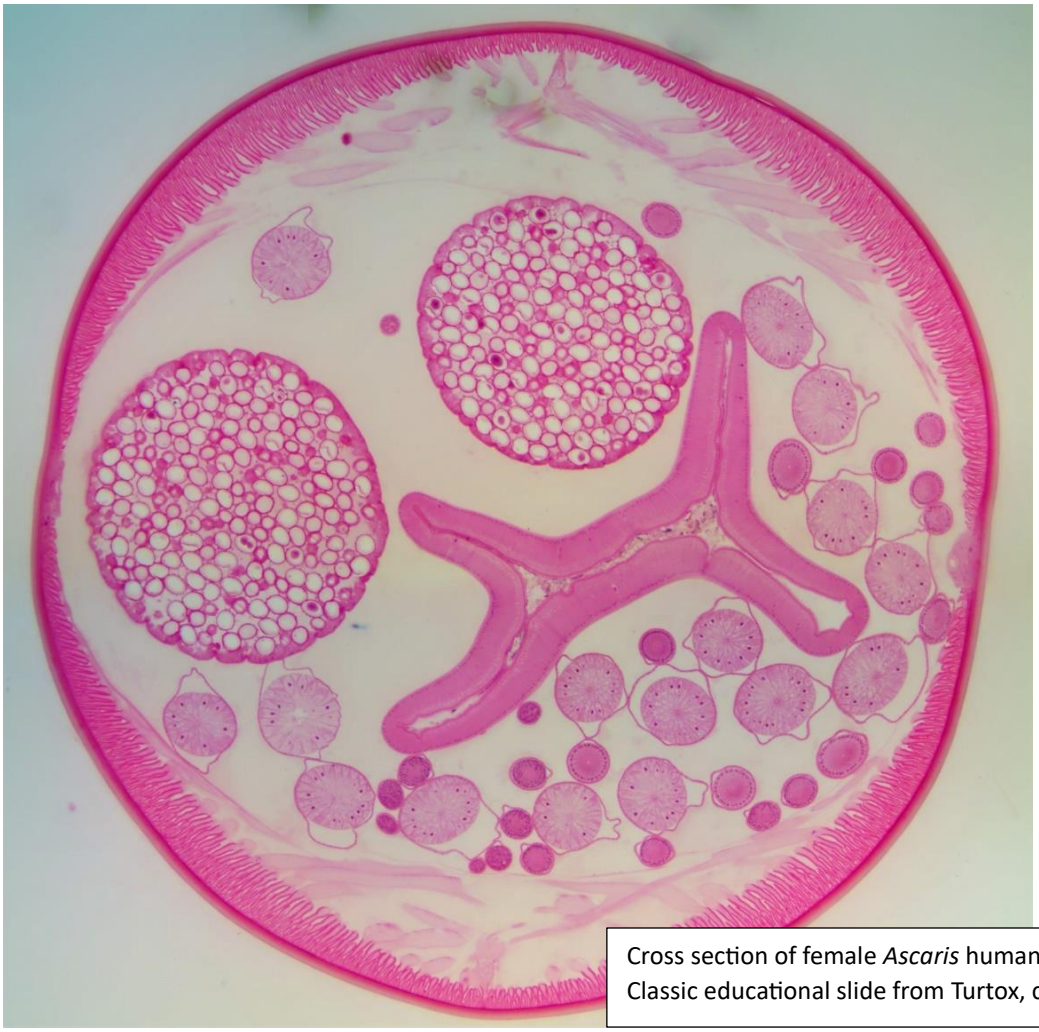
Triarch was started by George Conant in 1926 in his small hometown of Ripon, Wisconsin. It's still making slides there under the leadership of his granddaughter (I'm uncertain where their human tissue slides are made). Triarch makes slides of many biology subjects, especially beautiful high quality plant histology slides. **Ward's Science** in Rochester, New York was founded by Henry A Ward in 1862. It is currently associated with Boreal Science and Sargent-Welch. It supplies a wide range of science educational materials from various manufacturers including a large variety of histology and pathology slides. **Carolina Biological Supply Company** in Burlington, North Carolina was founded by Thomas Powell Jr. in 1927. It also has extensive supply chains; its source of prepared slides is unknown.

Now defunct **Turtox** was the former king of US slide makers. I've seen hundreds of great Turtox slides of many subjects including marine organisms, embryology, histology, pathology, and even various parasites inside various organs and in various life stages. Very sophisticated stuff, well done, made in the USA. Morris Wells started the Chicago Biological Supply House in 1913 while a graduate student at the University of Chicago. In 1918 he was joined by Frank Lillie, director of the Woods Hole Marine Laboratory and the name changed to General Biological Supply Company. In its heyday Turtox sold slides, charts, models and live and preserved marine specimens such as dogfish for dissection. *Turtox News* was a fascinating newsletter sent to science teachers around the US for decades. I can't find a proper later history of Turtox online, but I've found some clues. In 1967 Woods Hole divested its $2.7 million of General Biological stock. I have slides labelled "Turtox, Gen. Biol. Sup. House, Chicago, Illinois, made in USA", "Turtox CCM Gen. Biol. Inc. Chicago, Illinois, made in USA", "Turtox MacMillan Science Co. Inc. made in USA" and some that simply say "Ward's/Turtox". I find references to "Turtox/Cambosco Macmillan Science Co., Inc. 8200 South Hoyne Avenue. Chicago, IL 60620" in 1974 and 1978. I'm guessing that in 1970's merger mania Turtox merged with Cambosco, a Boston, Mass maker of physical science apparatus, then both merged with school textbook publisher MacMillan. At some time Ward's then bought Turtox or a stock of slides or just the name. Ward's still has a "Turtox Medical Histology Slide Set" of 100 slides for $788 in its catalog and VWR scientific offers the same "classic Turtox" set for $788 (in conjunction with Ward's? old stock?). I don't know when the last Turtox USA slide was made. An image of a Turtox slide of cell division is now interstellar, part of the golden records on NASA's 2 Voyager spacecraft.

My thinking everything had a "golden age" in the past likely reflects my own advancing age.

So vintage histology and pathology **slides from biological supply houses** are often of very good quality. I'd give most about 7/10, with some even better and only a few worse. They deliver the most consistent quality in my experience, more so than student, university, physician or hospital slides. Yet the very best, rare gems are scattered among the latter.

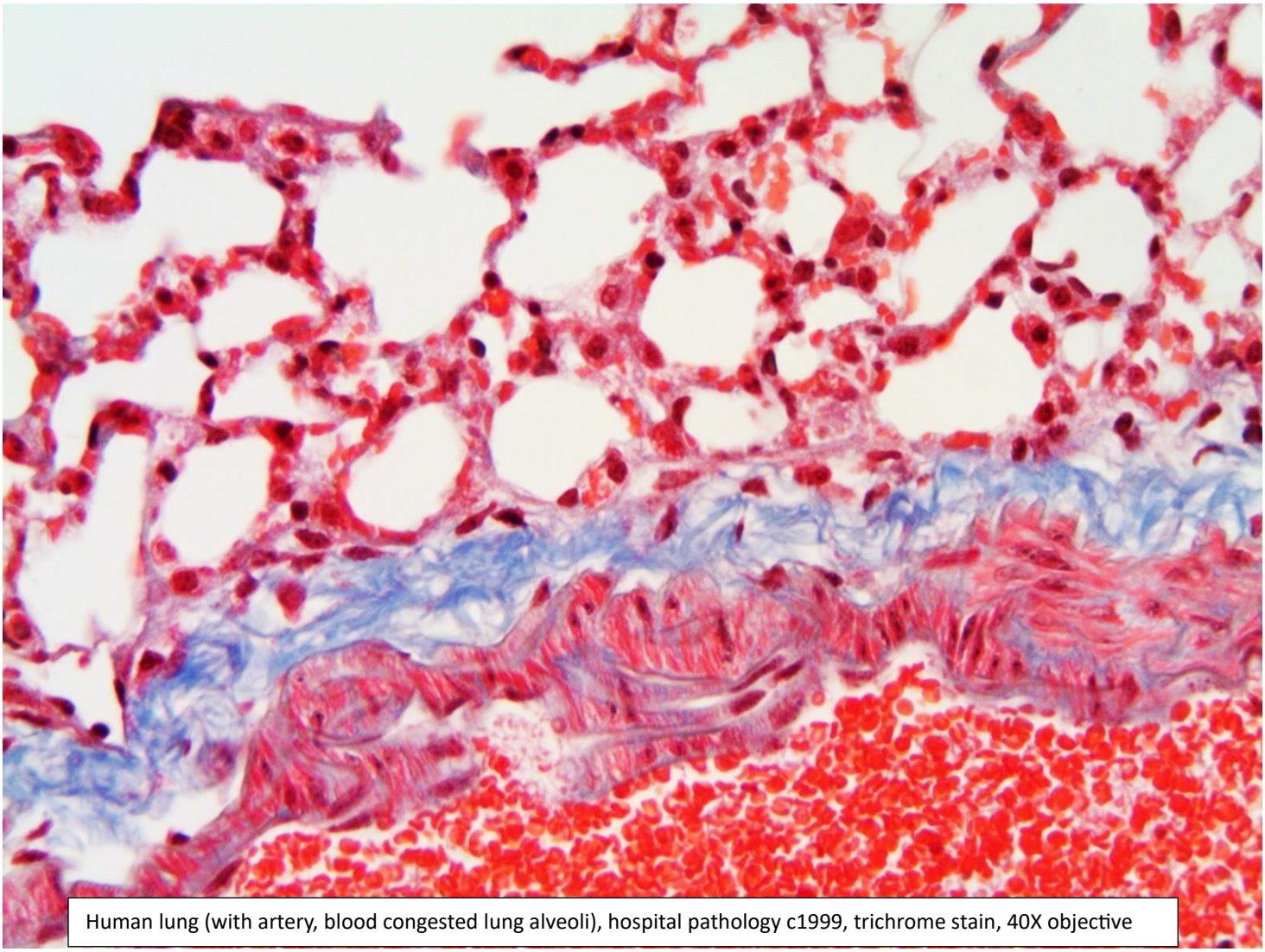
eBay sometimes has **slide sets from retired doctors**, either selling the set themselves or through their estate. These collections typically include slides made while in medical school as well as some favorite slides from their career. The caveat that student slides vary widely from grade A to grade F definitely applies to medical students. I see fewer of these doctor's slide collections over time, as in recent decades only pathology specialists use microscopes in day to day medical practice. This is a big change from the mid 20th century, when most doctors used microscopes, at least during medical school training. If a doctor collected the slides there will usually be some quite good ones, but not always. Nothing is sure but death and taxes. In the case of the former there might be an autopsy. Unfortunately for slide collectors, full autopsies with production of pathology slides are rarely done nowadays, and I rarely see autopsy slides come up on eBay.



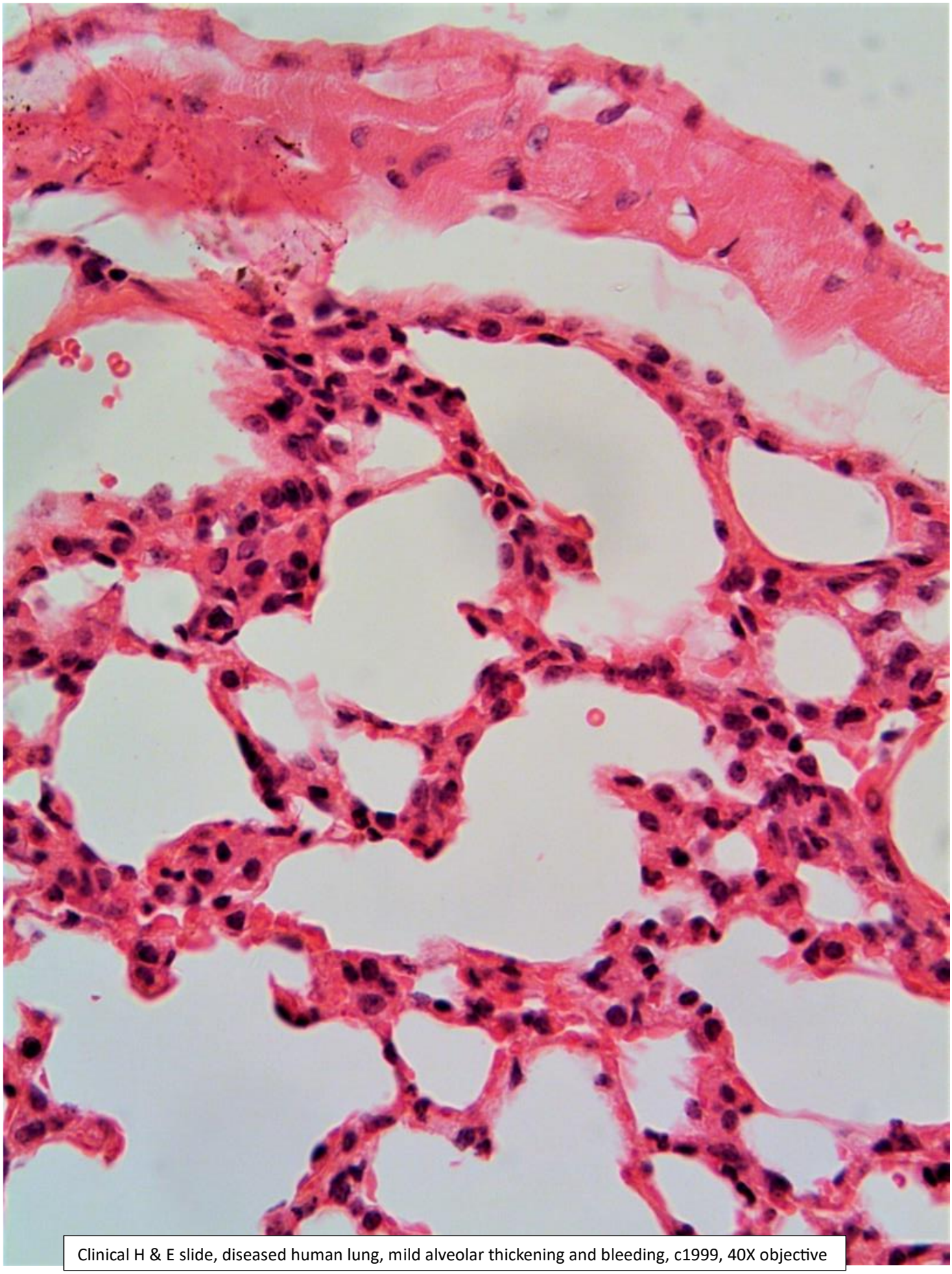
Cross section of female *Ascaris* human intestinal worm, stitch from 4X objective
Classic educational slide from Turtox, classic golden age biological supply house

Human appendix with acute appendicitis, 20X objective
Classic pathology slide by a pathologist retired to Florida

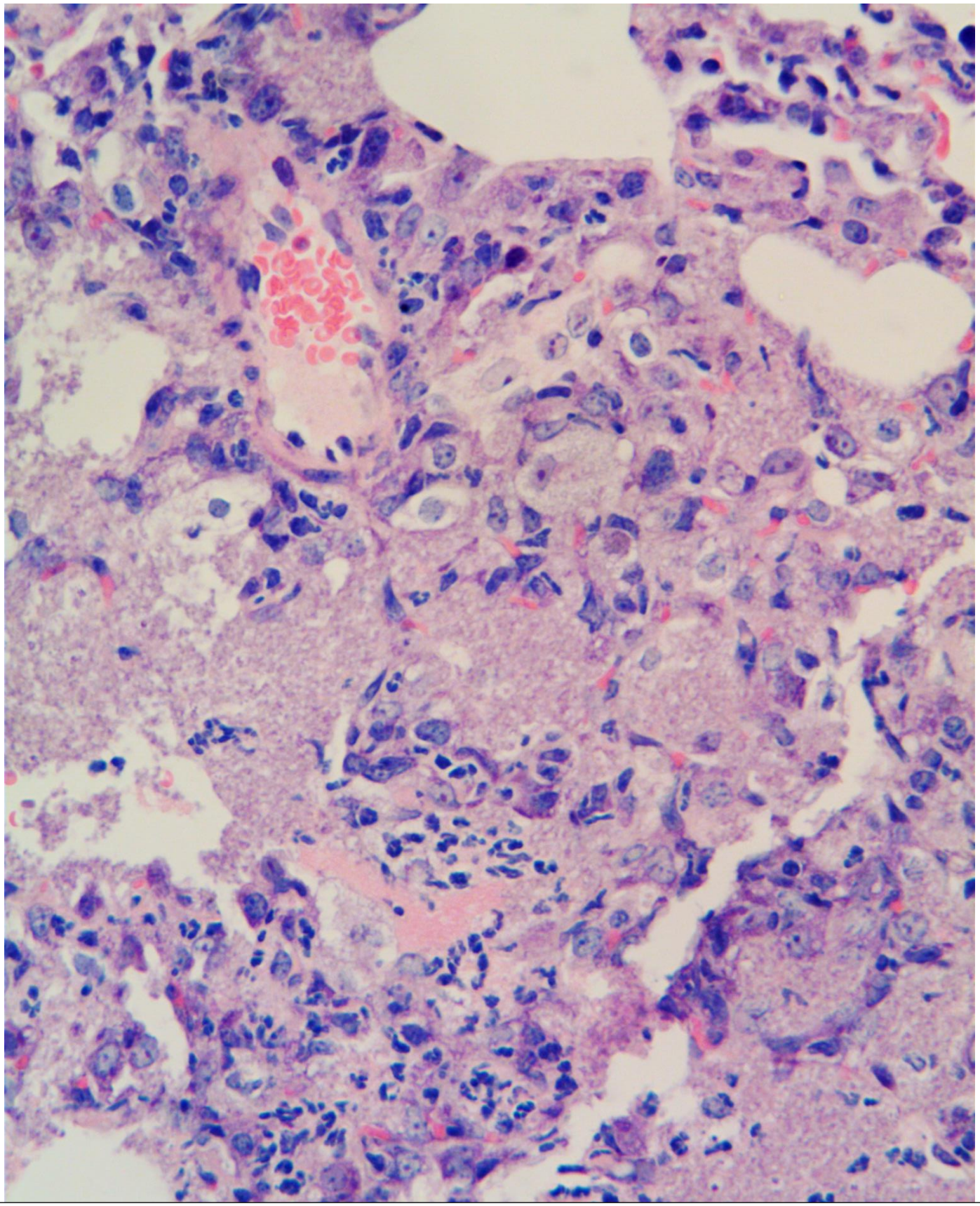
Some listings are for a box full of **clinical slides from a hospital**. Their quality is highly variable and I'm not as excited about these finds as I used to be. Although they were prepared in a professional pathology lab to high clinical standards, they weren't created to be keepsakes. Maybe the pathologist looked at them once, then they went into storage, then someone pulled them from the trash years later to sell on eBay. Inferior mountants were common and many of these slides have so much **crazing** (fine cracks in the mounting medium) that they are useless after a few decades, crazed all the way to the center of the specimen. You can see this sometimes in good listing photos as a haze of light concentric rings under the edges of the coverslip. In the past clinical slides often had the name of the patient scribbled on a label and occasionally a pathologic diagnosis ("pneumonia", "breast cancer"). Now days most pathology slides just have a number scribbled on with a sharpy, with no clues as to what the slide's subject is. Many sets of slides have just one slide from each patient. Multiple slides would have been made. Perhaps they archived one slide each and tossed the rest. Perhaps a pathologist saved some of his personal favorites. If you find hospital slides in good condition, they sometimes can be truly excellent. Some of the best pathology slides I've ever encountered are H&E and trichrome slides of the lung of a single patient, 'DY'. They were in a flat mailer rather than a standard slide box. A flat slide mailer may be associated with higher quality. Maybe some slides were sent out for a second opinion. Maybe a lawyer was involved. Part of the seriousness in the case of a favorite pathology slide set comes from holding a tiny piece of a sick person, probably someone's mom or dad, in my hands. I'm not skilled enough to know what sort of pneumonitis the patient had, but the slides are gorgeous. I hope they were obtained in life, but lung pathology can also be done at autopsy.



Human lung (with artery, blood congested lung alveoli), hospital pathology c1999, trichrome stain, 40X objective

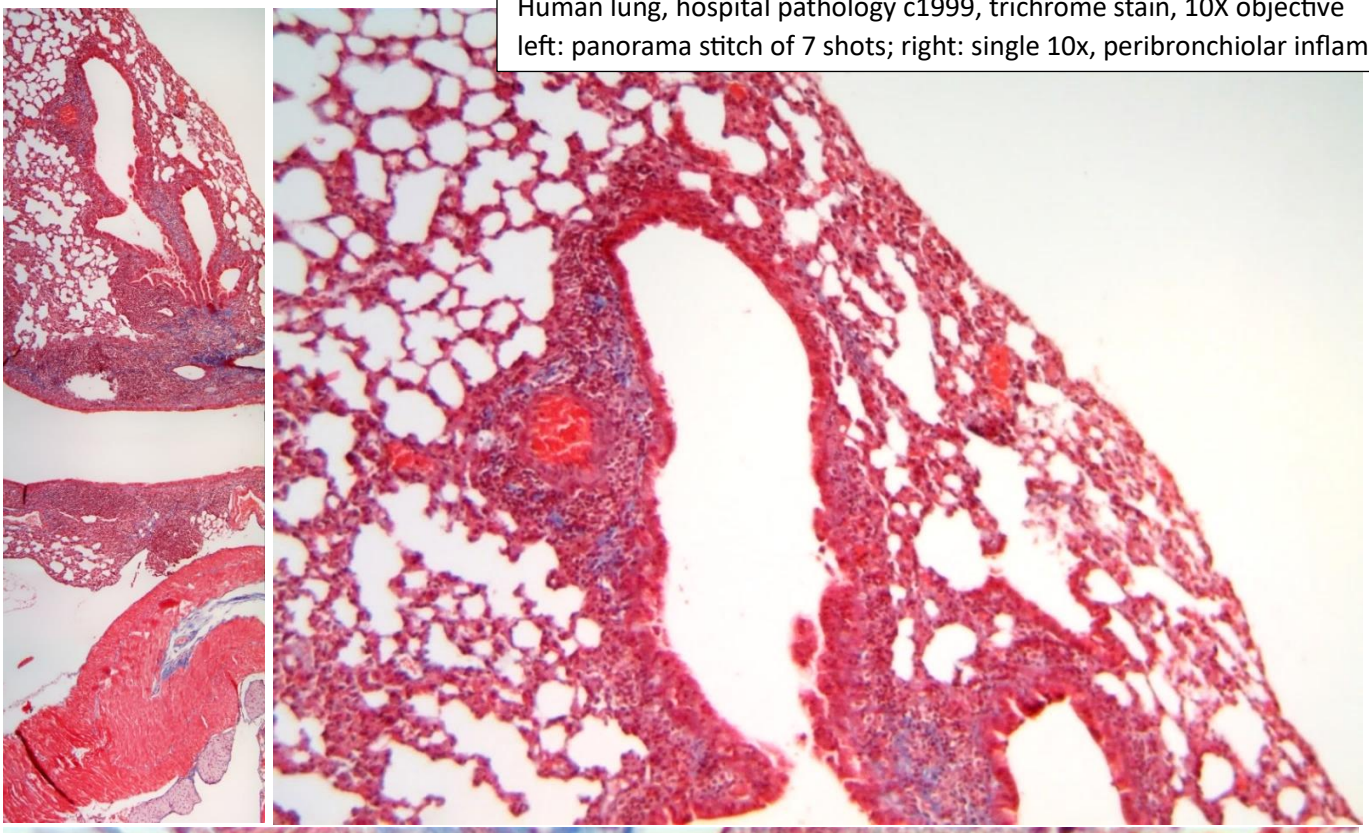


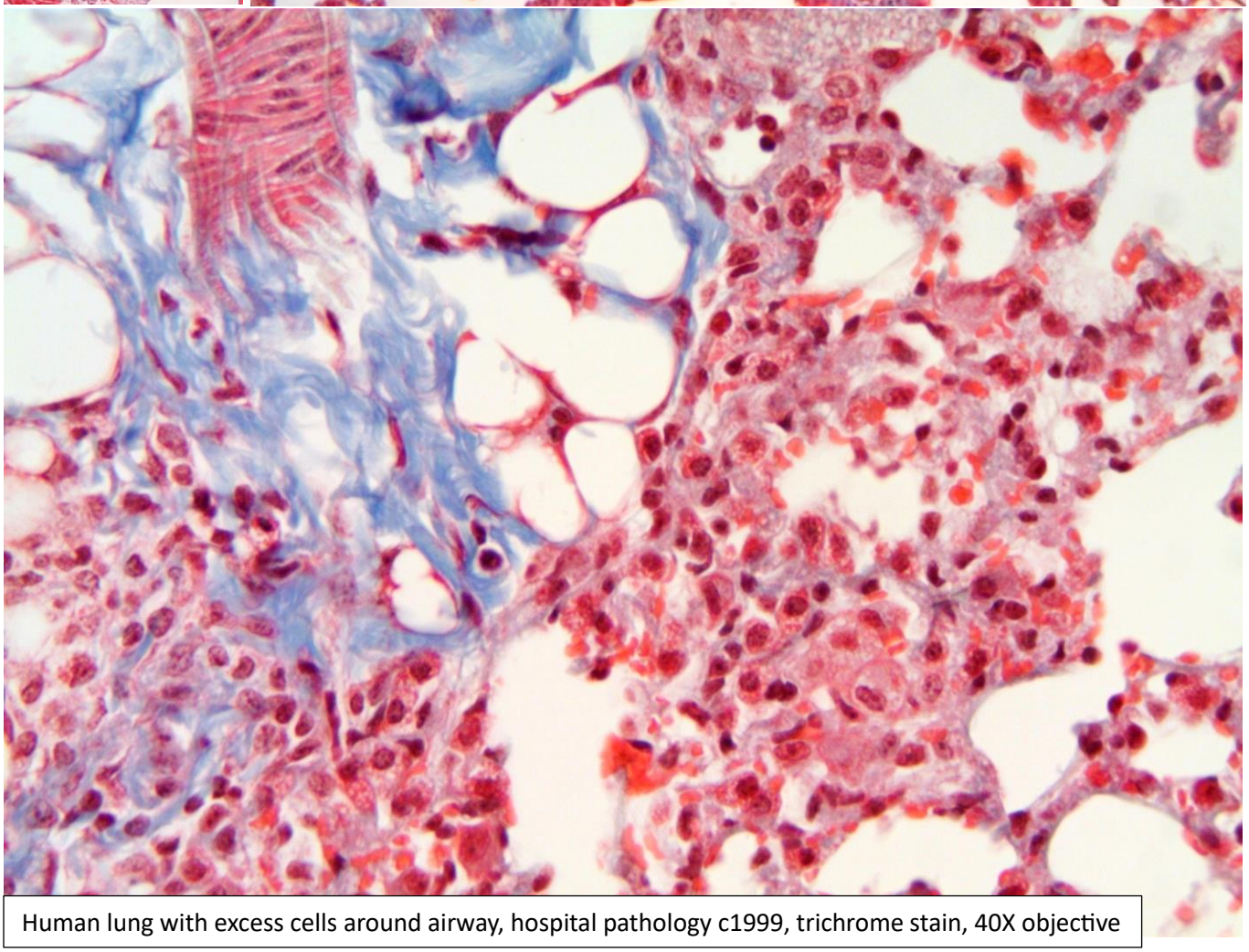
Clinical H & E slide, diseased human lung, mild alveolar thickening and bleeding, c1999, 40X objective



Giemsa stained diseased human lung, c1999, 40X objective. Combining methylene blue, eosin and azure B, Giemsa stains chromosomes. Developed by Gustav Giemsa in 1904, it was the first malaria test and is good for blood smears, protozoans, fungi and bacteria. I don't see pathogens here but note foamy macrophages which are seen in TB and other infections, various lung injuries and inflammation.

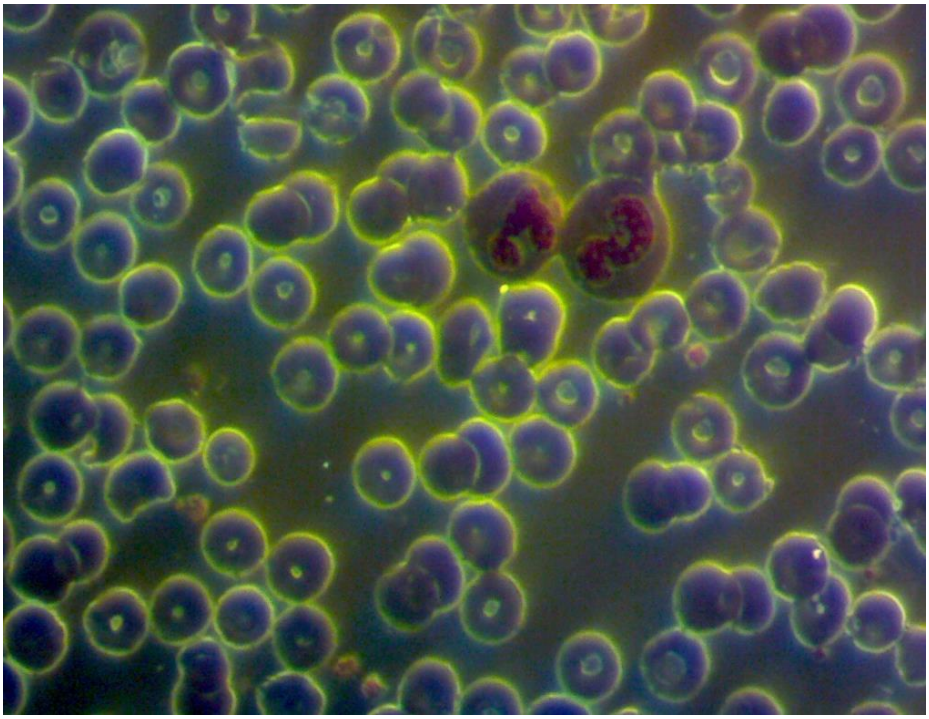
Human lung, hospital pathology c1999, trichrome stain, 10X objective
left: panorama stitch of 7 shots; right: single 10x, peribronchiolar inflammation





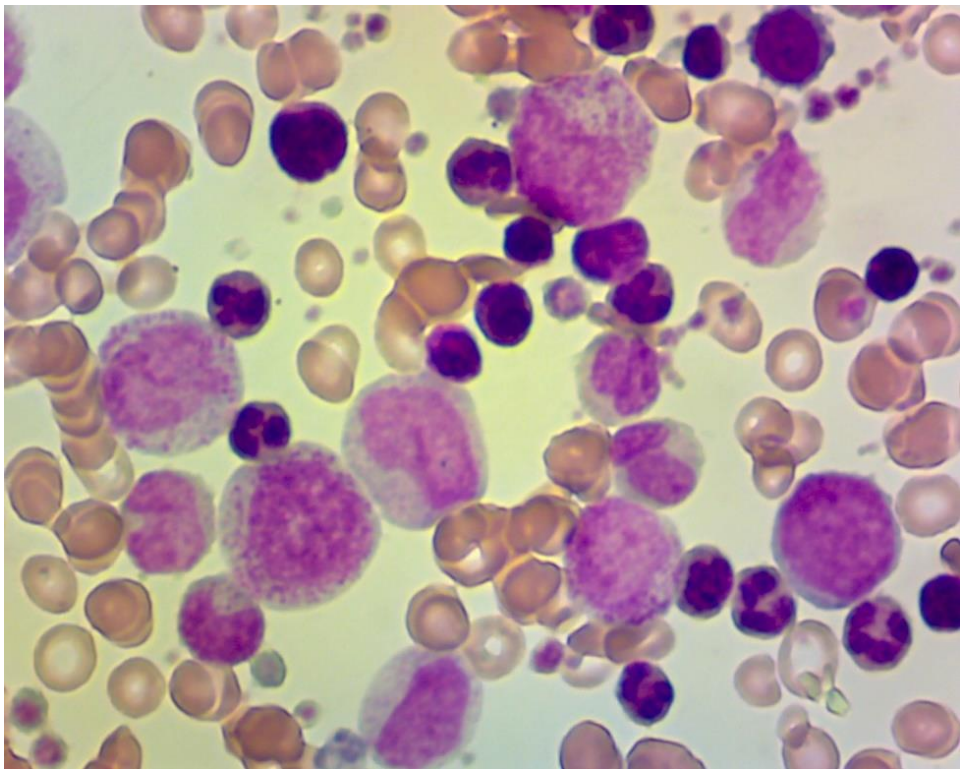
Human lung with excess cells around airway, hospital pathology c1999, trichrome stain, 40X objective

Blood smears are a special kind of clinical slide. Being limited to blood cells (and occasional pathogens visible in blood) hematopathology is a bit easier to learn than the full scope of histology and pathology in all tissues. The slides are also far easier to make, although getting the smear to draw out thinly and evenly requires meticulously clean slides and well practiced technique (try it yourself and stain with fountain pen ink). Like other slides, the used slides vary in quality and condition. Many were examined under oil immersion to see small details. If the oil was not removed a lot of dust sticks to it over the years. To save time many blood smears were prepared without a coverslip. They'll look fine scanning with a 10X objective but at higher powers the objectives on your microscope won't give perfectly sharp views (unless you add a drop of oil or mountant under a coverslip). Microscopes dedicated to hematology (haematology to my UK friends) often had special high power objectives corrected for no coverslip (having a dash where yours say 0.17).



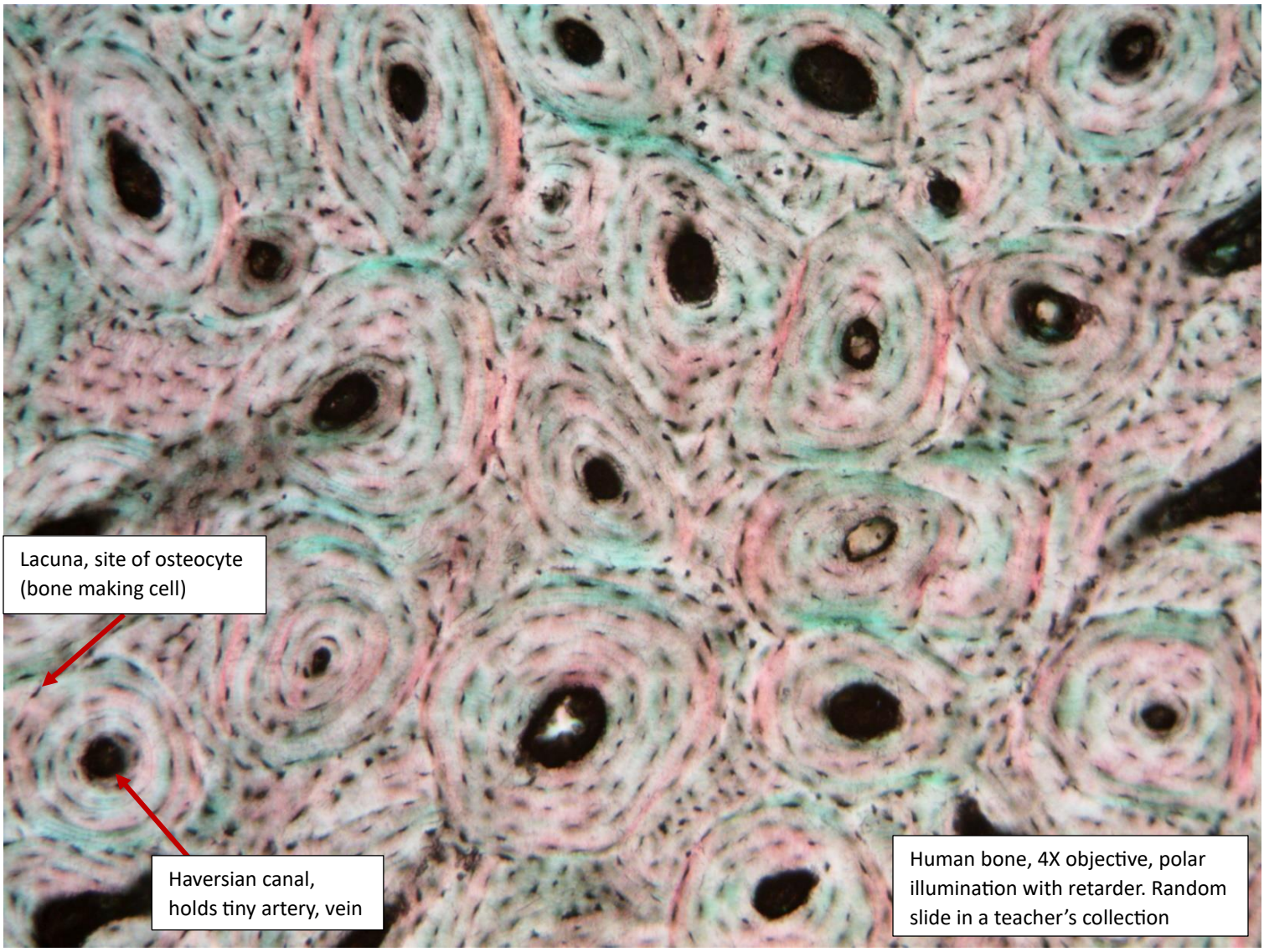
Blood smear of human with mononucleosis (Epstein- Barr virus infection)

phase contrast 100X oil objective
(dark field live blood analysis has a similar appearance before "vitamin mode" is used)



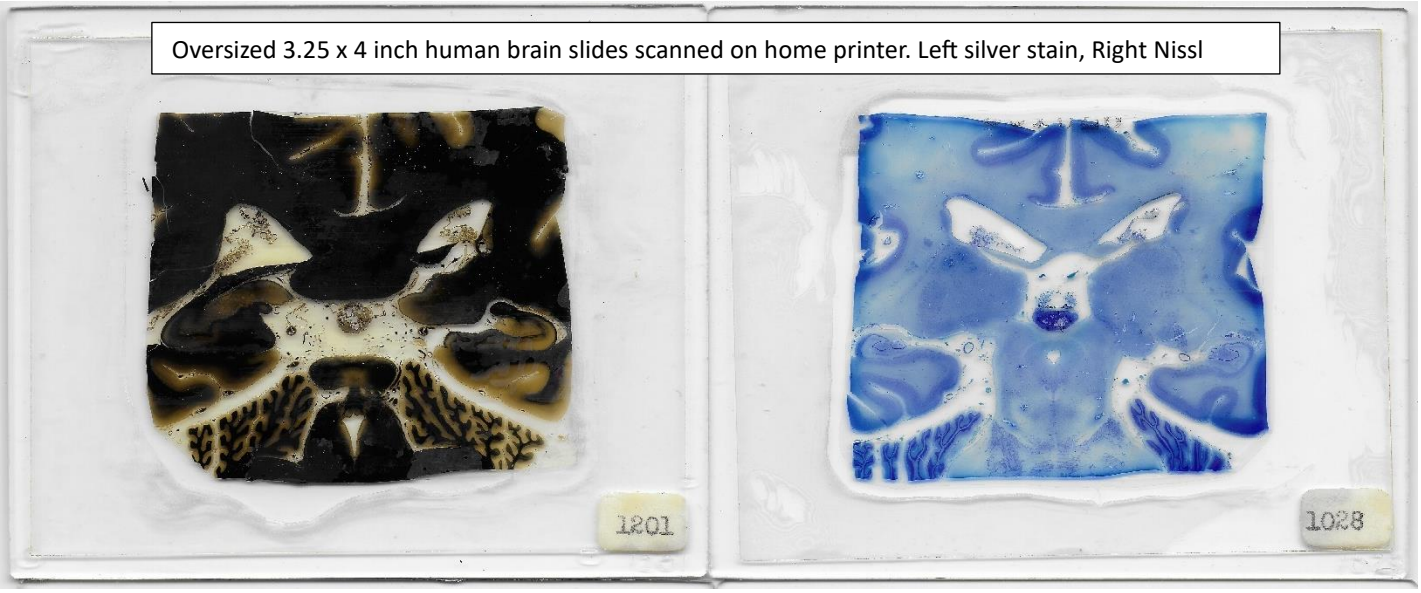
Wright stain blood smear of human with myeloid leukemia 100X oil objective

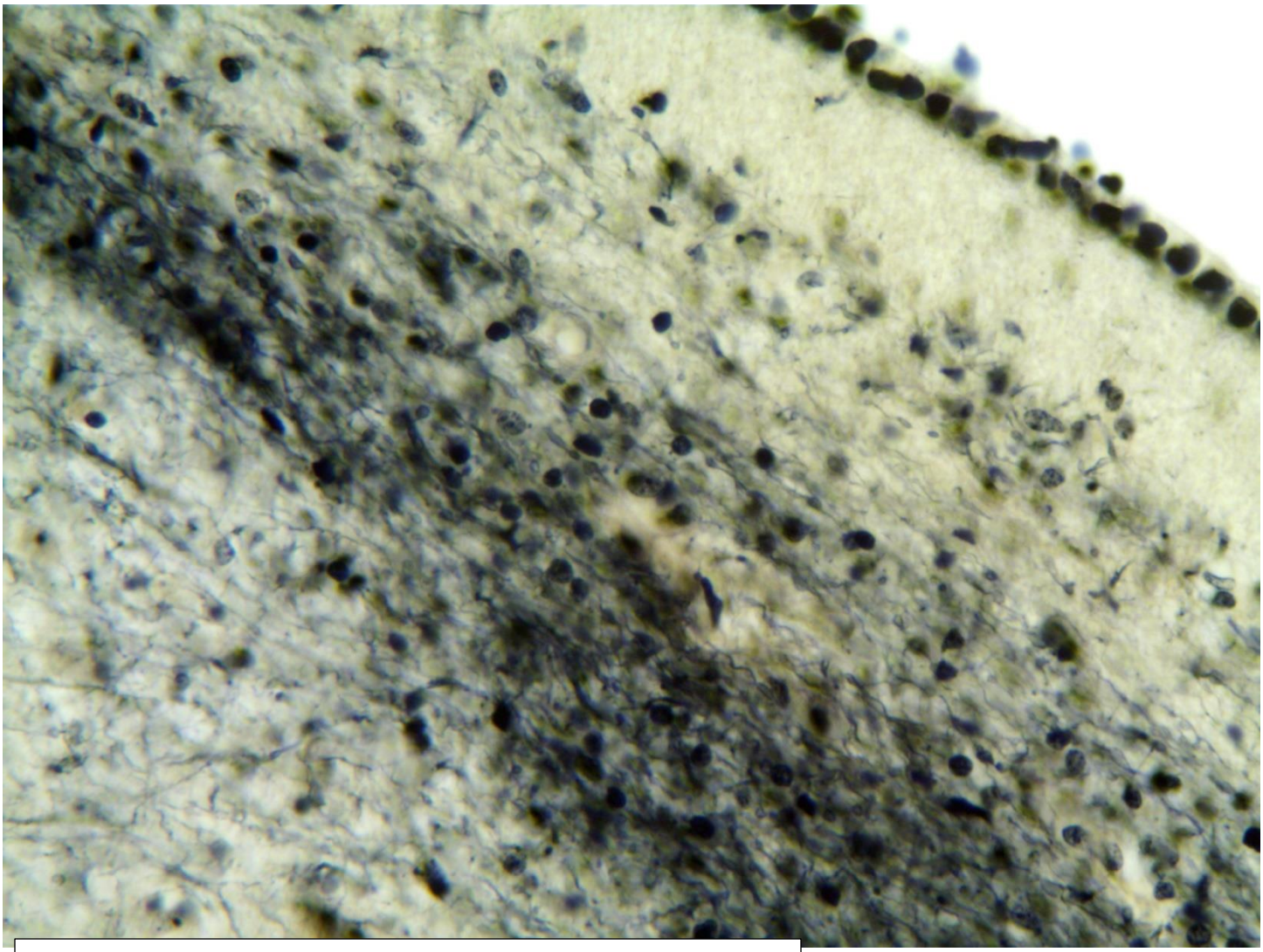
Bone marrow is where your body makes blood cells. In some cases it is biopsied by using a needle to draw some of the fluid marrow from your hip bone. This is processed as a thin smear on a slide, much like a blood smear, but providing a lot of additional information in certain clinical cases. **Bone** itself can also be looked at under the microscope. The processing more resembles that of geologist making slides from thin slices of rock than doctors making slides of other human tissues. A thin slice of bone is glued to a glass slide with clear epoxy, then ground down with a series of abrasive grits until about 25 microns thick. This is about 4 times thicker than most histology slides, but the same thickness as geologic slide sections. Under the microscope you can see the tiny holes called lacunae where the osteoblast cells that make the rocky bone mineral hydroxyapatite (a hydrated calcium phosphate) live. Like sections of rocks, bone slides look beautiful under polarized light. Ulf Griesman described how to make your own bone slides at home in the 2012 addition of *Micscape* magazine.



Brain slides are another niche specialty slide. Being the seat of human intelligence, brain circuits have undergone intensive study since the big breakthroughs of Ramon y Cajal using the silver stain of his rival, Golgi, in the late 1800's. Occasionally you can find a few slides for sale. Other tissues are typically stained with colorful H and E, but brain slides are often silver or Nissl stained to better show the nerve fibers, resulting in a black and white, or blue and white view. Often the sections are thicker than 10 microns, to allow following some fibers in 3 dimensions. Bigger can be better in neuroanatomy, and brain slides are often 3 by 2 inches, twice as big as standard microscope slides, or even bigger. For many reasons human brain slides are rare, often expensive, and might be sold individually instead of in sets.

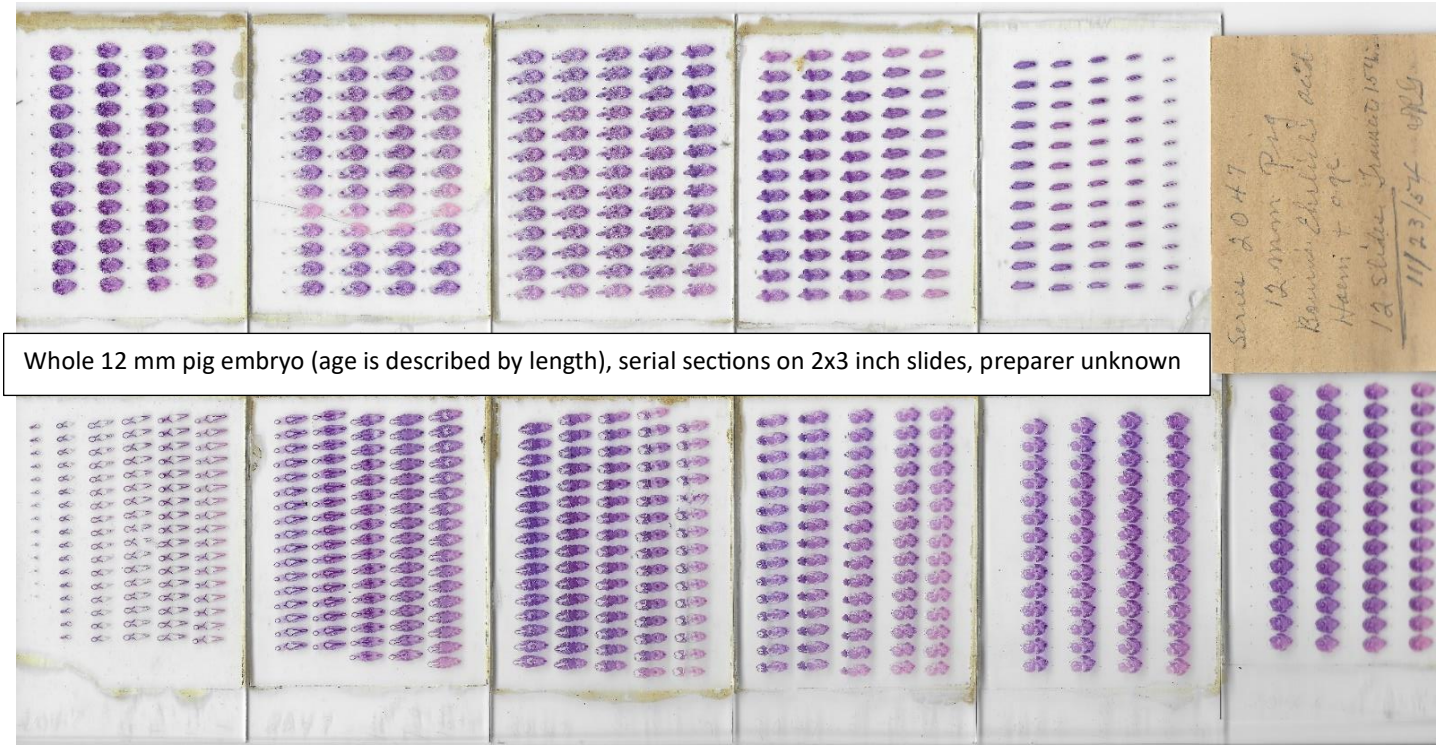
Oversized 3.25 x 4 inch human brain slides scanned on home printer. Left silver stain, Right Nissl



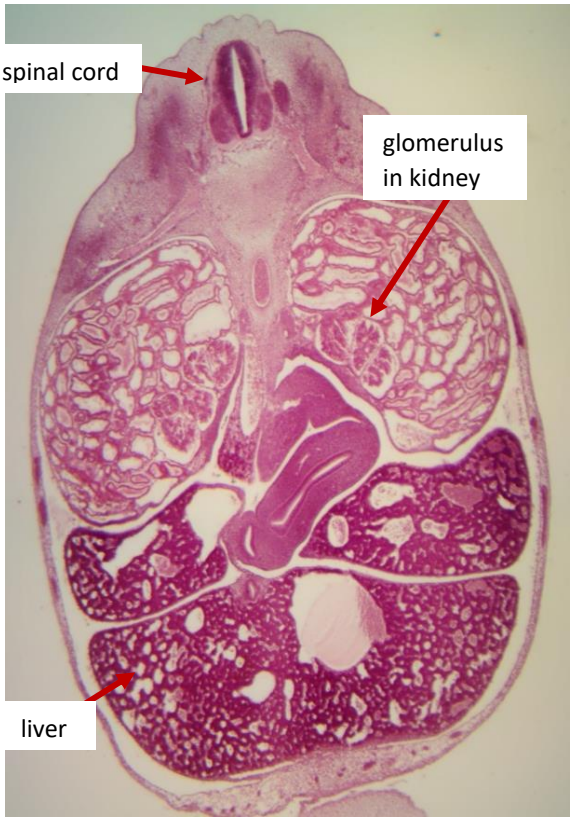


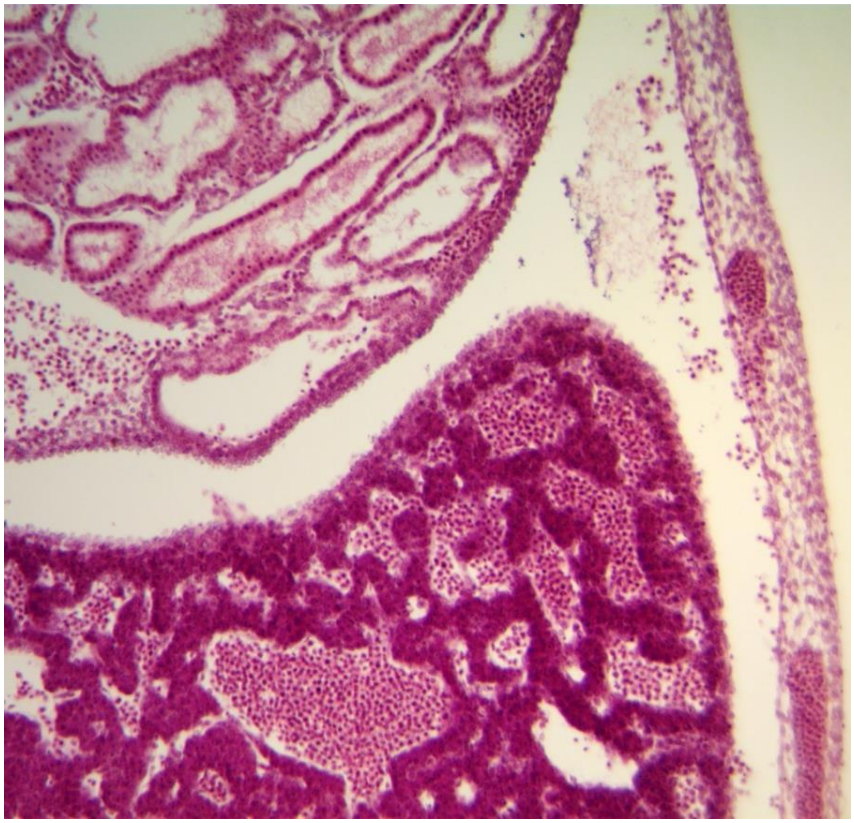
Somewhere in the above left slide of a human brain, silver stain, 40X objective

Much of biology research and teaching is about development, yielding **embryology slides**. Many of these slides seem to be well done and are fascinating. You get to see all the organs on a single slide, and the anatomy isn't quite the same as an adult. The whole fetus of a rat is a classic slide. At early stages whole embryos fit easily on a slide. Pig, chick and rat embryos are common subjects. Human fetus slides are rare, particularly in the past 50 years or so. As with all vintage and antique slides, the quality and condition of embryology slides can vary, but they are among my favorites.



Whole 12 mm pig embryo (age is described by length), serial sections on 2x3 inch slides, preparer unknown





Left: 12 mm pig embryo, H&E, stitch of 5 4X obj. images. Right: developing kidney and liver, 10X objective

Some eBay slides are from **scientific research**. With the help of Google, I occasionally figure out the scientific provenance of a set of slides. Using label information of gastrointestinal tissue of multiple bat species, I was able to trace a large but deteriorating collection of slides to chiropterist CS Rouk's 1968 master's degree and 1973 doctoral thesis. A few years ago I obtained some microscope slides of squirrel monkey brains that were associated with other slides from the Uniformed Services University of the Health Sciences in Bethesda, Maryland. The slides were labeled with a lot of acronyms (OMC, WGA-HRP, others) and Google eventually led me to MB Carpenter (of the Department of Anatomy in Bethesda) and his collaborators' paper "Immunocytochemistry of Oculomotor Afferents in the Squirrel Monkey (*Saimiri sciureus*)" in the *Journal für Hirnforschung* (Brain Research) 1992. Old slides from microscopic research are of variable quality. The bat stomach slides were likely good when made, but crazing of the mountant made most of them unusable when I got them. Some slide labels had fallen off (a fixable problem) or were water damaged beyond legibility. The squirrel brain slides were still in good shape and interesting, as all brain slides are. I have seen other sets that were probably for research, based on 50 or 100 slides that look much the same but don't correlate to usual histology or pathology subjects. Usually it looks like some small animal gland with a faint drab brownish stain (maybe it is also stained with immunofluorescence or other special research marker, but I don't have a fluorescent microscope).

US doctors used microscopes, then quit

From about 1930 (earlier at leading scientific schools) to the 1970's most US medical students purchased a microscope, learned animal then human dissections, fixation of tissues, making slices with a microtome, staining and mounting the slices on slides for microscopic observations, sometimes documented by hand drawings. Doctors then used microscopes in their private practice office (also extinct) and sometimes kept a collection of interesting slides. 20 years ago many medical student microscope slide collections came up at estate sales or on eBay, but that is becoming rarer today, as doctors from the golden age of medical microscopy die of old age. The slides show that the young doctors varied widely in their histology skill, from awful to great. By the time I arrived at Johns Hopkins medical school in 1982, it was a transitional era. We did not buy a microscope or learn to make histology slides. In pathology class we sometimes briefly looked at slides under a microscope, but we largely looked at tissue photomicrographs taken through a microscope. Today actual microscopes are completely gone from the core curriculum in most US medical schools. (Presumably students interested in becoming pathologists could electively get some experience with microscopes). Since the 1990's and especially in the 21st century, even doctors now live in the digital age. Nowadays students exclusively look at digital photos of histology and pathology slides, not by using a microscope with the slides themselves. It's much easier, faster, cheaper for the student and the university, and preferred strongly by med students over searching a hundred slides at multiple magnifications hoping to find the most informative views.

In my day we sometimes did Gram stains at the hospital, looking under the microscope for bacteria in body fluids, and at occasional Wright stained smears to examine blood cells. I still remember my excitement upon finding intracellular gram negative diplococci inside polymorphonuclear leucocytes, proving the super sick patient had meningococcal sepsis. Some student doctors were better at microscopy and lab work than others. My microscope skills were only average. We also used microscopes in the clinic for KOH testing for skin fungus and microscopic urinalysis. It was amazing to see *Trichomonas* ciliates swimming in vaginal secretions of some women complaining of a discharge. We did some other simple bedside lab tests like hematocrit, and urine testing for myeloma protein (nitric acid can precipitate Bence Jones protein in some cases). Some of my peers were less interested in diagnostic lab work than I, and it became known that practicing doctors in their offices usually performed lab testing with far less accuracy than real clinical laboratories. The Clinical Laboratory Improvement Amendments of 1988 (CLIA) subjected doctors to cumbersome government registration and regulations as a laboratory if they did even a single office-based test as simple as a home pregnancy test. 1988 was the end for most of the few regular doctors still using a microscope in the office. Now clinical microscopes are just for lab techs and pathologists, not for most doctors. Luckily there is no law against you or me using vintage pathologist's microscopes to look at live plankton or old slides as a hobby.

The Golden Age of eBay histopathology slides… and you missed it

Sorry if my enticing descriptions of eBay histology slide collections got you excited, because now I have to let you down, hopefully gently. When I started using a microscope as an adult hobby around 2011 (soon after I moved to Minnesota, where winters are long and dark), there were many interesting collections of histology and pathology slides available on eBay almost every day. Most weeks there were 10 cased sets that looked especially interesting to me. I binged and bought dozens of such sets, mostly in nice old wooden or Bakelite (often cracked near the hinges) or black papered fiberboard boxes of 100 and often for $50 or less total cost with shipping (luckily, I have a very tolerant spouse). At first most of the slide collections I bought were of mixed quality at best. Over time, I hope I got smarter and I obtained some sets with excellent slides. Recently, good looking used histology slides have become less common and more expensive.

At the time of this writing, I see over 1900 used microscope slide listings on eBay, including very old slides and of non-medical subjects. Relatively few are histopathology slides or sets. If you want, you can buy some expensive individual expensive antique or vintage slides of animal histology or medical subjects, but as I explained previously, the microscopic details of 19th century histology slides are mostly not up to modern standards. Lots of vintage used student imported vintage hobby slide sets, Tasco type 12 or 25 in a paper box are for sale, and a few say they have mammal organs, but those were usually of very poor quality in my experience. Be careful on eBay. Currently someone is trying to sell 22 old university pathology slides for $166; but they show crazing over the whole specimen (they are worthless, but the seller probably doesn't have a microscope or know the slides are ruined). I do see 2 slide collections in 100 slot boxes that look like clinical collections by doctors or from a hospital or university. I can't see whether the slides look clear with colorful sections, and I have an extensive collection already, so I am not going to take a $150 gamble.

As I eventually found some excellent histology and pathology slides, my standards went up. I also bought fewer sets and became more selective by applying my accumulated knowledge of used slides. One might think that the fewer slides I've bought in recent years would be of mostly greater quality, but they have still been hit or miss. I think the quality and quantity of used histopathological slides on eBay really has diminished somewhat in the past decade, due to the abandonment of microscopes by doctors in training 4 decades ago and the aging of the physician population.

Don't give up

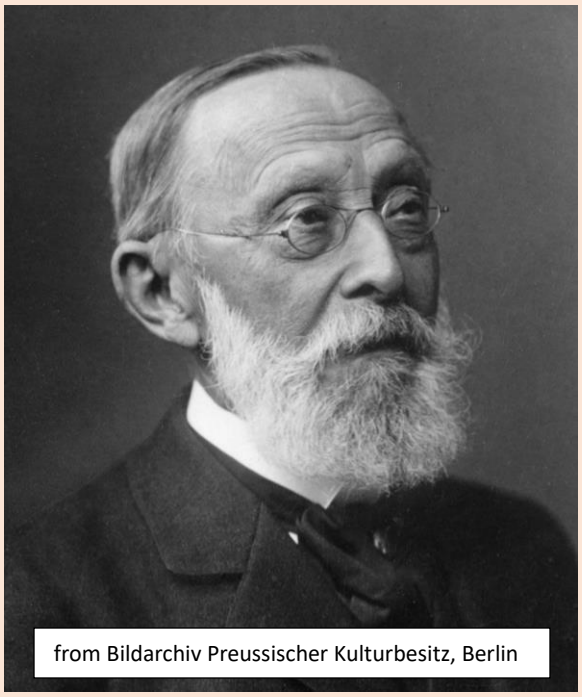
I still encourage you to do what I did in the 2010's. I derived great satisfaction (a dopamine high) from finding a few amazing slides in a set of mediocre ones. It's a harmless gambling addiction, like fossil hunting, fishing or picking up a box of chocolates. "You never know what you're gonna get". Maybe I'm just jaded now, after purchasing many crappy slide sets that were not as good as those I already had. I'm now happier with what I have. I mostly look at pond water critters now, and I really don't need any more prepared slides (my wife will confirm that).

If you buy some histology slides and don't like them, don't give up on eventually finding nice slides. Like me, if at first you don't succeed, you can try again. Histopathology is a window into a beautiful, important reality hidden from most people. But if you have a serviceable microscope and know how to use it, you are the relatively rare person who can potentially see for yourself what the inside of a human body is made of. (With a caveat: the beauty of histology slides is an illusion. Human senses limit perception and our insides may "really" look like mottled tan mush, but fancy stains and lenses project beautiful, very useful images). A great collection of interesting, affordable, well done pathology slides in great condition could appear tomorrow on eBay and certainly will in the days to come. There was a golden age of US doctors using microscopes from about 1930 to 1970. Many doctors who graduated from medical school in 1970 used microscopes in the office until shut down by new regulations in 1988, and some may have kept a collection of favorite slides. Those doctors would be about 80 years old now, likely retired, but some are still breathing. So some estate sale histopathology slide collections should still make their way to eBay for decades to come.

Good luck on finding your own decades old amazing little glass windows into hidden worlds of beauty and wonder.

Thank your father for your pathology slides

Rudolph Virchow was "the **father of pathology**" and one of the most important and remarkable physicians in all of history. Born in eastern Prussia in 1821, he went to medical school in Berlin and went on to bring medicine into the scientific era, largely via a microscopic view of human anatomy. He made medicine modern.

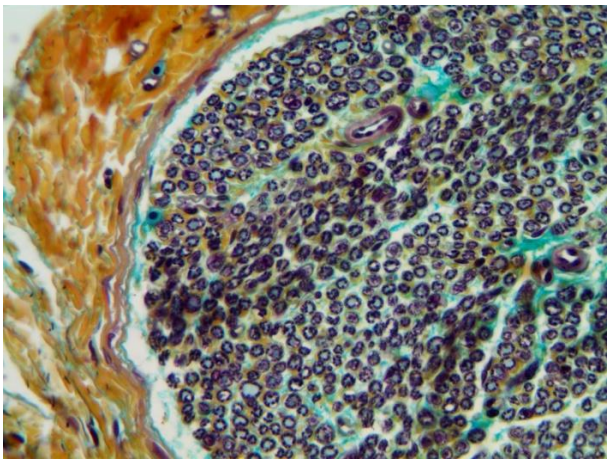


from Bildarchiv Preussischer Kulturbesitz, Berlin

Virchow's medical discoveries were almost endless, as he was one of the first to replace millennia of theories about imbalances of imaginary body fluids with a new, scientific view of bodies being made of cells, and their malfunction causing disease. His 1855 axiom "every cell arises from another cell" seeded a scientific revolution. Virchow started a medical journal, wrote textbooks and taught doctors from around the world. Among his discoveries:
leukemia (blood cancer), chordoma (a spinal tumor), thrombosis and embolism (blood clots)), myelin (sheath around some nerves), amyloid (an abnormal protein causing disease), chromatin (the stuff that makes chromosomes), cells inside bone, zoonoses (diseases acquired from animals), Virchow's node (swelling above collarbone from spread of stomach cancer), how to do a proper autopsy, the lifecycle of the parasitic worm Trichinella, microscopic meat inspection, and numerous human skull details and diseases.

Virchow adopted the microscope from his teacher Mueller. He told his students to "think microscopically" and taught cellular pathology to a stream of visiting professors from around the world, spreading the modern way of medical thinking still used today. But Virchow was much more than a doctor and medical professor. He travelled to a typhus outbreak and investigated tuberculosis, deeming them "social diseases" because they killed the poor much more often than the rich. Advocating sewers and clean water for Berlin, he was the **father of public health**. He was the German **father of anthropology**, and dug for artifacts in Germany, Troy and Egypt. He prescribed democracy and education to improve the health of the masses and became a **reformist politician**. He claimed "politics is medicine on a grand scale", opposing racism and high military spending. Virchow died in 1902, age 80.

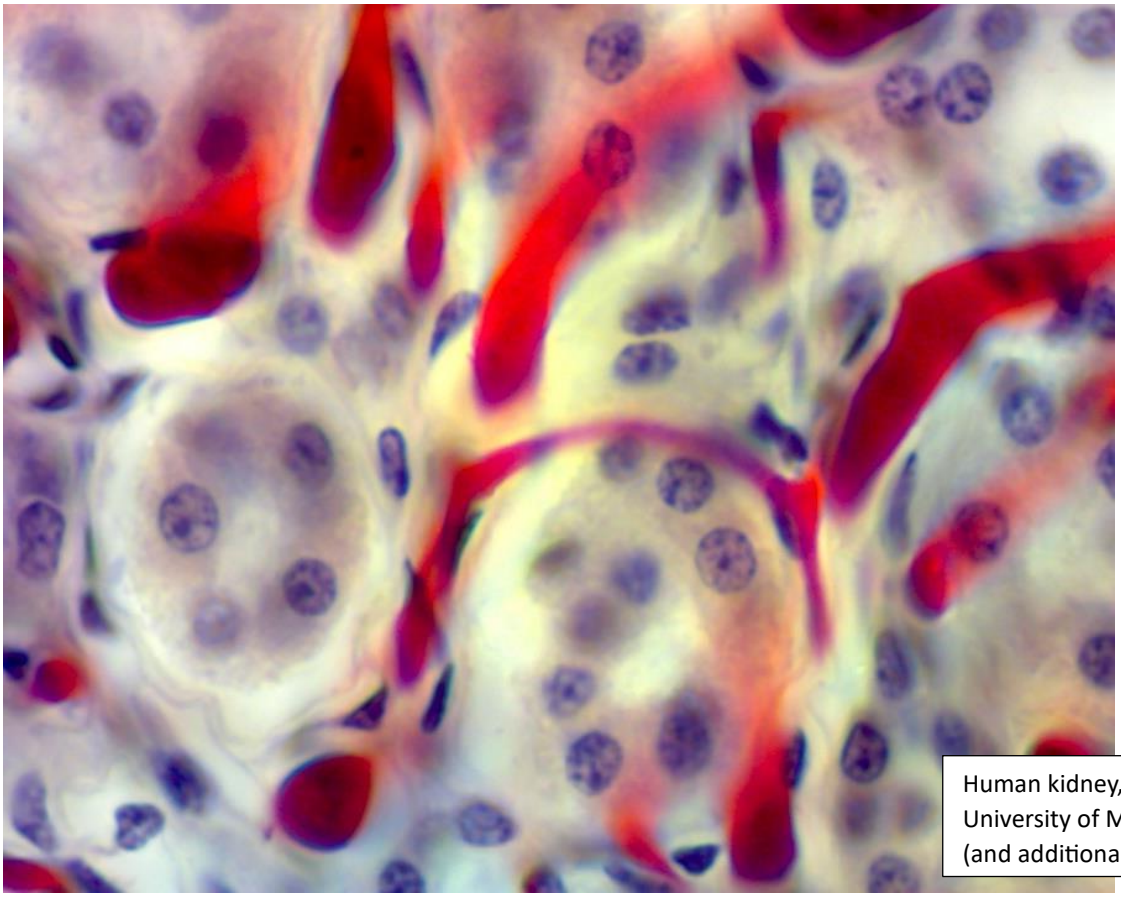
Virchow wasn't perfect. He argued against the germ theory of disease and against the theory of evolution, deeply mistaken both times. At least Virchow's heart was in the right place. Many proponents of evolution, including his own student Ernst Haeckel, used evolution to argue for eugenics, stating undesirable peoples should be sterilized or killed. Half a century later, that pseudoscientific evil led Germany into profound catastrophe.



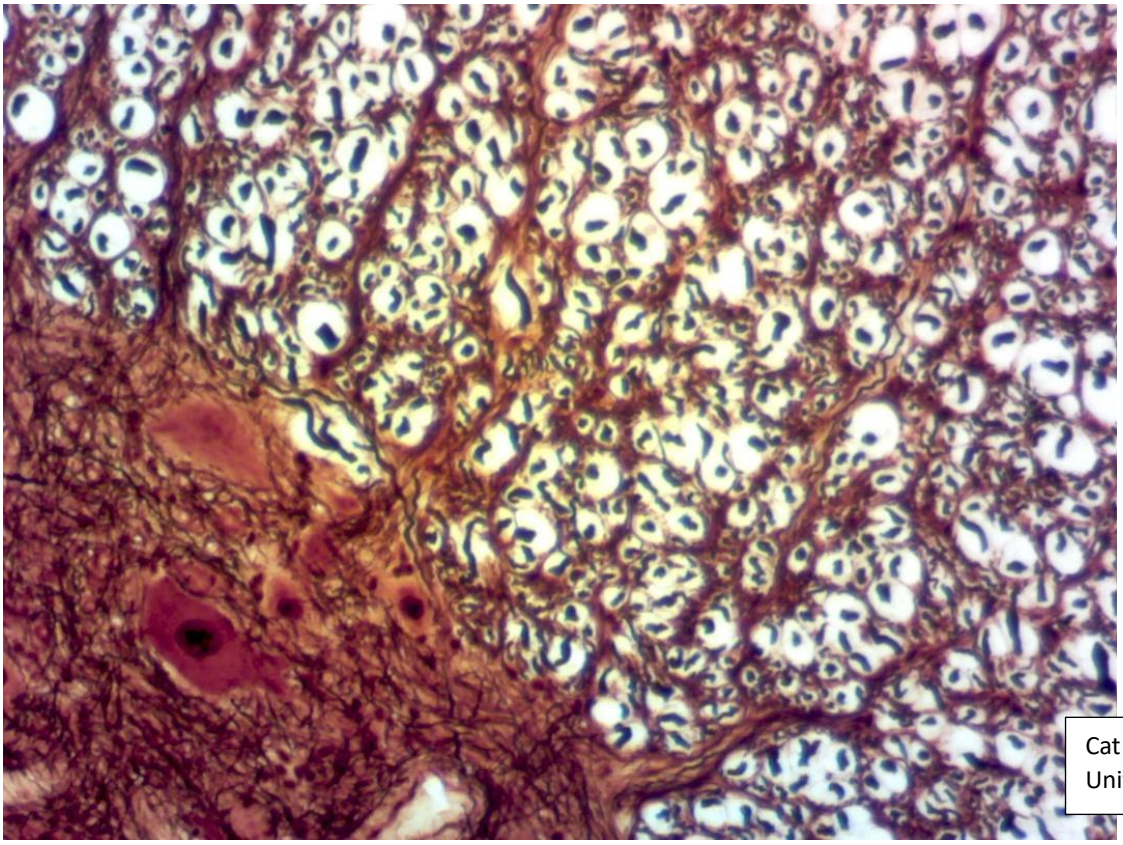
Mystery pathology slide, pentachrome stain, 40X objective
Connective tissue on left (yellow stained); Virchow was first to see cells in this type of tissue.
Nerve cross section on right; The dark brown stained rings are myelin sheath around axons; Virchow discovered myelin.

More examples to inspire your searching for great histology slides

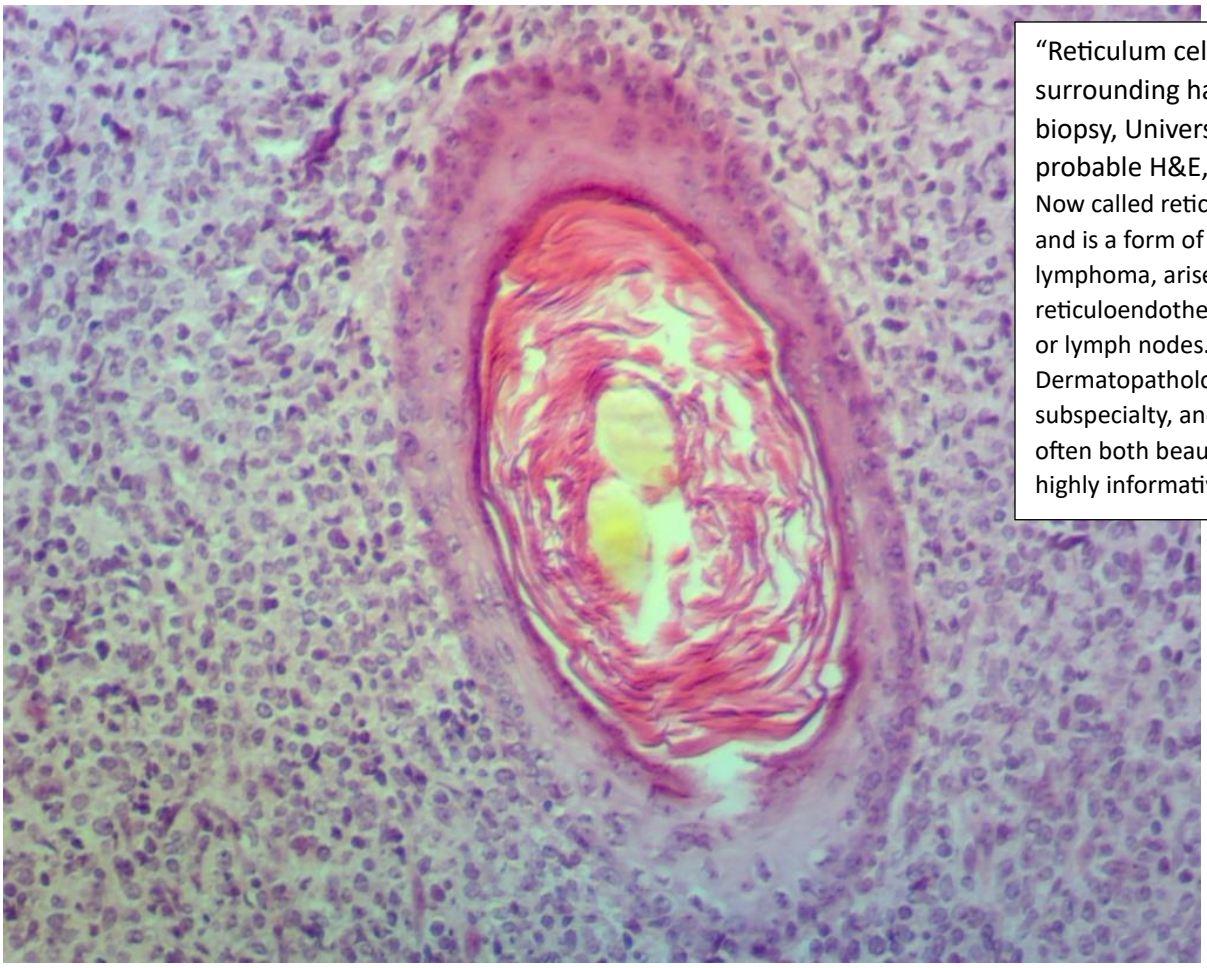
Note these are all mid 20th century vintage slides, all were made at universities, and I would rank 8-9/10 in quality.



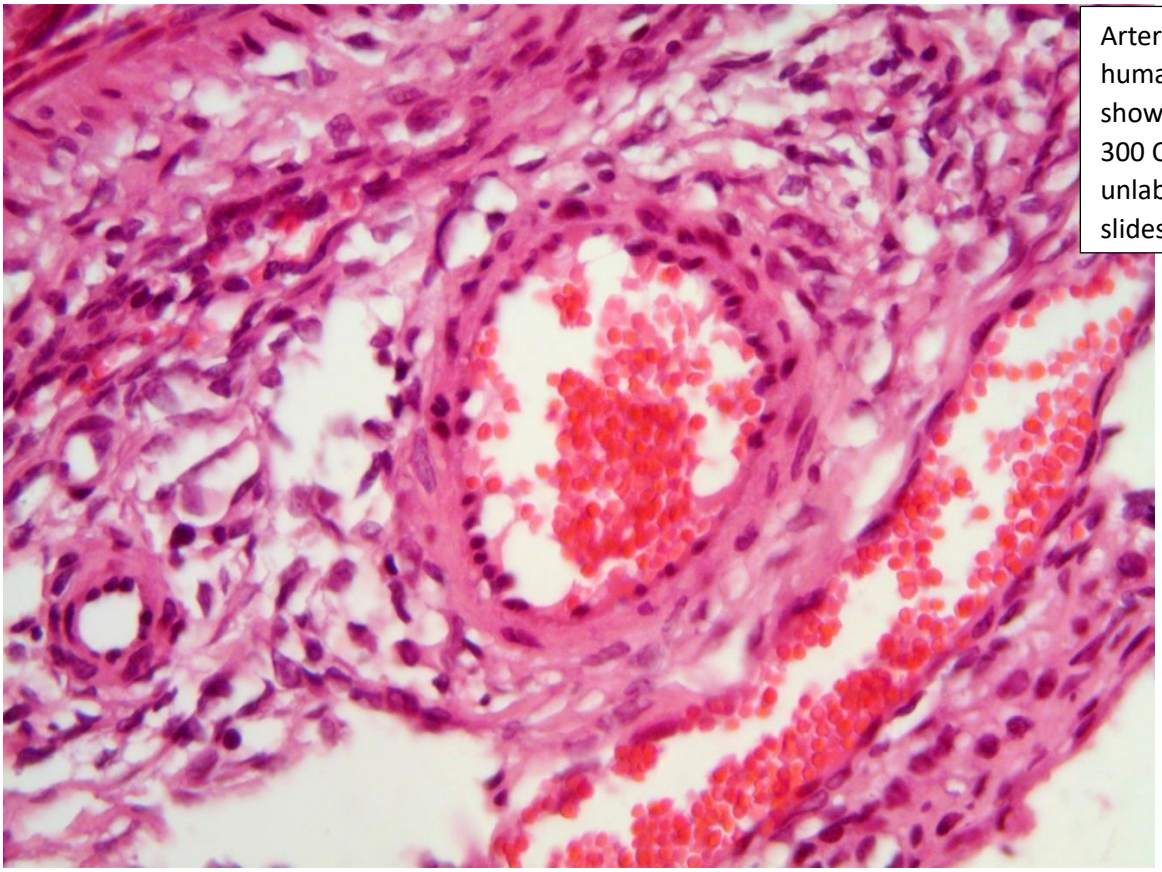
Human kidney, injected to show arterioles
University of Michigan, 40X objective
(and additional 1.6X camera magnification)



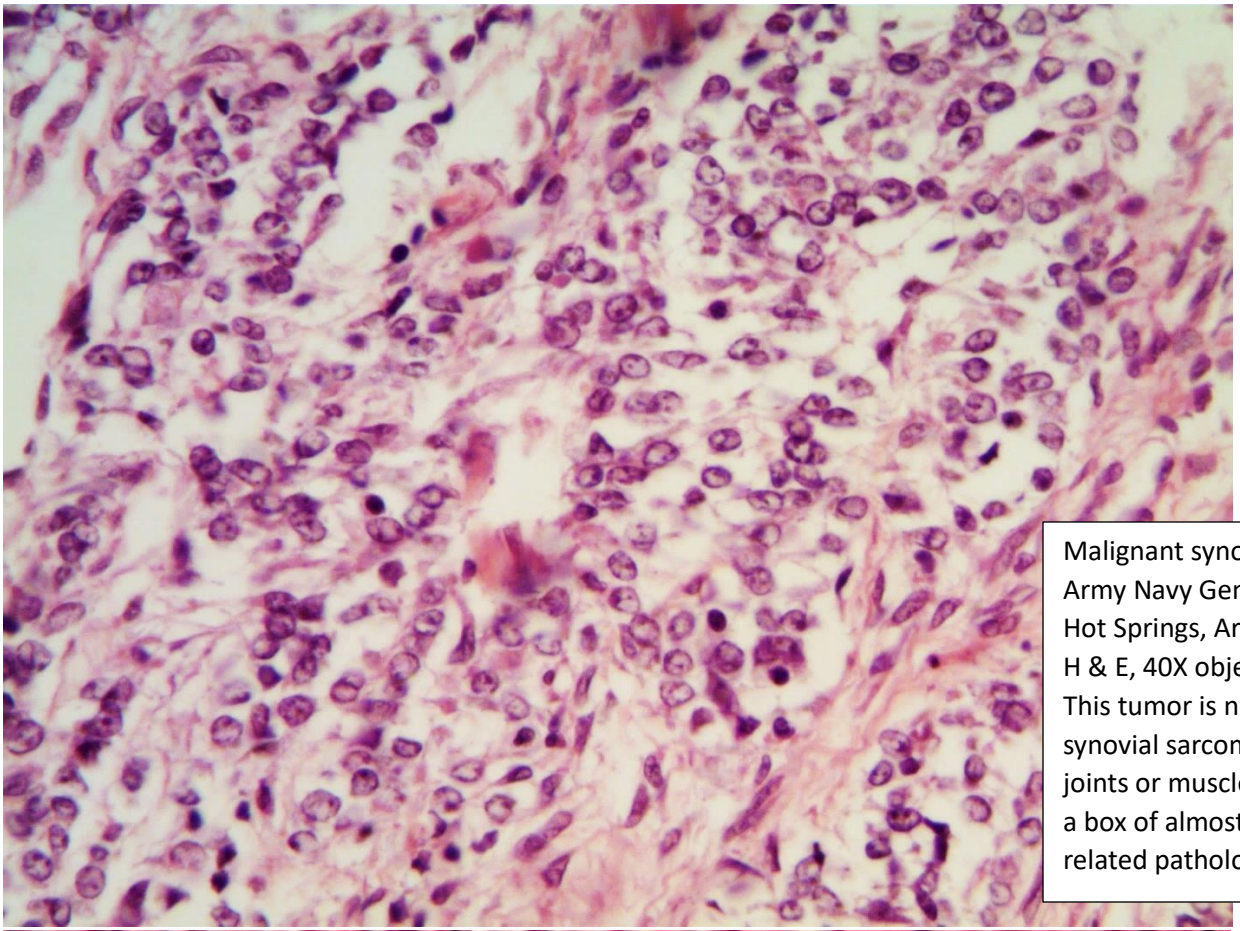
Cat spinal cord, fibrillar stain
University of California 40X obj.



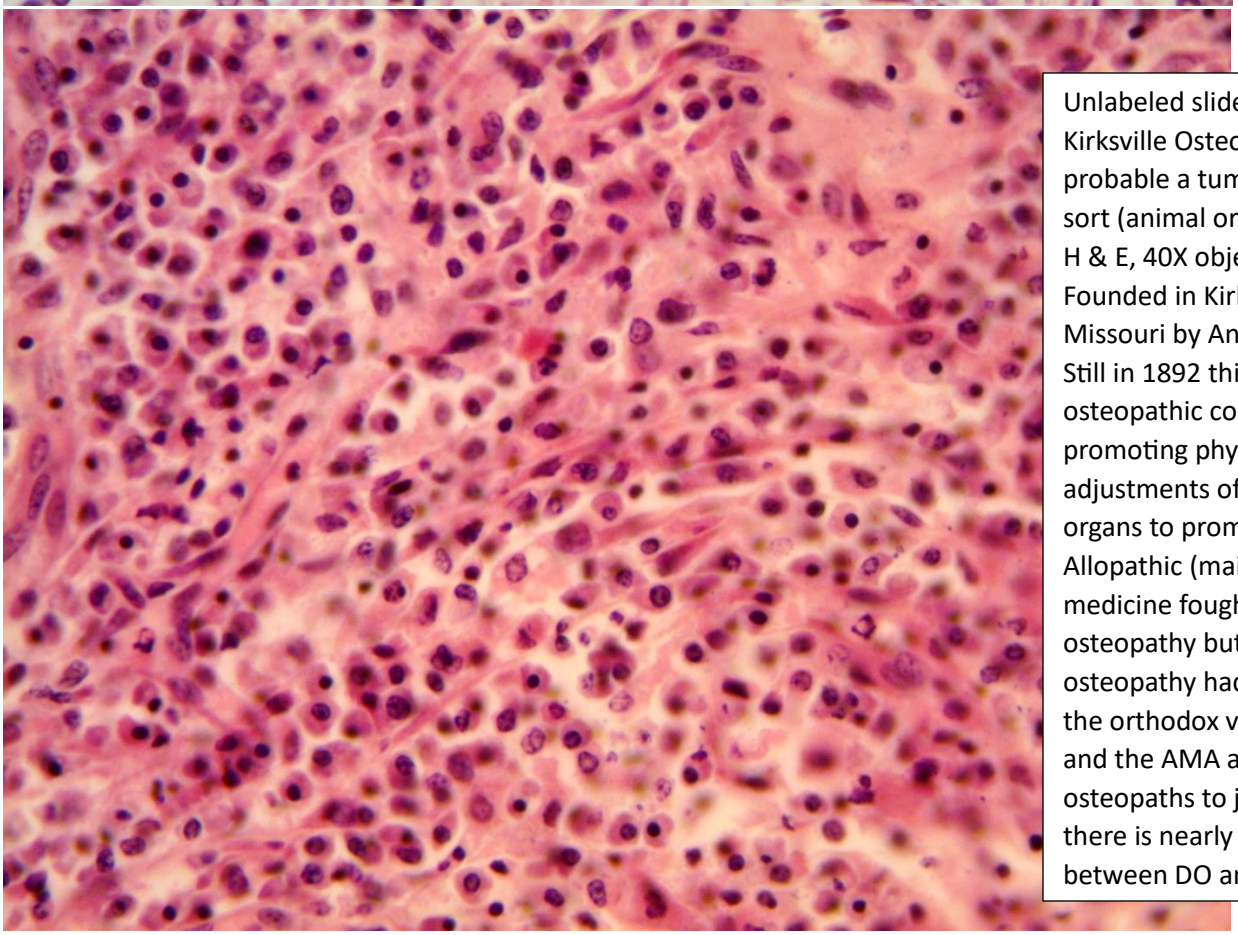
"Reticulum cell carcinoma" surrounding hair follicle in skin biopsy, University of Edinburgh probable H&E, 40X objective
Now called reticulum cell sarcoma, and is a form of non- Hodgkin's lymphoma, arises from reticuloendothelial cells in spleen or lymph nodes.
Dermatopathology is an important subspecialty, and skin slides are often both beautiful and clinically highly informative.



Artery and vein, unknown human specimen, slide shown below, part of set of 300 OSU med school unlabeled teaching or test slides. 40X objective



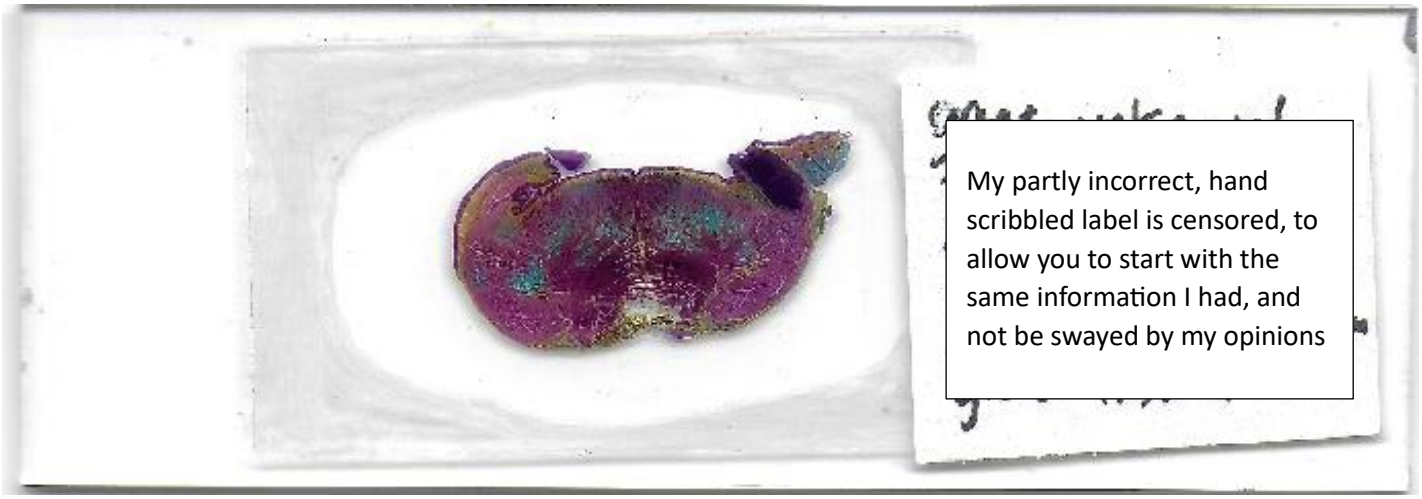
Malignant synovioma
Army Navy General Hospital, Hot Springs, Arkansas, 1940's
H & E, 40X objective
This tumor is now called synovial sarcoma, arises from joints or muscle. Slide was in a box of almost 100 bone and related pathology slides.



Unlabeled slide from Kirksville Osteopathic College, probable a tumor of some sort (animal or human)
H & E, 40X objective
Founded in Kirksville, Missouri by Andrew Taylor Still in 1892 this was the first osteopathic college, promoting physical adjustments of bones and organs to promote health. Allopathic (mainstream) medicine fought hard against osteopathy but by 1969 osteopathy had embraced the orthodox view of disease and the AMA allowed osteopaths to join. Today there is nearly no difference between DO and MD doctors.

There is always room for one more special slide…

My beautiful mystery slide



One of my favorite slides is an unlabeled pathology slide of an unknown subject by an unknown mounter. The specimen is nearly 24 by 12 mm, under an oversized coverslip. The slide came in a box with miscellaneous other slides, some medical and some not. As I recall (but didn't write down, my mistake) the slides came from New York or Pennsylvania in the northeast of the USA, and I thought they were likely an eclectic collection made by a doctor. The other slides looked probably last half 20th century. Next to the mystery slide was another slide with oversized coverslip labelled "beef kidney cut on 830C" (a circa 1980 American Optical rotary microtome). The kidney was an unremarkable H&E stained slide. In the same box were human and probably nonhuman pathology slides including 8 nice looking trichromes labelled "SUI pathology" with a felt tip marker on the glass slides (an institution I cannot identify; SIU, Southern Illinois University has an active histology department, could they have a dyslexic lab tech?). The colorful trichrome skin slide on page 2 of this article was one of those "SUI" slides.

At first, I was frustrated that such a nice, beautiful slide had no label. But I've come to love the slide even more because of the journey of discovery it sent me on. I'll reveal more of what I learned on my own, and hopefully lots more I learn from Micscape readers in a future article about this great slide.

Look at the overall shape, noting bilateral symmetry with epithelium on "top" (see the cover page photo for details) and perhaps a groove down the center. I noted lots of tissue types: nonkeratinized squamous epithelium, lots of voluntary muscle, many clusters of glandular tissue that stained different colors, connective tissues, arteries, veins, nerves.

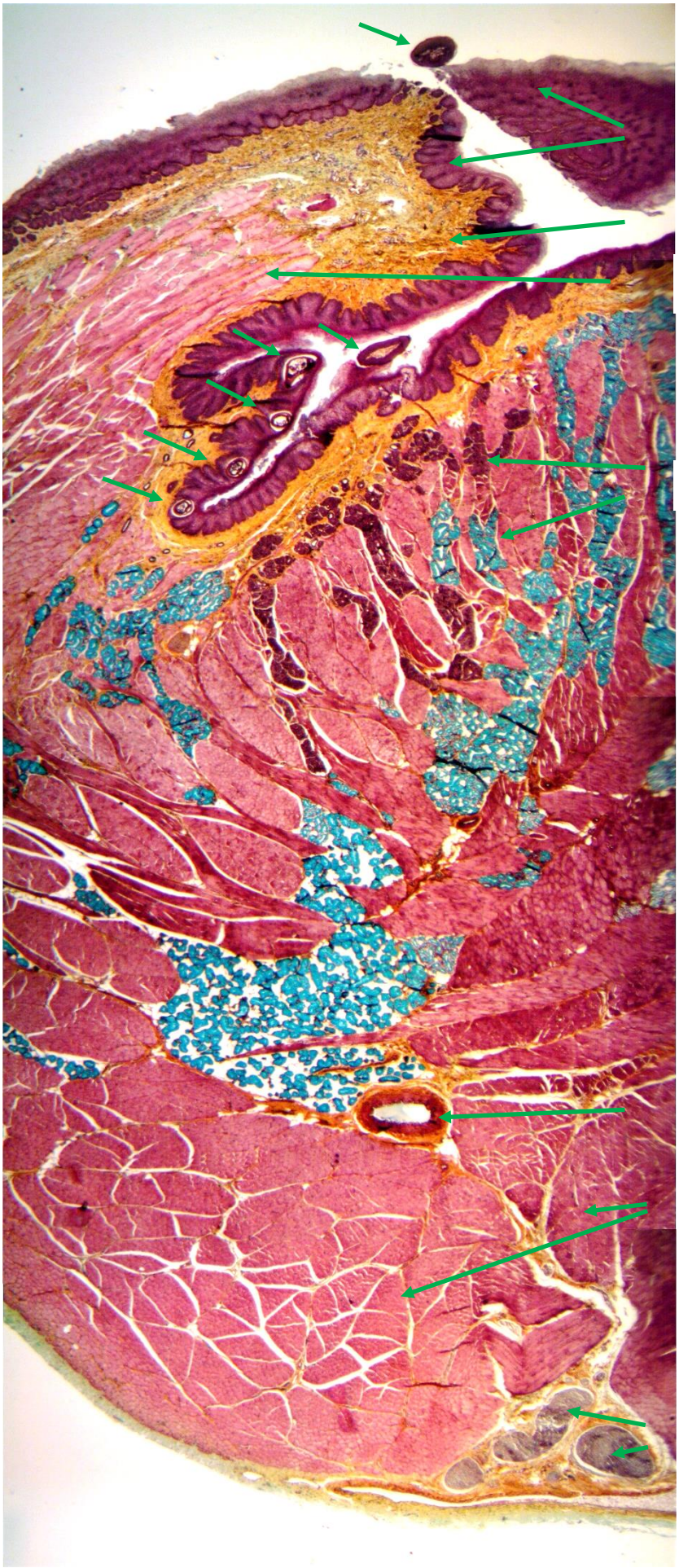
I thought it was a very colorful, very nice histology slide. The multiple deeply stained colors are amazing, but I didn't identify the colors as matching other histology slides I'd seen. Then after a couple of years I noticed something super interesting in the "fold" in the upper left (as seen on the slide; microscope views are upside down and backwards). That finding is shown in some of the photos below. It made me rethink what body site the specimen came from and added a whole new twist, catapulting this from a good to a great slide in my always curious mind. Consider these questions:

What tissues are present and how are they arranged? What organ? What animal(s)? About how old is the slide? What stain and processing?

A series of photomicrographs follows. I've not yet been able to get a clean panoramic stitch of the whole specimen even with low power objectives. (I still have so much to learn about microscopy.) I look forward to some smart *Micscape* readers telling me more about what my mystery slide is.

A brief gallery of the mystery slide follows. See also cover page, page 13, and page 40 for other photomicrographs.

Mystery slide, top to bottom
stitched panorama with 2.5X objective
with some tissues pointed out by me



squamous epithelium

connective tissue (stained yellow)

voluntary muscle in longitudinal section (pink)

what are these mysterious things?
and is there something similar at the surface?

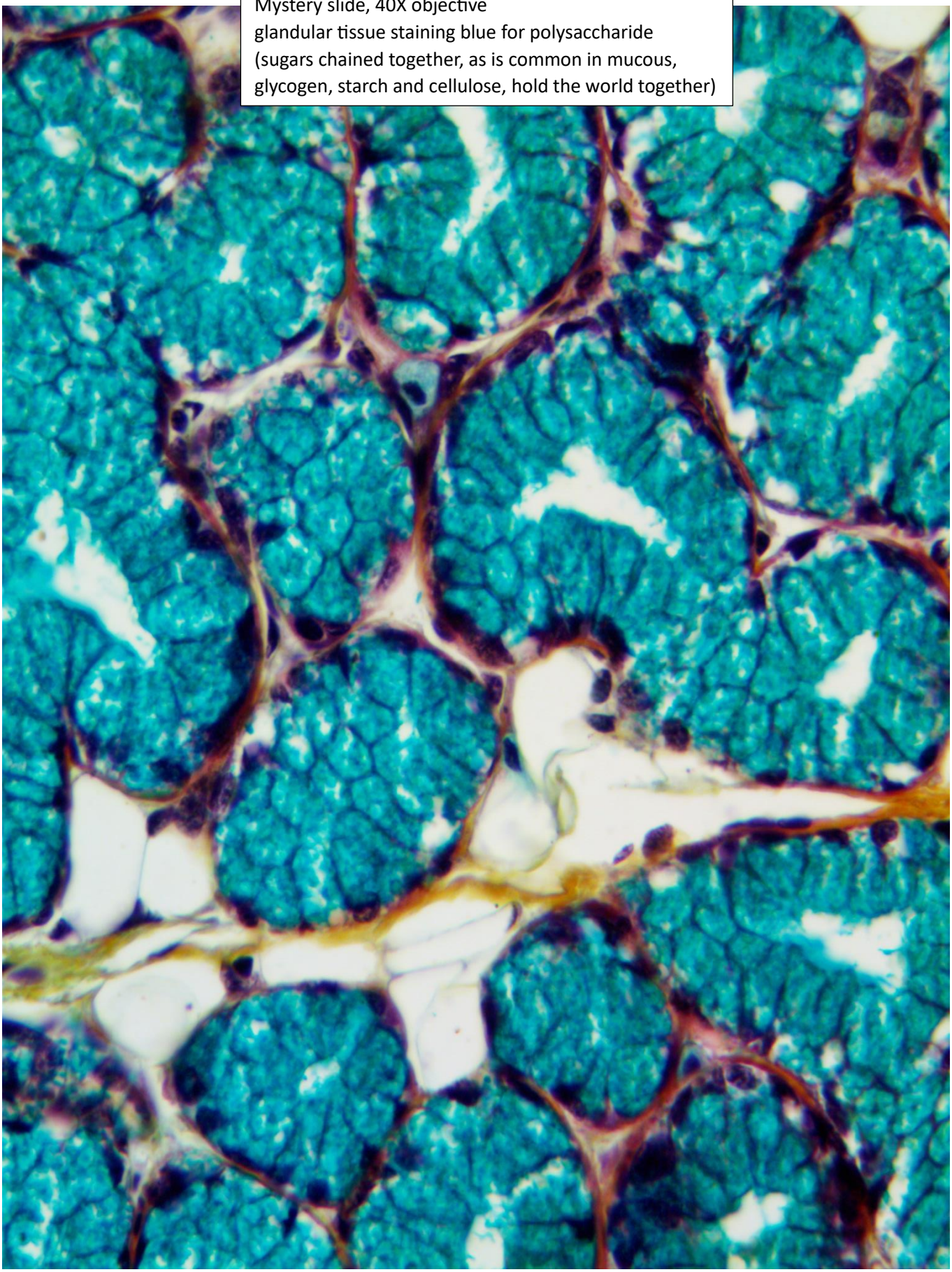
2 glandular tissue types (blue and brownish purple)

artery

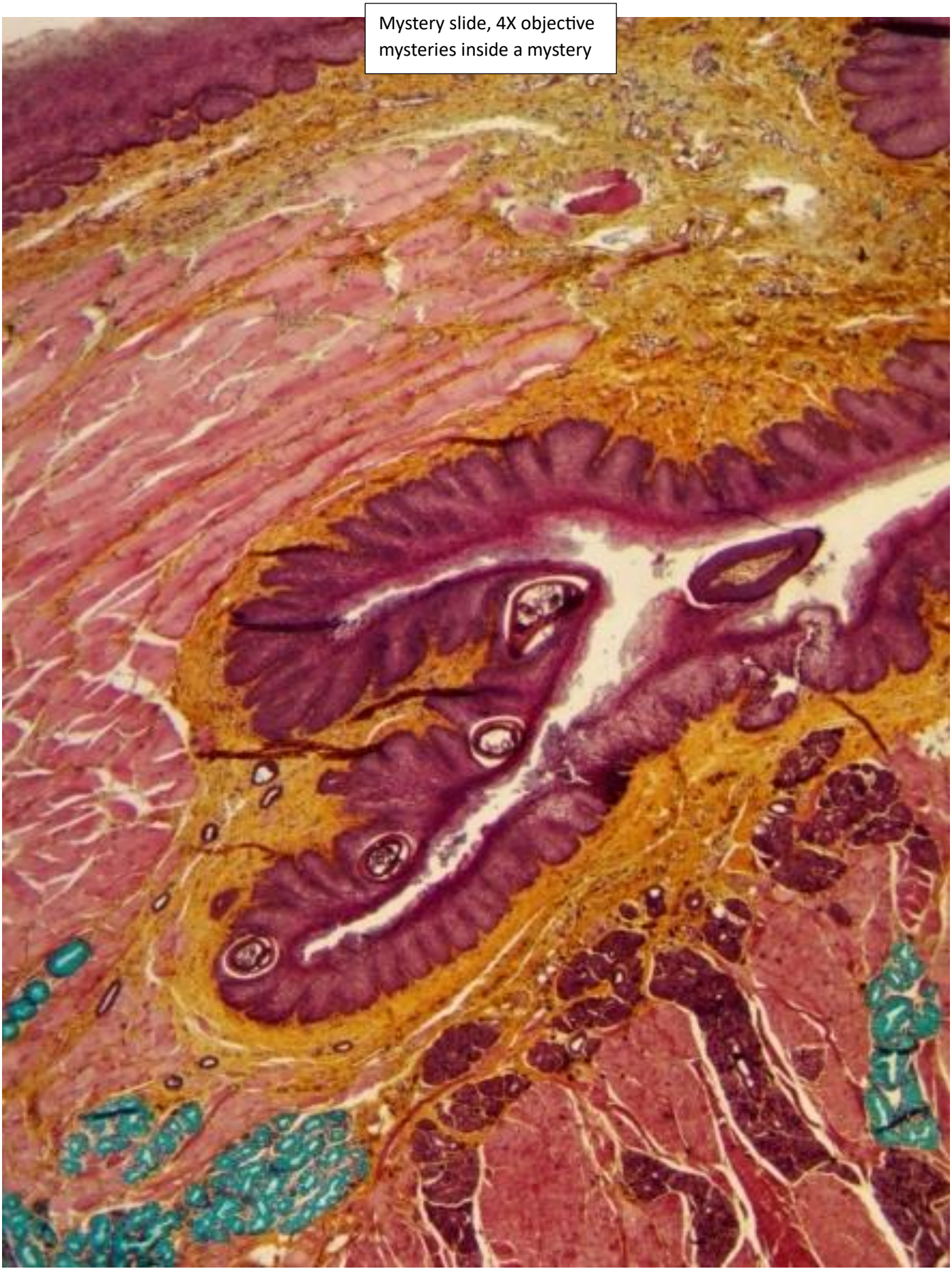
voluntary muscle in cross section
(various shades pink, most abundant tissue on slide)

nerves

Mystery slide, 40X objective
glandular tissue staining blue for polysaccharide
(sugars chained together, as is common in mucous, glycogen, starch and cellulose, hold the world together)



Mystery slide, 4X objective
mysteries inside a mystery



Mystery slide, 40X objective
mysteries inside the mysteries inside a mystery

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Micscape always has lots of good information for amateur microscopists wanting to learn more about how to do it yourself. I was inspired to defend histology and pathology slides in part by Richard Hovey commenting years ago in one of his many fascinating essays that he doesn't find them particularly appealing. I think Richard just needs to find the right slides. More recently I noticed a very good set of tips on how to shop for used histology slides by Neal Shields on the informative forum at Oliver Kim's Microbe Hunter site, spurring me to write down and illustrate my own thoughts. After learning so much from *Micscape* over the years, I need to give something back to the community here.

I have more articles on the way. The peripatetic Rudolph Virchow cannot be confined to just the small box in this article. So I will be publishing a series on his seminal contributions to modern medicine and modern multicultural society later this year in *Micscape*. Some readers might find that article just dry history, so I start by publishing this article to hopefully inspire some love for pathology slides.

Ed Ward, comments welcomed, email – eward1897 AT gmail DOT com

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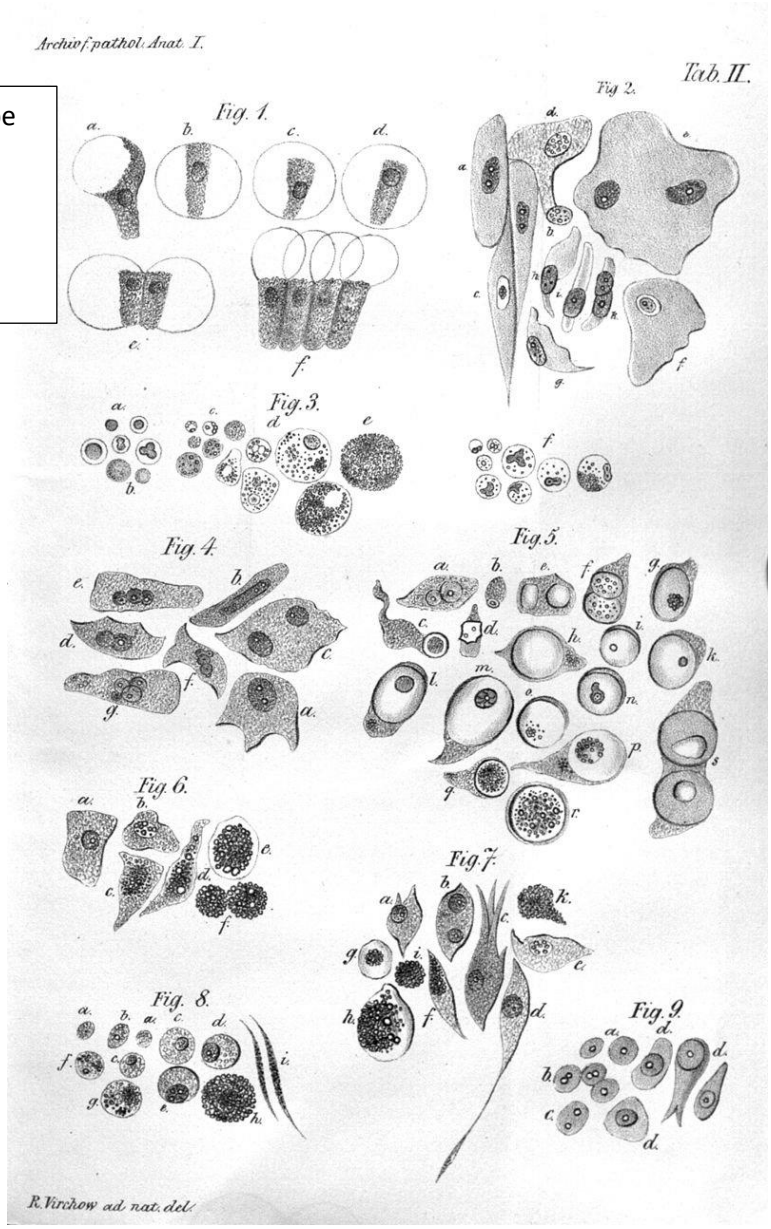
Right, Virchow's drawings of cells under a microscope

1847 figures for an article in the 1st edition of Virchow's self-published medical journal (*Archiv für Pathologische Anatomie und Physiologie*, still published as "*Virchow's Archives*")



Lower left, Histology in Outer Space

Turtox/Cambosco magnified slide image of "cells and cell division" (?whitefish blastula) used on the NASA Voyager golden records. Launched in 1977, Voyager 1 and 2 are beyond heliopause, moving at 17 and 15 kilometers per second in interstellar space