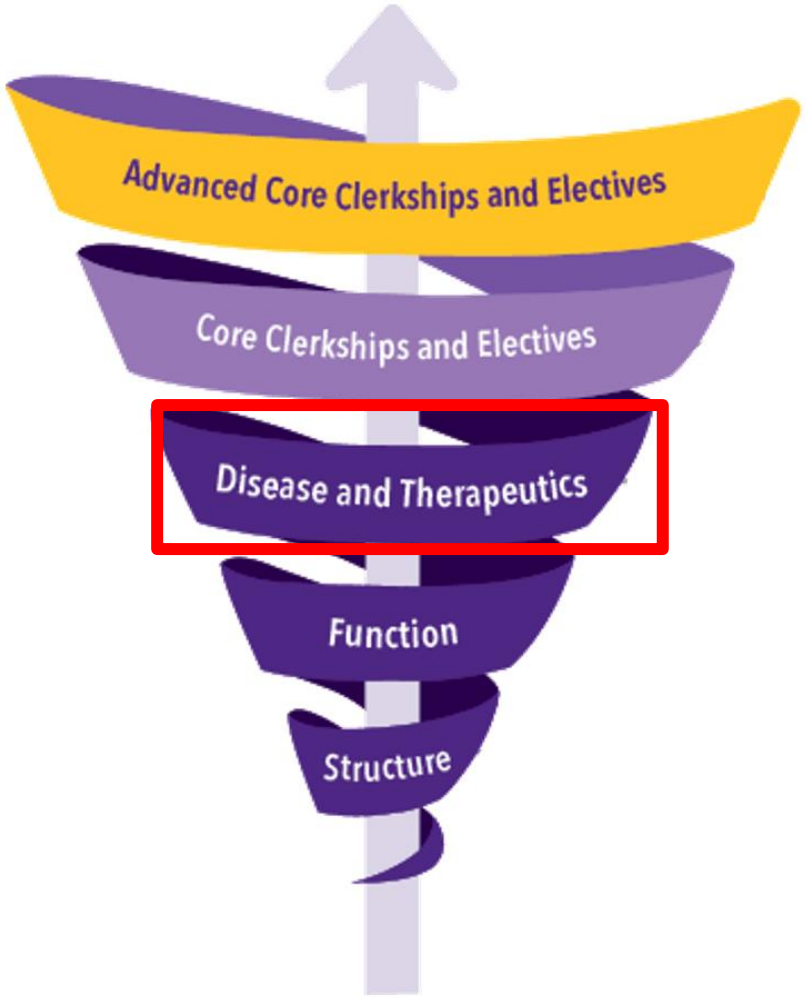
Pathology Laboratory Sessions in the Pre-Clinical Medical Curriculum: Assessment of Construct and Effectiveness

Michael Denning, M3
Brody School of Medicine, East Carolina University

Background

- At the Brody School of Medicine, **pathology topics** are taught
  - **M1 Year**: **Basic pathology** concepts
  - **M2 Year**: **Organ-system pathology** concepts integrated with pharmacology and clinical applications concepts

Brody School of Medicine Curriculum Spiral



DIFFERENTIATION PHASE - 13 Months

Transition to M4

Advanced Core Clerkships:
Emergency Medicine - 4 weeks
Neurology/PM&R - 4 weeks

Required Experiences:
Ambulatory Primary Care - 4 weeks
Acting Internship - 4 weeks
Intensive Care - 4 weeks
Electives and Flex - 30 weeks

Transition to Residency

M4

CLINICAL PHASE - 12 Months

Required Core Clerkships and Electives:

Family Medicine	Internal Medicine	OB/GYN	Pediatrics	Psychiatry	Surgery	Electives
8 weeks	8 weeks	6 weeks	8 weeks	6 weeks	8 weeks	4 weeks

Radiology

M3

FOUNDATIONAL PHASE Continued

Block 4:

Heme/Renal | Cardiopulmonary | Nervous & Sensory | Muscle & Skin | GI & Multisystem | Endocrine & Reproductive

Organ System Capstone

Foundations of Medicine and Doctoring

Society, Culture, & Health Systems and Basic Psychiatry

USMLE Step 1 Dedicated Study

M2

FOUNDATIONAL PHASE - 20 Months

Orientation

Block 1:
Gross Anatomy & Embryology
Molecular Basis of Medicine
Histology and Cell Biology

Block 2:
Medical Neuroscience
Physiology

Block 3:
Mechanisms of Disease & Therapeutics

Medical Microbiology & Immunology

Foundations of Doctoring (Preceptorships and PBL)

Ethical Issues in Medicine | Behavioral Science | Society, Culture, & Health Systems

Summer:
Independent Research activities

M1

Background

- Pathology instruction at Brody includes:
  - **Lectures**
  - **Laboratories**
  - **Flipped Classroom Session**
- Laboratory sessions have traditionally been a fundamental element in pathology instruction.
- However, limited literature exists regarding the specific purpose, content, and goals of pathology laboratory sessions.
- In **Brody general course evaluations**, pathology **laboratory sessions** have been consistently cited as an **important and interesting component of the pathology course** and as a **highlight of the course**.
- However, a **systematic evaluation** of the **components of the Brody laboratory sessions** had **not been conducted to date**.

Methods and Materials

- The **current pathology laboratory session design** and **content** at the Brody School of Medicine was **summarized**.
- **Students were surveyed** using a SurveyMonkey.com survey regarding their thoughts about the pathology session with a distinction between the **small group** and the **macroscopic / gross organ components** of the laboratories.
- A **literature review** was conducted using pubmed.gov, scholar.google.com, and google.com using key words including medical education, pathology, and laboratory.

M1 & M2 Pathology Laboratory

Goals of Laboratory Session

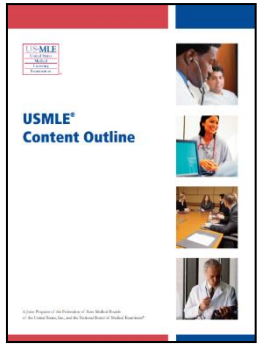
- **Reinforce "high-yield" topics**
  - No "new" content introduced
- Provide forum for **active learning** discussion of topics
- Allow students to **see disease processes in situ**
  - Normal lung vs. emphysematous lung
  - Normal kidney vs. end-stage renal disease kidney
  - Normal aorta vs. aorta with mild/moderate/severe atherosclerosis

What Topics Should Be Covered in Laboratory Sessions?

"High-Yield"

USMLE Content Guideline, 2022

(https://www.usmle.org/pdfs/usmlecontentoutline.pdf)



Nervous System & Special Senses

Normal Processes

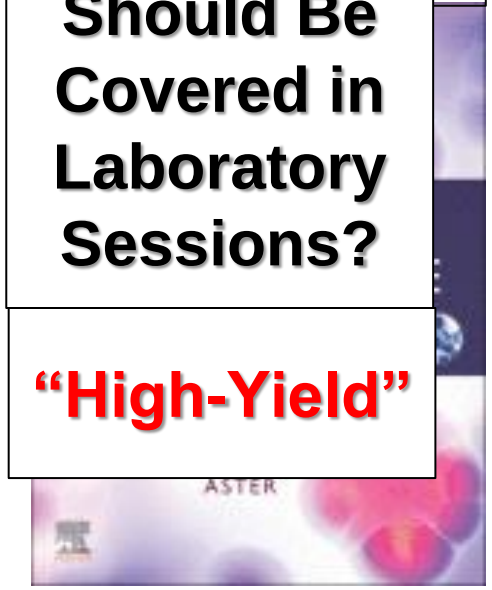
- **Embryonic development, fetal maturation, and perinatal changes, including neural tube derivatives, cerebral ventricles, and neural crest derivatives**
- **Organ structure and function**
  - spinal cord
    - gross anatomy and blood supply
    - spinal reflexes
  - brain stem (eg, cranial nerves and nuclei, reticular formation, anatomy and blood supply, control of eye movements)
  - brain
    - gross anatomy and blood supply
    - higher function: cognition, language, memory, executive function
    - hypothalamic function
    - limbic system and emotional behavior
    - circadian rhythm sleep-wake disorder
  - sensory systems
    - general sensory modalities, including sharp, dull, temperature, vibratory, and proprioception
    - special sensory modalities, including vision, hearing, taste, olfaction, and balance
  - motor systems
    - brain and spinal cord (upper motoneuron)
    - basal ganglia and cerebellum
  - autonomic nervous system
  - peripheral nerves
- **Cell/tissue structure and function, including neuronal cellular and molecular biology**
  - axonal transport
  - excitable properties of neurons, axons, and dendrites, including channels
  - synthesis, storage, release, reuptake, and degradation of neurotransmitters and neuromodulators
  - presynaptic and postsynaptic receptor interactions, trophic and growth factors
  - brain metabolism
  - glia, myelin
  - brain homeostasis: blood-brain barrier, cerebrospinal fluid formation and flow, choroid plexus
- **Repair, regeneration, and changes associated with stage of life**

Abnormal Processes: Health and Health Maintenance, Screening, Diagnosis, Management, Risks, Prognosis

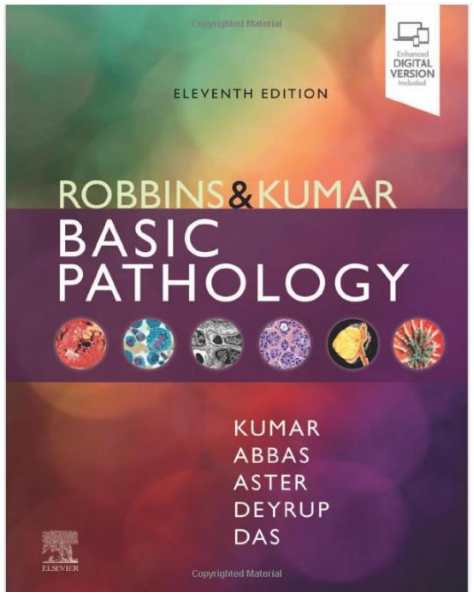
- **Infectious, immunologic, and inflammatory disorders**
  - **infectious disorders:** meningitis: bacterial (*Actinomyces israelii*; *Haemophilus influenzae*; *Listeria monocytogenes*; *Mycobacterium tuberculosis*; *Neisseria meningitidis*; *Staphylococcus aureus*, *epidermidis*; *Streptococcus agalactiae*; *Streptococcus pneumoniae*); viral (adenovirus, arboviruses, echovirus and coxsackie A & B viruses, polioviruses, herpes simplex virus, varicella zoster, human immunodeficiency virus, lymphocytic choriomeningitis virus, measles virus, mumps virus, St. Louis encephalitis virus, California encephalitis virus, Western equine encephalitis virus); fungal (*Blastomycosis dermatitidis*, *Cryptococcus neoformans/gattii*); spirochetal (*Borrelia burgdorferi*; *Leptospira*; *Treponema pallidum*, including neurosyphilis); protozoal/helminths (*Acanthamoeba*, *Naegleria fowleri*, *Strongyloides stercoralis*, *Angiostrongylus cantonensis*, *Baylisascaris procyonis*); encephalitis (herpesvirus [HSV-I], varicella-zoster virus, Epstein-Barr virus, cytomegalovirus, mumps virus, enterovirus, West Nile virus, St. Louis encephalitis virus, rabies virus, Eastern and Western equine encephalitis virus, poliovirus, *Taenia*, *Toxoplasma gondii*); prion disease (eg, Creutzfeldt-Jakob disease); botulism (*Clostridium botulinum*), tetanus
- **Cerebrovascular disease:** arteriovenous malformations, ectatic cerebral vessels; transient ischemic attack; stroke, thrombotic: cerebral artery occlusion/cerebral infarction; stroke, embolic: cerebral embolism; stroke: intracerebral hemorrhage, including subarachnoid hemorrhage, traumatic intracranial hemorrhage; cerebral artery aneurysm; carotid artery stenosis/atherosclerosis/occlusion/dissection; vertebral artery deficiency/dissection; subclavian steal syndrome; vascular dementia; hypertensive encephalopathy; posterior reversible encephalopathy syndrome; venous sinus thrombosis
- **Disorders relating to the spine, spinal cord, and spinal nerve roots:** cauda equina syndrome; spinal artery thrombosis/embolus/infarct; spinal cord compression; spinal cord transection, paraplegia and quadriplegia, acute and chronic effects (eg, autonomic dysreflexia); spinal stenosis (cervical, lumbar); syringomyelia
- **Cranial and peripheral nerve disorders**
  - **cranial nerve injury/disorders:** cranial nerve injury; Bell palsy; anisocoria, miosis, mydriasis; internuclear ophthalmoplegia; nystagmus and other irregular eye movements; vestibular neuritis, labyrinthitis; ptosis of the eyelid; Horner syndrome
  - **peripheral nerve/plexus injury/disorders:** peripheral nerve injury, including brachial plexus; carpal/cubital/tarsal/peroneal tunnel syndrome; mononeuritis, Guillain-Barré syndrome; Miller Fisher syndrome; neuropathy (eg, Charcot-Marie-Tooth disease); herpes zoster

What Topics Should Be Covered in Laboratory Sessions?

"High-Yield"



Robbins Basic Pathology, 11th Edition, 2023



Textbook Topics / Key Words (From Pathologic Basis of Disease, 10th Ed.)

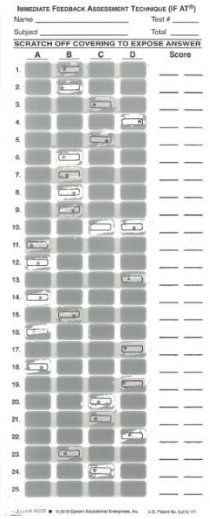
28

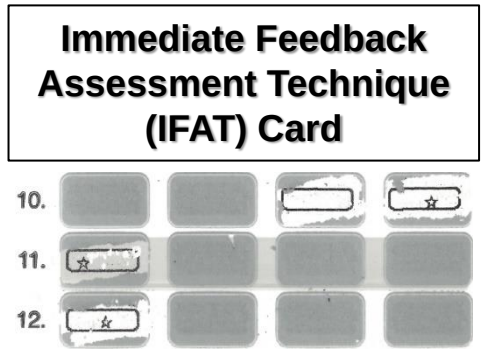
The Central Nervous System

Marta Margeta
Arie Perry

Design

- **Number: Basic Pathology = 2; Organ System Pathology = 12 ➔ 14 Total**
- **Setting:** Laboratory Space, 7th Floor of Brody Building
- **Components:**
  - **Small Group Case-Based Discussion:** Case-based PowerPoint content with questions are reviewed; group responses to questions are recorded on Immediate Feedback Assessment Technique (IFAT) scratch cards (Epstein Educational Enterprises).
  - **Macroscopic / Gross Organ Review - Normal and Abnormal:** Demonstration and discussion of key, "high-yield" pathologic entities.





- **Attendance**: Attendance = Required

M1 & M2 Pathology Laboratory

Small Group Cases: Clinical / Lab Data / Imaging / Pathology

Turning Point Question **Question 1**

A 55-year-old man presented with **increasing dyspnea on exertion**. Past medical history was significant for hypertension, hyperlipidemia, 3-vessel disease coronary artery disease with a chronic, total occlusion of LAD deemed not amenable to intervention.

Physical Examination: **Lower extremity edema bilaterally** to above the knees; Liver enlarged and tender to plapation; Ascites

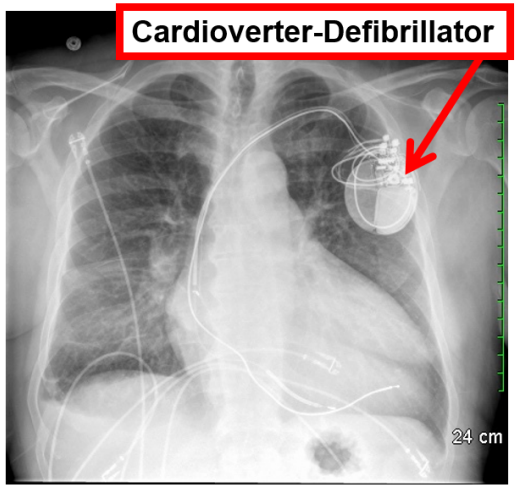
Chest X-Ray: Cardiomegaly, severe; Pulmonary edema, interstitial, moderate

Echocardiogram: Left ventricle and atrium dilation, severe; Left ventricle thrombus; right ventricle wall thick and lumen dilated.

The patient's findings are consistent with **congestive heart failure (CHF)**. What **serum analyte** is valuable as one piece of data in (1) making the **diagnosis of CHF** and (2) **assessing severity and response to treatment**?

A. AST and ALT
B. Troponin I or T
✓ C. B-type natriuretic factor
D. Creatinine kinase – MB isoform

Heart Is an Endocrine Organ Too!



Most Common Use:
Marker of Left Heart Failure …
Most Common Form of HF

- **Elevated in Right Heart Failure too … doesn't distinguish R and L Heart Failure**
- **Lab Tests:**
  Must be interpreted in clinical context

Heart Failure

Laboratory Data

- **B-Type Natriuretic Peptide** (BNP) produced and secreted by ventricular myocytes
  - Stimulation: volume expansion / pressure overload

- Good marker for "cardiac failure": can follow over time

<100 pg/mL	No heart failure
100-300 pg/mL	Possible heart failure
>300 pg/mL	Mild heart failure
>600 pg/mL	Moderate heart failure
>900 pg/mL	Severe heart failure

- Not specific for heart failure: Interpret in clinical context including echocardiogram, etc.

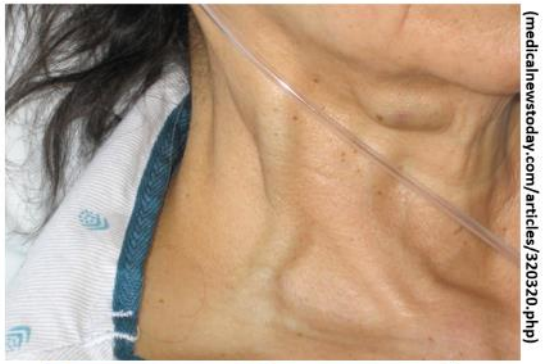
M1 & M2 Pathology Laboratory

Small Group Cases: Clinical / Lab Data / Imaging / Pathology

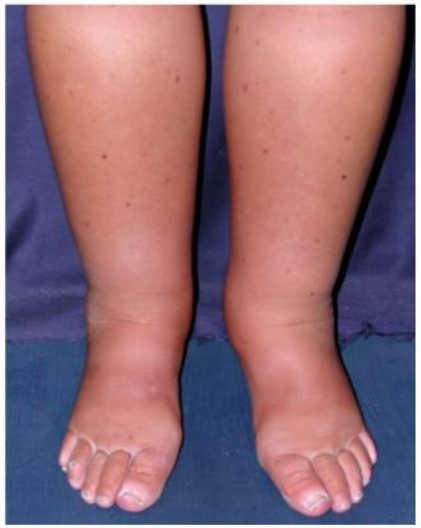
Turning Point Question **Question 3**

Physical examination revealed of a patient identified **jugular venous distension, lower extremity edema, and ascites**. In addition, serum aspartate aminotransferase / transaminase (**AST**) and alanine aminotransferase / transaminase (**ALT**) levels were moderately elevated. **Which one of the following best explains this combination of physical examination and laboratory abnormalities?**

A. Myocardial infarct
B. Right and left heart failure
C. Left heart failure
✓ D. Right heart failure



(medicalnewstoday.com/articles/320320.php)



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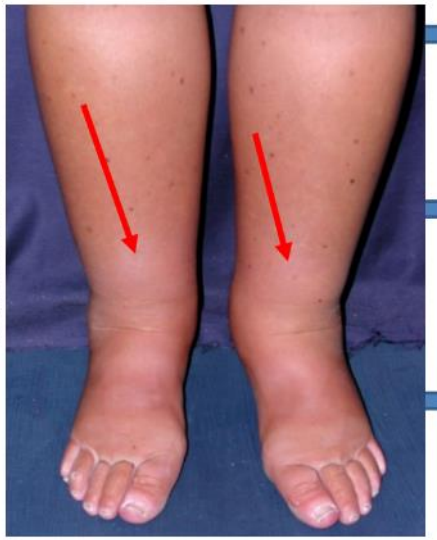
Hemodynamic Problem

Clinical Finding	Organ System Differential
 (Source Not Known)	**Heart** • Right Heart Failure ↑ Hydrostatic Pressure in Inferior Vena Cava
	Liver • Cirrhosis ➔ ↓ Protein Synthesis ↓ Protein Synthesis ➔ ↓ Osmotic Pressure:
	Kidney • Nephrotic Syndrome (or Severe Nephritic Syndrome) ↑ Protein Loss ➔ ↓ Osmotic Pressure:

M1 & M2 Pathology Laboratory

Small Group Cases: Clinical / Lab Data / Imaging / Pathology

(Credit Andrew Renneisen for The New York Times Sept. 16, 2018 NYT.com Denise Grady)

(https://www.nytimes.com/2018/09/16/health/rwanda-strep-heart-disease.html)

- **Once a year, 40 to 60 volunteers fly to Kigali, Rwanda**: heart surgeons, cardiologists, nurses, anesthesiologists, experts in cardiac ultrasound, biomedical technicians, pharmacists, support staff and perfusionists who run the heart-lung machine that keeps patients alive during surgery.
- They come from the University of Vermont, Harvard-affiliated hospitals and other medical centers. They pay their own airfare, and Rwanda's Ministry of Health covers some hotel rooms and meals. Most use their vacation time, and this year Team Heart asked each volunteer also to raise $500 in donations to help cover costs.

Answer 8

Which haeart valve is **MOST COMMONLY involved in rheumatic heart disease**?

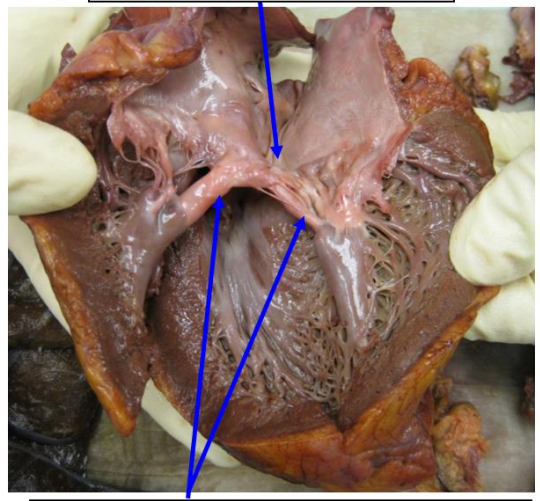
A. Mitral valve

B. Tricuspid valve

C. Pulmonary valve

D. Aortic valve

E. All valves equally involved



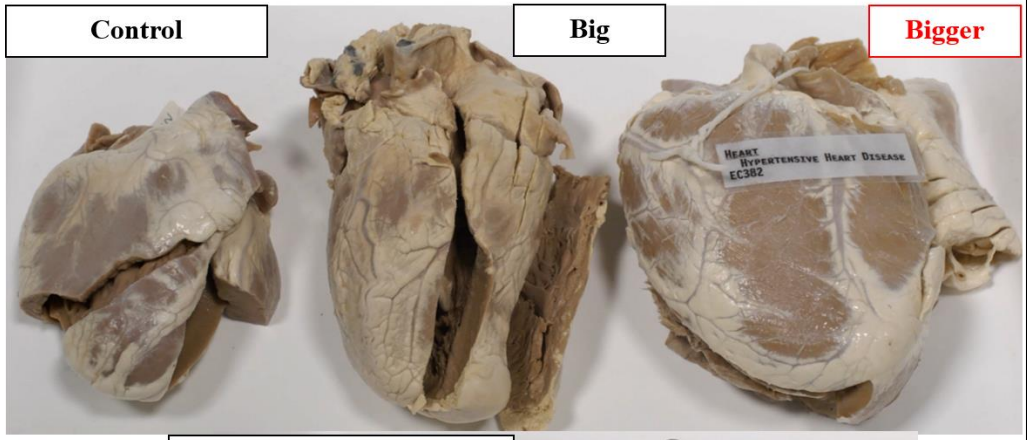
The mitral valve is by far the most commonly involved valve for reasons that are unknown. Per Robbins:

- Mitral Valve (alone):	**65-75%**
- Aortic Valve (usually with Mitral Valve involvement too)	**25%**
- Tricuspid	**Uncommon**
- Pulmonary	**Uncommon … LEAST COMMONLY INVOLVED**

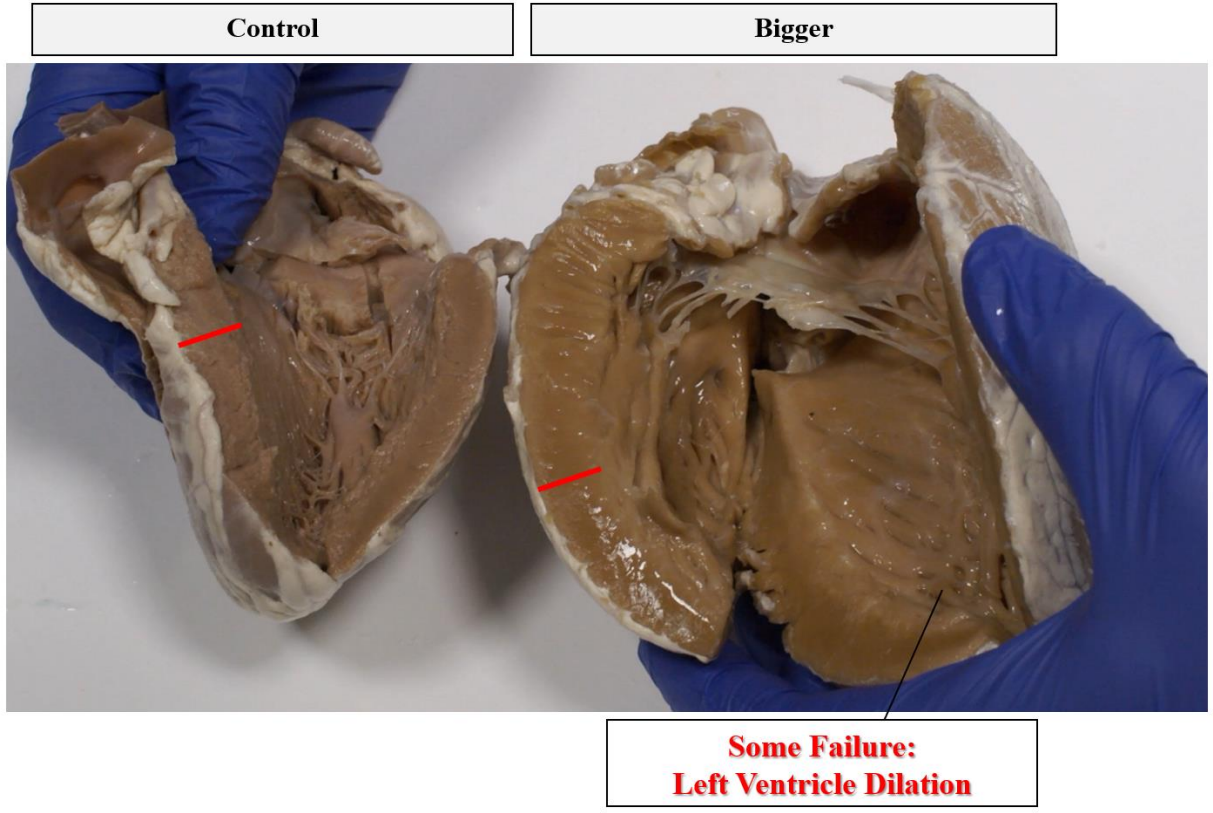
M1 & M2 Pathology Laboratory

Macroscopic Specimens

Hypertensive Heart Disease: Cardiomegaly



Risk of Arrythmia and Sudden Death



Some Failure:
Left Ventricle Dilation

M1 & M2 Pathology Laboratory

Macroscopic Specimens

Gentle, Non-Scar-Forming Pimping of Students

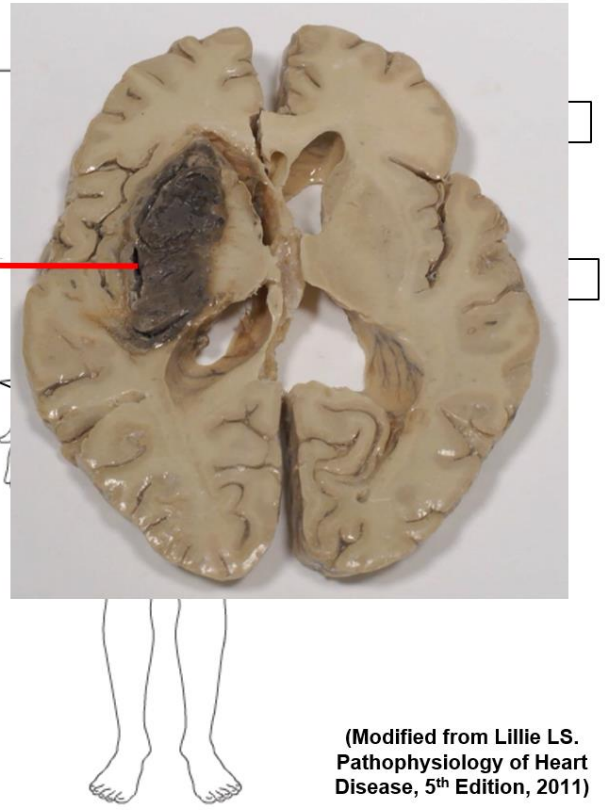
Hypertension
Complications by Organ System

Brain
- **Arteriolosclerosis:**
  - Ischemic injury → Infarct
- **Aneurysm**: Charcot-Bouchard in basal ganglia
  - **Hemorrhage risk**
- **Embolic stroke**

Eyes
- **Arteriolosclerosis:**
  - Copper or Silver Arteries (light reflex) → Ischemia
  - Vessel Narrowing and Kinking
  - Hemorrhages
  - Leakage: Plasma
    - Cotton wool Spots & Exudates
  - Optic disc edema
- **Aneurysms**: microscopic, retina

Kidneys
- **Arteriolosclerosis:**
  - Ischemia
  - Glomerulosclerosis
    - Glomerulus loss
    - Tubule loss
    - Fibrosis
    - Chronic inflammation

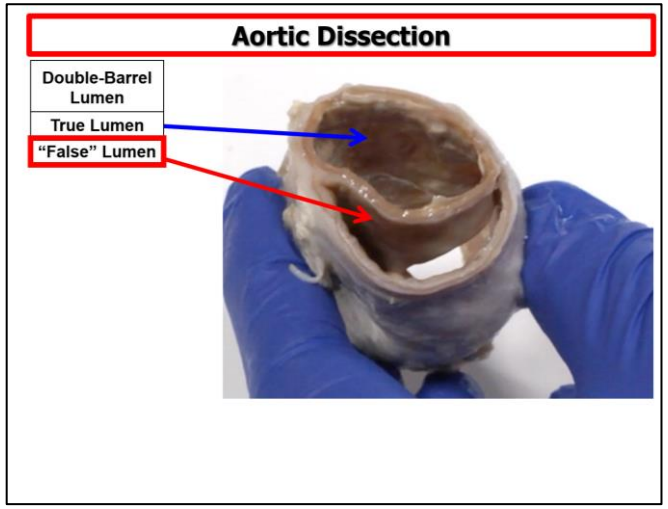
Blood Vessels: Aorta & Major Branches
- **Arteriolosclerosis:**
  - Ischemic injury
  - Limb claudication
- **Atherosclerosis**
  - Ischemic injury
  - Thrombosis on surface
  - Embolization
  - Aneurysm formation: Hypertension contributes

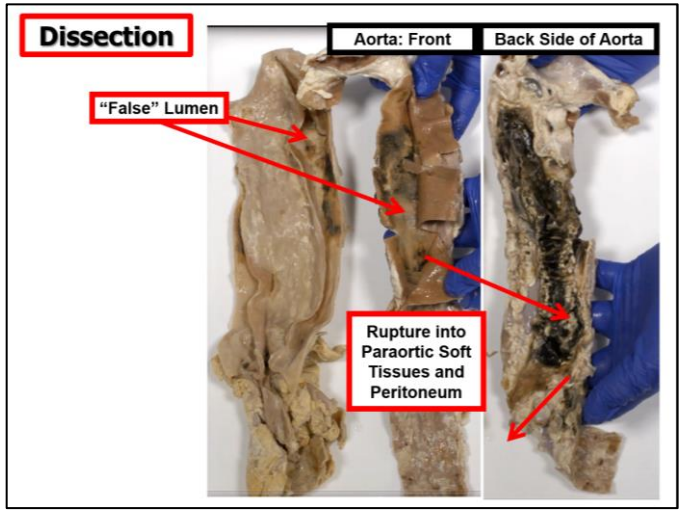


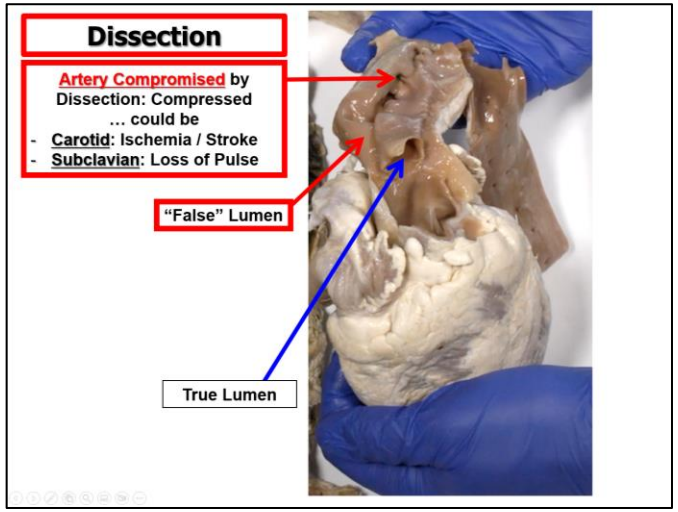
(Modified from Lillie LS. Pathophysiology of Heart Disease, 5th Edition, 2011)

M1 & M2 Pathology Laboratory

Macroscopic Specimens

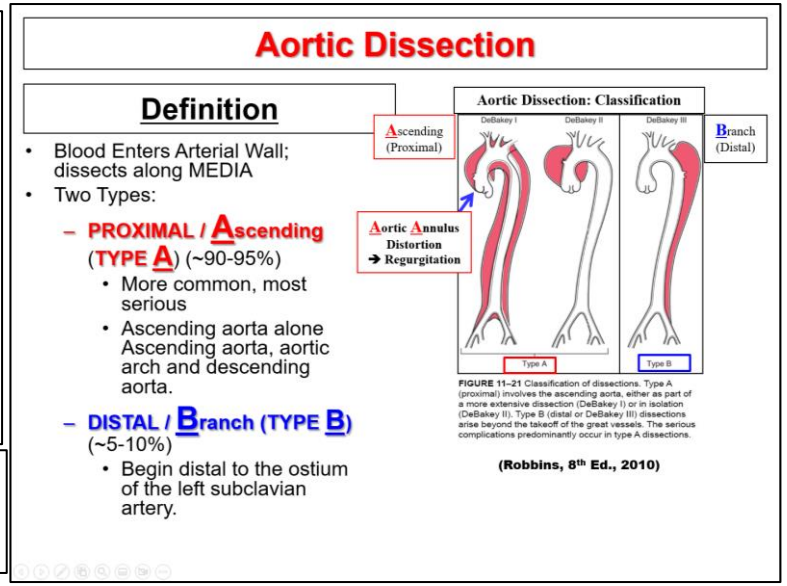


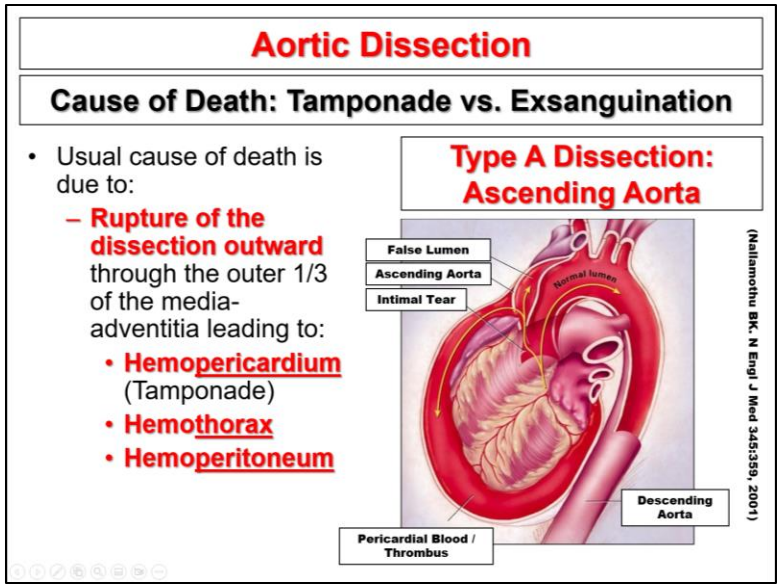




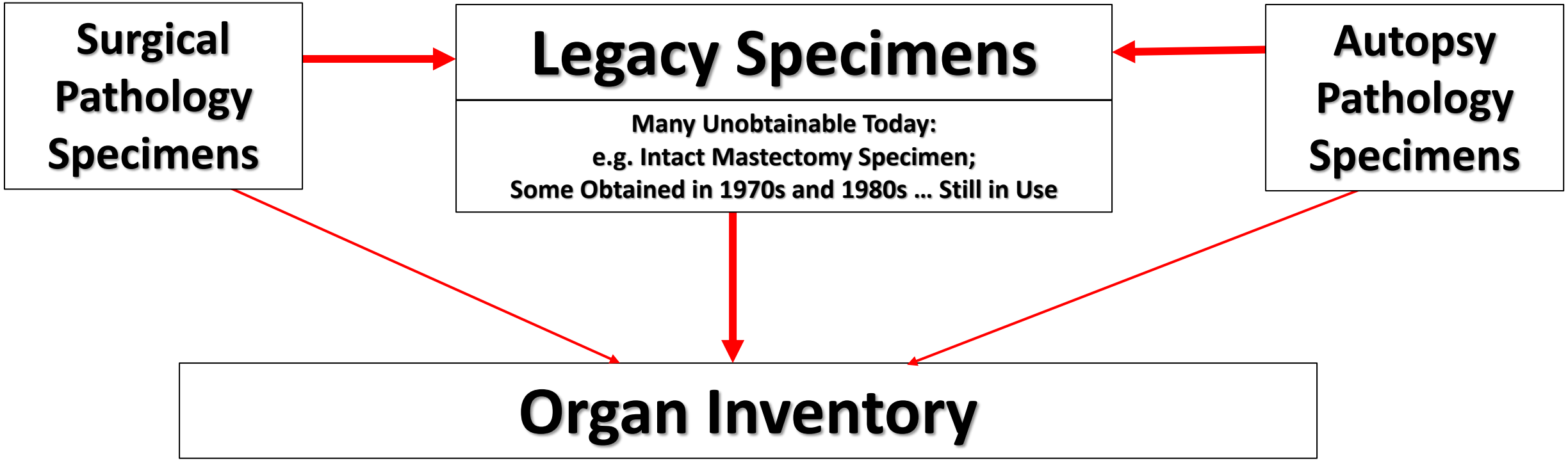
Lab Reinforces Concepts Discussed in Lecture

Nothing New!





Acquisition of Macroscopic / Gross Organs



Living Patient Consent: General Photo / Video / Drawing

PHOTOGRAPHS/VIDEO: I give permission to ECU Health and Medical Staff Members (including agents and contractors) to take photographs or make videos or drawing of me for permissible treatment, payment, or health care operations purposes (may include quality assessment, patient identity, education, and training) as long as consistent with policies and laws that protect my rights. If you do not want to participate in photographs/videos/drawings, please initial:

Photograph _____ **Video** _____ **Drawings** _____

Authorization/Consent is effective one year from date signed; however, will not expire for service or claims processing for admissions or visits occurring while it was in effect.

Note: If the services provided are recurrent therapeutic series (rehab/chemo), you will only need to sign one consent form to cover all the recurrent services provided within 90 days from the date of your signature.

Patient:

X _____ _____ _____

Signature of Patient *Date* *Time*

X _____

Print Name of Patient

Representative:

_____ _____ _____

Signature of person signing on behalf of Patient *Date* *Time*

_____ _____

Print Name of person signing on behalf of Patient *State why patient can not sign for him/herself*

Guarantor: (person or entity that agrees to be responsible for payment) By signing below as guarantor [does not apply to the patient, spouse (when medical care is necessary), or parents of a minor child], I hereby agree to pay all charges of Facility that are not covered or paid within a reasonable time by any medical insurance/coverage, whether or not I am otherwise legally obligated to pay.

_____ _____

Signature of Guarantor *Print name of Guarantor*

Witness:

_____ _____ _____

Signature of Witness *Date* *Time*

Surgery Consent Form

- I understand that the risks, benefits, and alternatives of the anesthetic (including conscious sedation when appropriate) will be explained to me prior to the anesthetic being administered.

- I consent to the examination and retention for scientific purposes and study by a pathologist, of all tissues and organs removed during the course of the above treatment with privilege of ultimate disposal resting with said Pathologists.

- I consent to the photographing or televising of the operations or procedures to be performed, including appropriate portions of my body for medical scientific or education purposes, provided my identity is not revealed by the pictures or by descriptive texts accompanying them.

- I understand that the expected results of said treatment cannot be guaranteed. The healthcare provider listed above has discussed to my satisfaction the following:

  A. The nature and character of the proposed treatment/procedure.
  B. The anticipated benefits and results of the proposed treatment/procedure.
  C. The recognized alternative forms of proposed treatment/procedure.
  D. The recognized serious possible risks, complications, side effects of the proposed treatment/procedure, including any that might occur during recuperation, and of the recognized alternative forms of proposed treatment/procedure, including non-treatment.
  E. The anticipated date and time of the proposed treatment/procedure.

- I understand that Vidant Health, together with its affiliated hospitals, clinics, and other services, is associated with East Carolina University and other educational institutions, and I agree that students training to be physicians, nurses, and Allied Health personnel may assist in providing my care. I understand that I have the right to decline to participate in teaching activities. I further understand that observers and/or agents of contract vendors may be admitted to the procedure area and may assist in my care.

- The healthcare provider listed above has offered to answer all inquiries concerning the proposed treatment/procedure. I understand that I am free to withhold or withdraw consent to the proposed/treatment at any time.

(Cross out any paragraphs above which do not apply. Date and initial at the time you cross out.)

X _____ _____ _____ _____

Patient or representative signature | Witness signature | Date | Time

Autopsy Consent Form

VIDANT™ Medical Center

AUTHORIZATION FOR AUTOPSY

I, _____, bearing the relationship
(Name of Next-of-Kin)

OF _____ as closest next-of-kin of
(Relationship)

_____ hereby:
(Name of Deceased)

Authorize staff physicians and employees of Vidant Medical Center, to conduct a diagnostic postmortem examination of the deceased, to include removal, examination, and disposal of organs in a manner consistent with and within the scope of applicable state law, regulations, procedures, and standards of care [NCGS 130A-398(5A)].

I further authorize the removal and retention of organs for purposes of education, research, or the advancement of medical science in a manner consistent with and within the scope of applicable state law, regulations, procedures and standards of care as long as the donor's identity remains anonymous [NCGS 130A-402 et seq. (N.C. uniform anatomical gift act)].

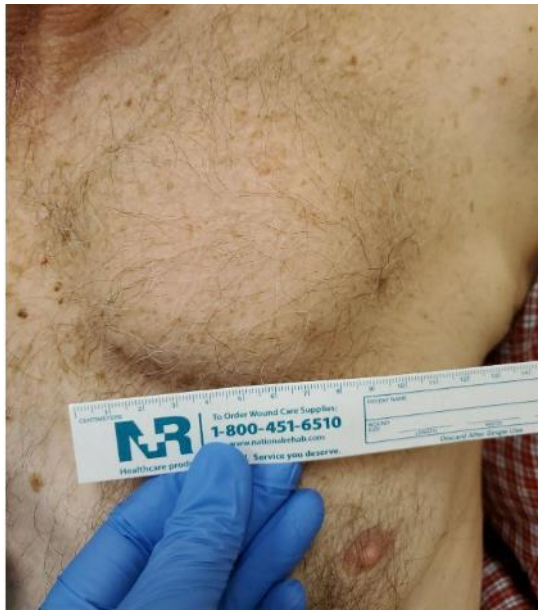
List restrictions, if any: **(required)**

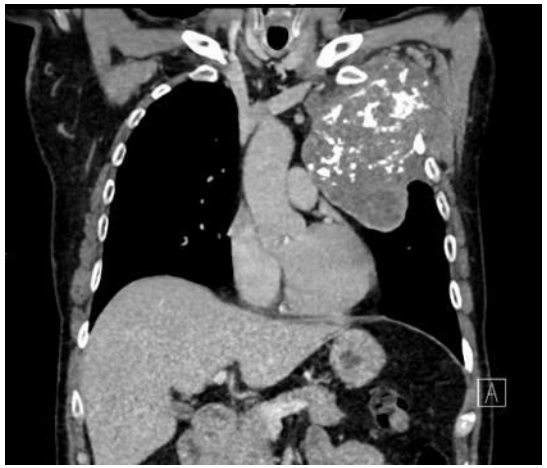
_____
(Write "NONE" if there are no restrictions)

Signed_____(relative)

Specimen Needed

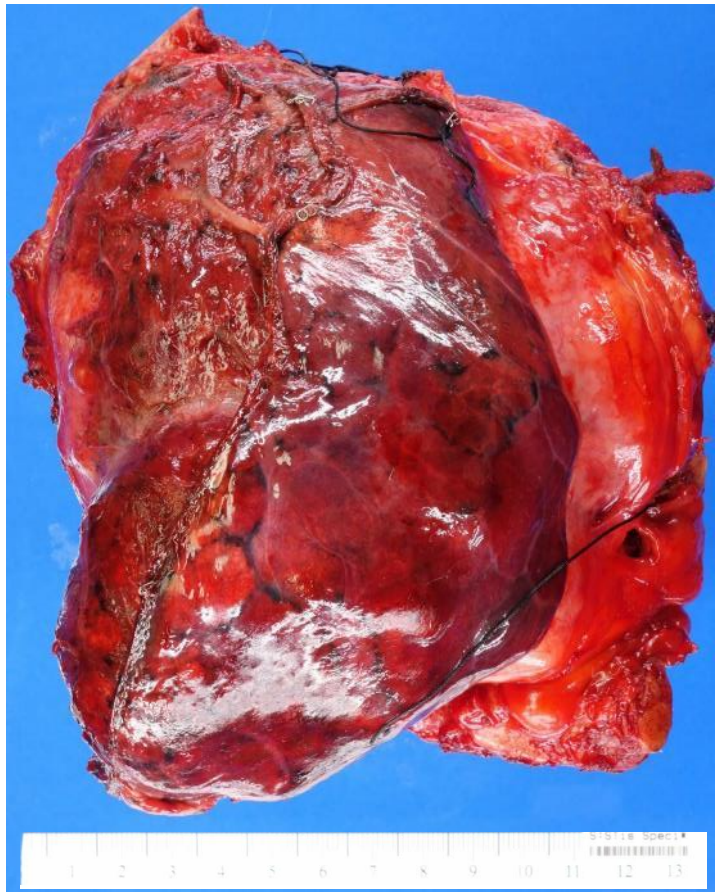
Chondrosarcoma

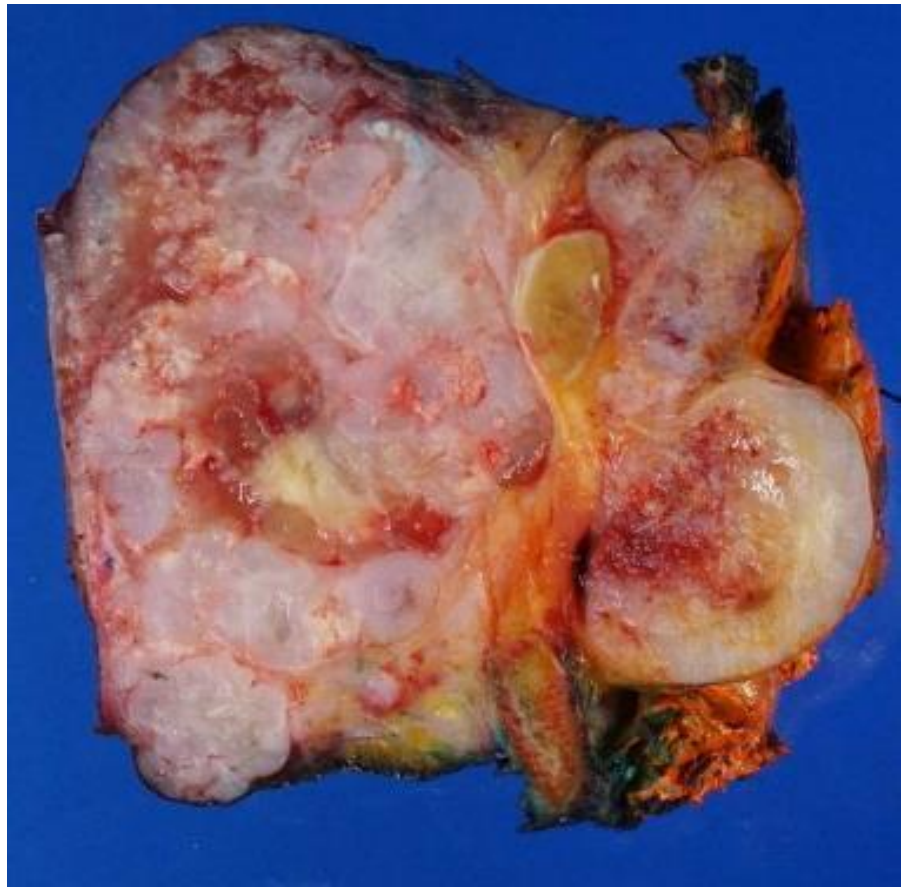




Case and Specimen Now Available for Teaching in 2023 Block 4 Course

Left Rib / Chest Wall Mass





Felicia Davis, M.D.

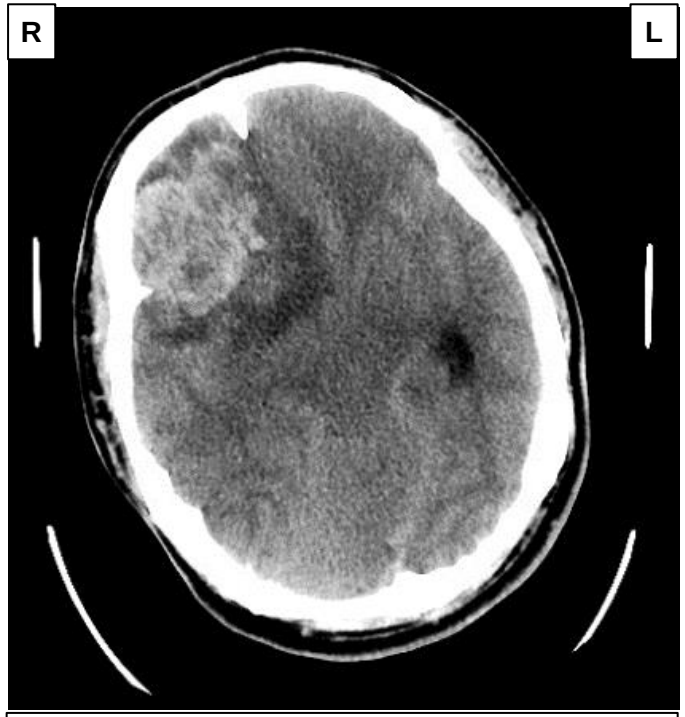
Supplementation

Photographs of Specimens For Which Sectioning Makes Specimen Itself Not Usable

Germ Cell Neoplasm: Choriocarcinoma

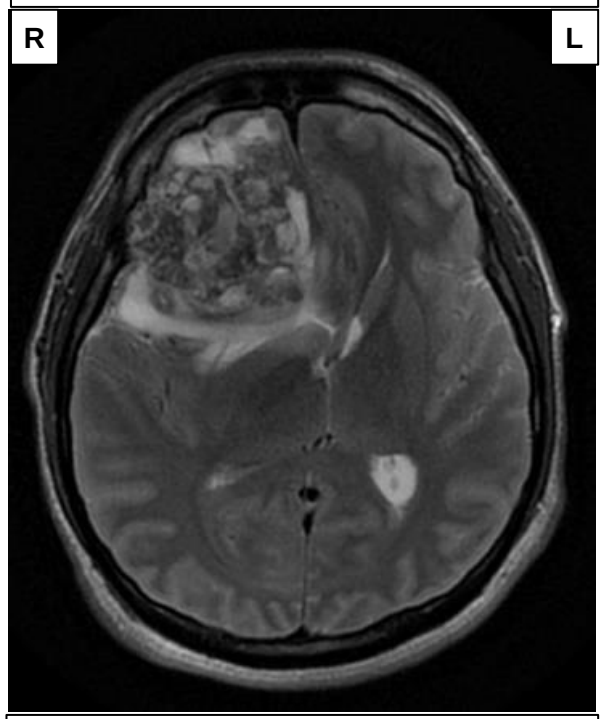
18-Year-Old Presenting with Headaches / Hemorrhagic Right Frontal Mass

CT Scan: Axial



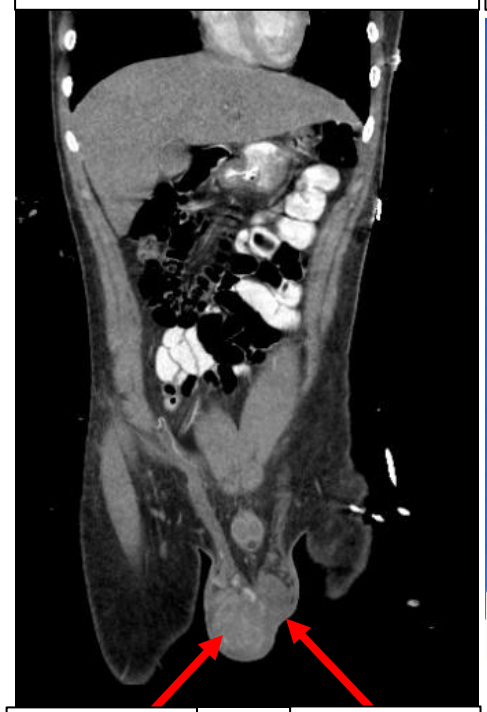
Right Frontal Hemorrhage

MRI Scan: Axial – T2



Right Frontal Hemorrhagic Mass

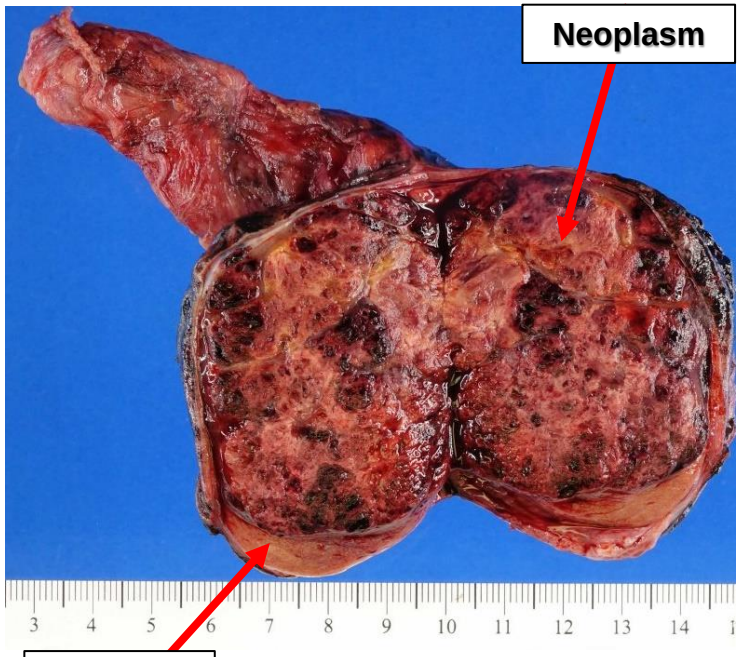
CT Scan: Coronal



Right Testis

Left Testis

Right Radical Orchiectomy



Use of Macroscopic / "Gross" Specimens

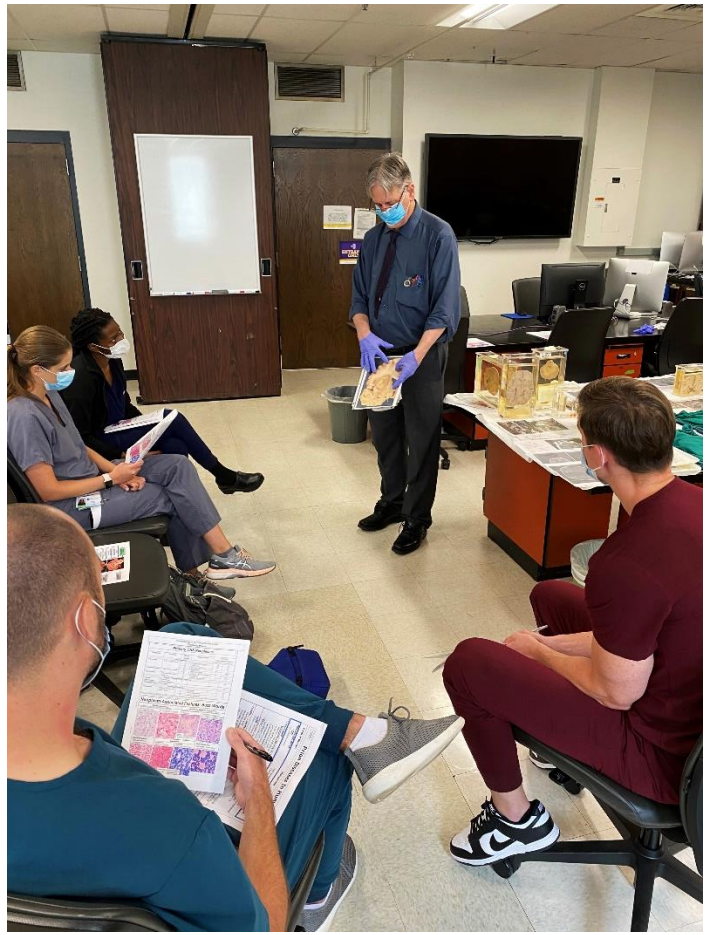
- **M1 & M2 Students**
  - Pathology Laboratory Sessions
- **M4 Students**
  - Neurology / PM&R Clerkship
- **Special Sessions**
  - Second Look
  - Brody Ambassadors Health Sciences Academy
  - SNMA Pre-Medical Conference
  - Brody Rise

Multipurpose Teaching Materials: Positioned for Various Settings

Use of Macroscopic / “Gross” Specimens

M4 Neurology / Physical Medicine & Rehabilitation Clerkship:

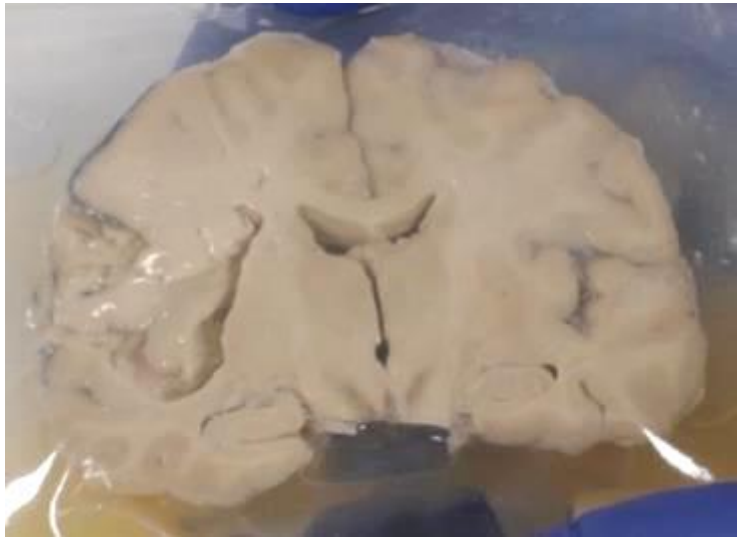
Neuropathology PM Sessions X2



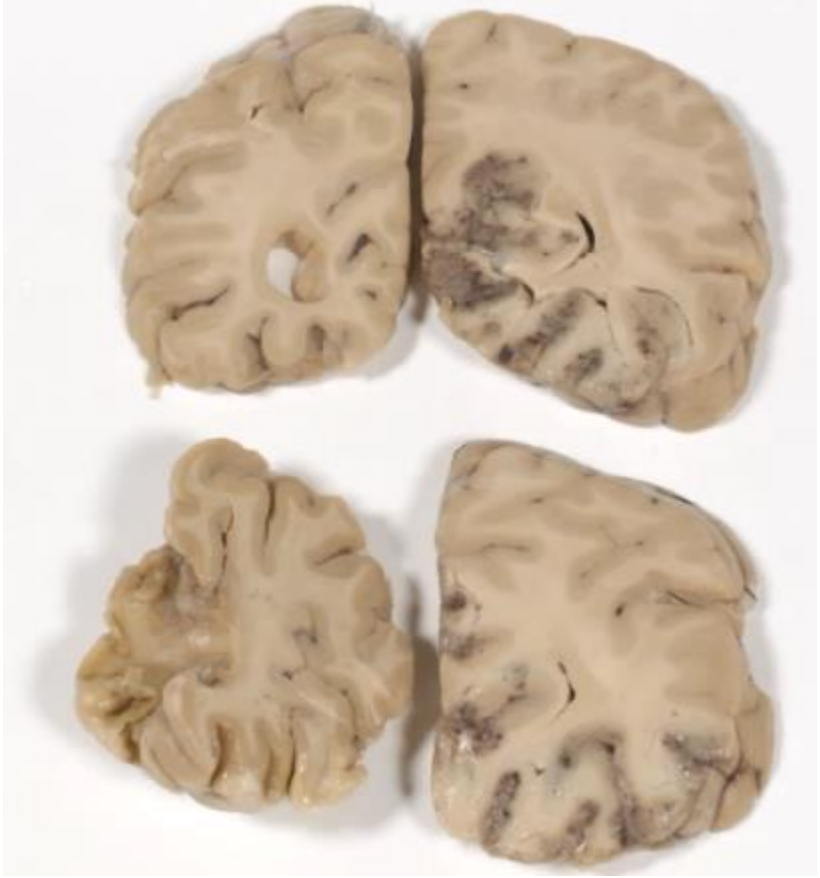
Vascular Disease

Infarct: Focal / Embolic

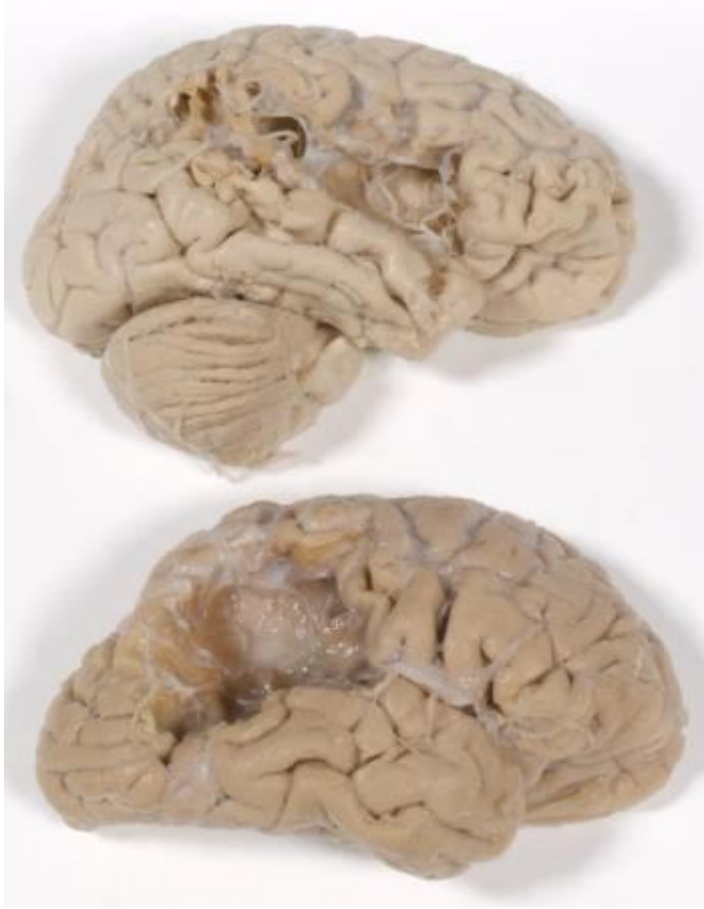
MCA Distribution:
Acute: Pale



PCA Distribution:
Acute vs. Chronic / Hemorrhagic

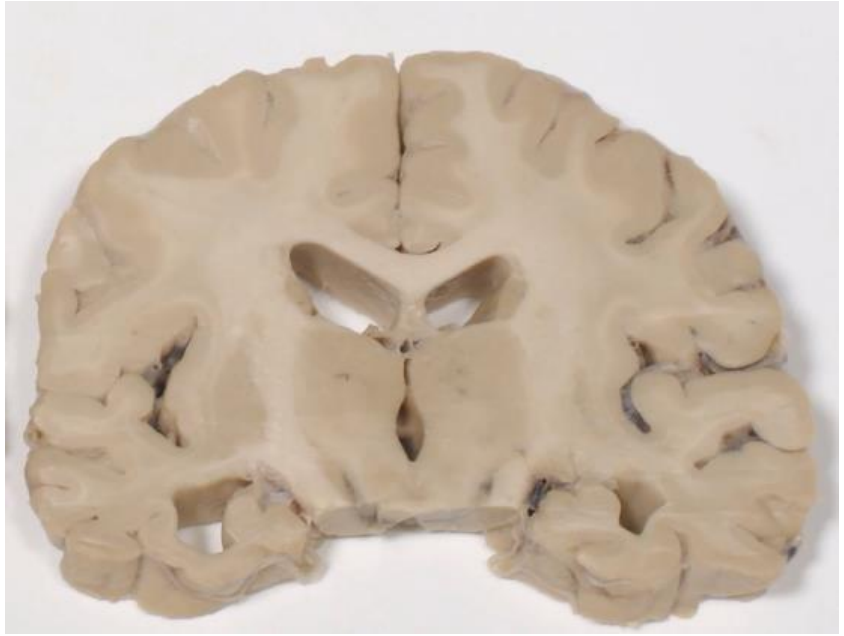


MCA:
Chronic

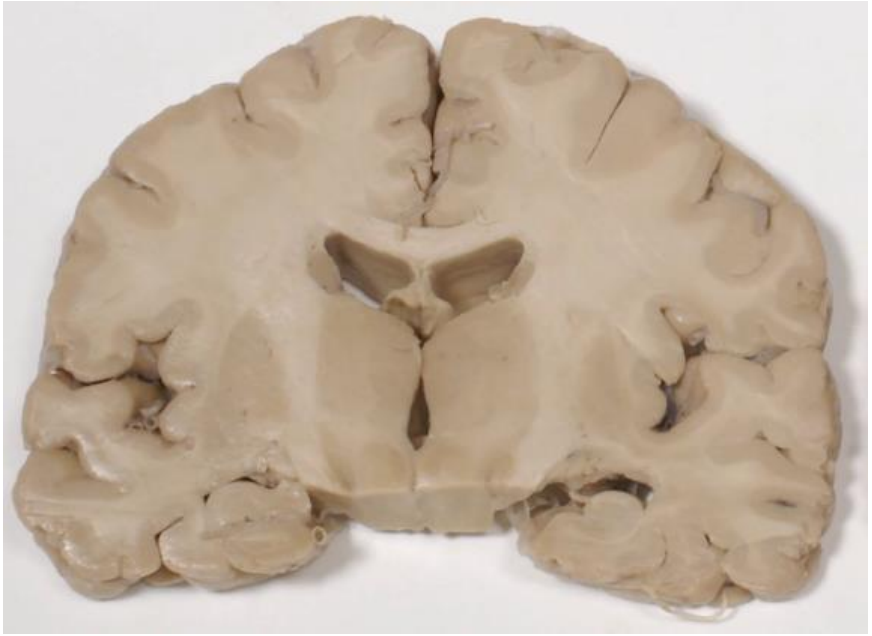


Degenerative Disease

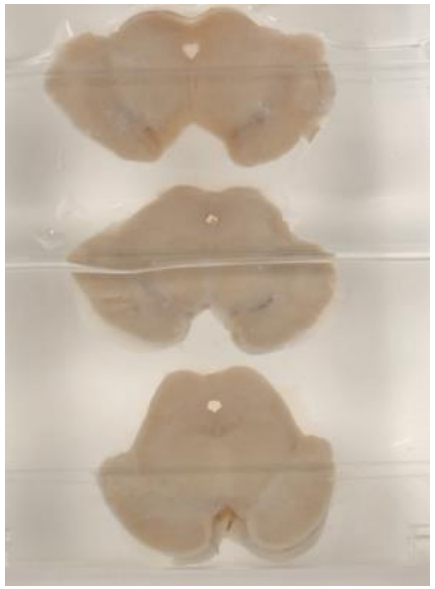
Dementia: Alzheimer Disease



Dementia: Lewy Body Dementia



Movement Disorder: Parkinson Disease



Survey

- Survey responses from **72 of 78 students** (92.3%) were obtained.
- Likert scale (1-5): Scores of 4 (agree) and 5 (strongly agree) were combined:
  - **Laboratory Sessions in General**
    - Useful way to reinforce pathology concepts 83%
  - **Components of Laboratory Session** considered Useful in Reinforcing Pathology Concepts and Enhancing Education
    - Small Group Case-Based Component 68%
    - Macroscopic / Gross Organ Component 89%
  - **Session Construct for Laboratory Sessions**
    - Gross Organ Review Only Laboratory Sessions (No Small Group) Useful When Number of Organs Justifies It (e.g. Single Laboratory for Female & Male Reproductive systems and Pregnancy) 82%

Survey

Positives

General:

- The laboratory sessions are a **great way to review high-yield material** covered in lecture.
- I think it has been a **great tool to reinforce what we are learning** and to **repeatedly hit on high yield concepts** in preparation for quizzes and examinations.
- I think the laboratory sessions are very useful and allow students to have an in-person experience of **seeing real organs and how certain pathologies manifest**.
- It was great to be able to **see in person what we were learning about**.
- I think we **need to see these organs at some point to make us well-rounded physicians**, so we need to do it.
- **Hearing Dr. Boyer talk things out, and pimping us** on useful information has been **incredibly helpful** and I appreciate all of the time and effort that you put into each session.
- **Love seeing the macroscopic effects of microscopic processes**, really **helps solidify the pathology for me**.

Small Group vs. Gross Organs Only:

- I **like** the powerpoint portion of the **group sessions** to **talk over answers with colleagues**.
- I **enjoy the large group sessions** because it **gives Dr. Boyer more time to review more organs**.

Survey

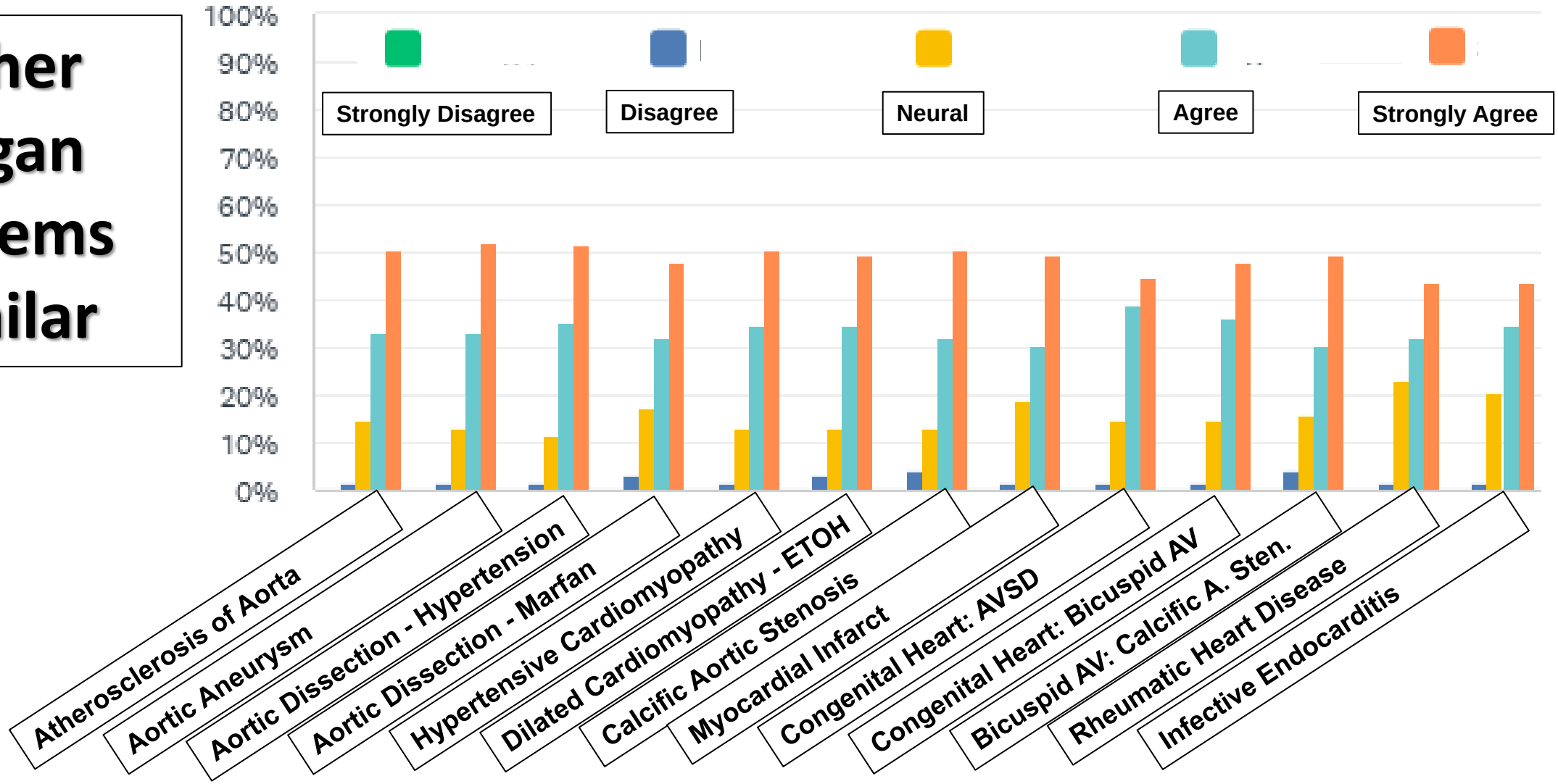
Areas for Improvement

- The **two smaller lab groups sometimes feels rushed**, either going over the time allotted or having to skip the organs. I felt like I **could see the organs just as well during the large group** and we had **more time to talk about disease processes/organ examples**.
- These **sessions can run long**, and **cover too many topics**, decreasing the usefulness. Potentially **making more sessions with fewer topics to cover in each would be helpful**.
- It is **oftentimes difficult to see exactly what we are looking at** when it comes to looking at the gross organ specimens. I think it would be more beneficial to have the gross organ specimen laboratory session structured the **same way as they are when we have Psychiatry Standardized Patient sessions**: have **one group for 50 minutes at 10:00 A.M**. and **another group for 50 minutes at 11:00 A.M.** to have a **smaller concentrated group** for more useful and thorough time to be spent reviewing concepts and really paying attention to what we are looking at
- I think the **two small sessions are nice** but the **time alotted doesn't seem to be quite enough** to get through everything. so maybe a little more time allotted so we know ahead of time how long to expect to be there while you the professor are also not feeling too rushed
- The sessions **should not be mandatory for those who do not learn well with this method**.

Survey

Specific Disease Processes by Organ System: Cardiovascular

Other Organ Systems Similar



Literature Review

- There is very limited peer-reviewed literature regarding medical student pathology laboratory.
- Case-based presentations are well-received by students.
- Clinical laboratory data (hematocrit, blood urea nitrogen and creatinine concentration, calcium concentration, etc.) can and should be incorporated into pathology laboratory sessions.
- There is no description in the literature of:
  - Gross specimen acquisition opportunities
  - Specific specimens and disease processes that should be incorporated into and illustrated in pathology laboratory sessions

Conclusions

- Students consider pathology laboratory sessions to be a **valuable component** of the pathology course and the M1-M2 curriculum:
  - **Reinforcing concepts** discussed in lecture.
  - **Allowing examination of disease processes in human specimens**.
- Both **small group** and **macroscopic review of organs** are considered to enhance student understanding of pathology content.
- **Macroscopic review and discussion of organs** demonstrating pathology is considered the **most valuable** element of the sessions.
- **Small group case-based discussions** are also considered to be **excellent learning opportunities** by most students
  - They provide the **opportunity to evaluate cases** and **discuss pathologic processes with peers**.

Conclusions

- **Time limitations** and **group size impose limitations** on macroscopic review of organs.
  - Sessions when **class is split between pathology and psychiatry** sessions **overcome limitations**.
- This study will be a **valuable contribution to the literature** by describing:
  - Acquisition, storage, and display of gross specimens
  - Specific disease processes that can be illustrated by gross specimens

References

1. Bhusnurmath SR, Bhusnurmath BS, Goyal SB. Helping medical students to learn pathology more effectively. Indian J Pathol Microbiol. 2021 Oct-Dec;64(4):746-751. doi: 10.4103/IJPM.IJPM_790_20. PMID: 34673596.
2. Bryant RJ, Wilcox R, Zhang B. Engage in Exploration: Pathology Gross Laboratory in the COVID-Era. Acad Pathol. 2021 Mar 25;8:23742895211002843. doi: 10.1177/23742895211002843. PMID: 34192134; PMCID: PMC7994920.
3. Burton JL. Teaching pathology to medical undergraduates. Current Diagnostic Pathology. 2005 11(5):308-316.
4. Diaz-Perez JA, Raju S, Echeverri JH. Evaluation of a teaching strategy based on integration of clinical subjects, virtual autopsy, pathology museum, and digital microscopy for medical students. J Pathol Inform. 2014 Jul 30;5(1):25. doi: 10.4103/2153-3539.137729. PMID: 25191624; PMCID: PMC4141419.
5. Koch LK, Chang OH, Dintzis SM. Medical Education in Pathology: General Concepts and Strategies for Implementation. Arch Pathol Lab Med. 2021 Sep 1;145(9):1081-1088. doi: 10.5858/arpa.2020-0463-RA. PMID: 34086852.
6. Lee BC, Hsieh ST, Chang YL, Tseng FY, Lin YJ, Chen YL, Wang SH, Chang YF, Ho YL, Ni YH, Chang SC. A Web-Based Virtual Microscopy Platform for Improving Academic Performance in Histology and Pathology Laboratory Courses: A Pilot Study. Anat Sci Educ. 2020 Nov;13(6):743-758. doi: 10.1002/ase.1940. Epub 2020 Jan 27. PMID: 31883209.
7. Marchevsky AM, Relan A, Baillie S. Self-instructional "virtual pathology" laboratories using web-based technology enhance medical school teaching of pathology. Hum Pathol. 2003 May;34(5):423-9. doi: 10.1016/s0046-8177(03)00089-3. PMID: 12792914.
8. Molinaro RJ, Winkler AM, Kraft CS, Fantz CR, Stowell SR, Ritchie JC, Koch DD, Heron S, Liebzeit J, Santen SA, Guarner J. Teaching laboratory medicine to medical students: implementation and evaluation. Arch Pathol Lab Med. 2012 Nov;136(11):1423-9. doi: 10.5858/arpa.2011-0537-EP. PMID: 23106588; PMCID: PMC3767850.

Acknowledgements

- **Department of Pathology**
  - **Jared Ratz**
  - **Karen Kelly, M.D.**
  - **Gina Murray, M.D.**
  - **Philip Boyer, M.D., Ph.D.**

Previous Faculty Members:

- **Paul Strausbach, M.D., Ph.D., Retired Pathology Course Director**
- **Other Pathology Specimen Horders**

Questions?