



THE UNIVERSITY OF GEORGIA

College of Veterinary Medicine

# Elephant Postmortem Examination

Practical Application  
of General Principles

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# Compilation of Experiences “Lessons Learned”

academic, zoo, field situations  
clinician/pathologist perspective

# Elephant Necropsy Procedure

<http://www.nature-documentaries.com/wildlife-documentaries1/352-inside-natures-giants.html>

# Essential References

(\*equipment, techniques, tissues)

- ▶ **\* Montali RJ: *Chapter 14: Postmortem Diagnostics*. Fowler & Mikota (eds): Elephant Biology, Medicine, and Surgery. Blackwell Publishing, 2006. Pp. 199–209.**
- ▶ **Guidelines for Control of Tuberculosis in Elephants, USDA (current)**
- ▶ **\* Elephant SSP Necropsy Protocol (current)**
- ▶ **Elephant SSP EEHV Protocol (current)**

Why perform  
a postmortem examination ?

***“The purpose of a necropsy  
is to answer questions.”***

Barry G. Harmon, DVM, PhD, DACVP

# What are the questions ?

- ▶ *“There are known knowns.*  
These are things we know that we know.
- ▶ *There are known unknowns.*  
There are things that we know we don't know.
- ▶ *But there are also unknown unknowns.*  
There are things we don't know we don't know.”

Donald Rumsfeld

# Identify and Agree on Questions, Expectations And Plan Before Necropsy

- ▶ Establish cause of death ?
- ▶ Scientific/health benefit to elephants/humans ?
- ▶ Confirm or determine TB status ?
- ▶ Document “known” health issues ? (best way?)
- ▶ Discover “unknown” health issues ?
- ▶ Necropsy leader must know questions, make a plan with prioritized tasks
- ▶ **Establish agreement on Plan A**
- ▶ **Also agree on Plan B for “unknown” (granulomatous disease)**

# Pre-Planning

- ▶ Plan before needed
- ▶ Identify necropsy team/leader in advance (Plan A/Plan B)
- ▶ Ideal leader: pathologist/clinician with elephant necropsy experience
- ▶ Institution ? Vet School /Diagnostic Lab ?  
Field Situation ?
- ▶ Animal <-> Necropsy Team ?



# Balancing Act

## ▶ Time available

Tissue deterioration–Personnel–Equipment–Tasks

## ▶ Personnel

### ◦ Academic/non–TB case

- 10–20 people (teams) @ 5–6 hours for complete details

### ◦ Field or TB suspect/positive

- Smaller group(s) of “essential” team members

## ▶ Level of Detail

All tissues? TB only ? Joints? Feet? Neuro ?

## ▶ Equipment Choice and Power Availability

# Other Factors

- ▶ **Weather:** Cold, Heat, Rain, Snow, Wind
- ▶ **Exposure/Spread of Potential Pathogens:**  
TB but also *Salmonella* sp. ? Others ?
- ▶ **Sensitivity:** Beloved animal, grief, psychological effect on staff, other animals; choice of procedures and equipment

# Preparation for Procedure

- ▶ Heavy equipment /personnel move animal to necropsy site (platform helpful in field)
- ▶ Back up equipment (if breakdown)
- ▶ Hoist or Equipment to manipulate at beginning/after necropsy
- ▶ Ice in bags (1 000 – 2000 #)  
on/around abdomen to counteract heat from digestive tract
- ▶ Remove ice before procedure (slippery !)

# Settle Responsibility/Authority

- ▶ Owner, Vet, Pathologist of Record
- ▶ Choice of necropsy site/burial (local regs)
- ▶ Choice/training necropsy team members
- ▶ Safety/risk hazards/PPE
- ▶ Submit tissues, distribute lab results
- ▶ Reporting to health authorities if needed
- ▶ How is client/record confidentiality handled
- ▶ Press Inquiries
- ▶ Issuing Preliminary (if any) vs Final Results

# Personal Protective Equipment (PPE)

- ▶ Tyvek gowns/hoods – sturdy, room for physical exertion, water resistant
- ▶ Gloves – double
- ▶ Aprons on dissection team members
- ▶ Respiratory Protection
- ▶ Face Protection ?

# Respiratory Protection

- ▶ “Surgical mask is not adequate” to prevent transmission of *M. tuberculosis*
- ▶ NIOSH-rated N-, R-, P-95, 99, 100 mask
- ▶ +/- face shield
- ▶ PAPR (powered air-purifying particulate respirator)

# N95 mask fit test

- proper size, correct fit
- PAPR better if facial hair



# N95 mask, gown/hood, apron, boots





# PAPRs



Half hood PAPR



Full hood with scarf



# CDC Guidelines for TB Prevention in Health Care Settings (2005)

“The facility's risk assessment may identify a limited number of selected settings (e.g., bronchoscopy performed on patients suspected of having TB or *autopsy performed on deceased persons suspected of having had active TB at the time of death*) where the *estimated risk* for transmission of *M. tuberculosis* may be such that a level of respiratory protection exceeding the standard criteria is appropriate. *In such circumstances, a level of respiratory protection exceeding the standard criteria and compatible with patient-care delivery (e.g., negative-pressure respirators that are more protective; powered air-purifying particulate respirators {PAPRs}; or positive-pressure airline, half-mask respirators) should be provided by employers to HCWs who are exposed to M. tuberculosis.* Information on these and other respirators may be found in the NIOSH Guide to Industrial Respiratory Protection (55)”

# Organizing the Procedure Institution or Field

- ▶ **Move animal to necropsy site**
- ▶ **Clean/dirty tables (material storage/tissue processing)**
- ▶ **Cold packs for fresh tissues**
- ▶ **Respiratory protection (levels) available**
- ▶ **Extra PAPRs and charged batteries**

# Organizing the Procedure Institution or Field

- ▶ Heavy equipment operator
- ▶ Dissection team (3–5)
- ▶ Tissue transfer/processing person(s) or teams
- ▶ “Helpers” :
  - Notetaker(s) – tissue collection/tissue processing
  - Photodocumenter(s)
  - Safety monitor
  - Gown assist/re-taping person(s)
  - Re-supply person(s)



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Authorized  
Personnel Only

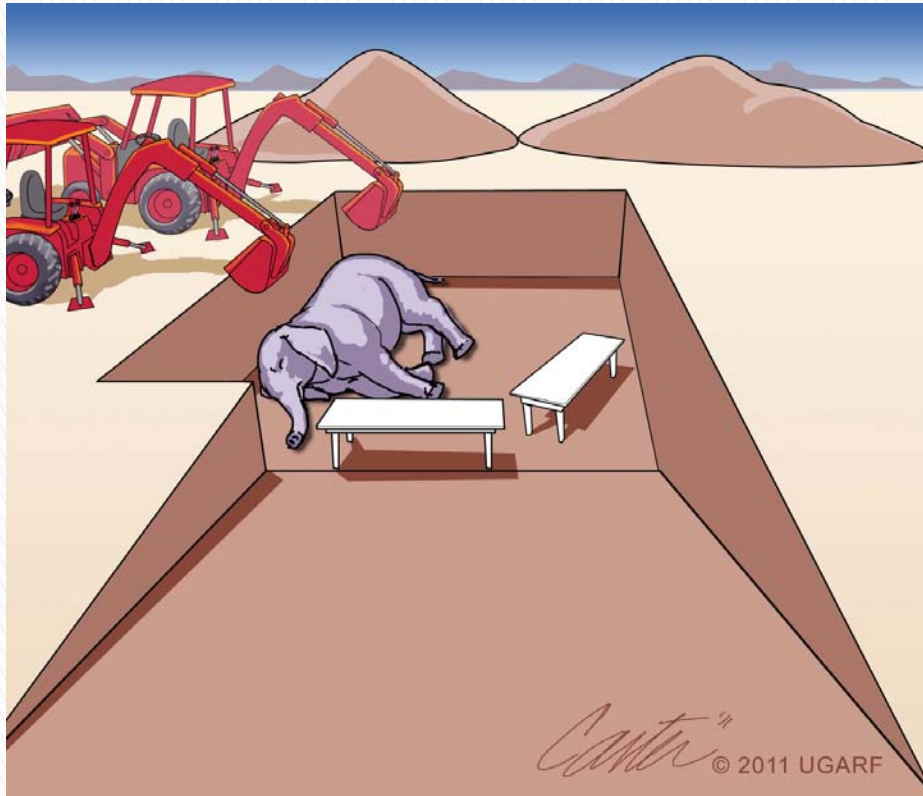
FRESH  
TISSUES  
FETUS

FRESH  
TISSUES  
ADULT

# Field Situation/Burial

- ▶ **Ideal if potential TB case**
- ▶ **Establish a perimeter – exclude other animals and non-essential personnel**
- ▶ **Power? Water? Shade? Rain/Snow shelter?**
- ▶ **Rest breaks ? Monitor for exhaustion**
- ▶ **Perform procedure, bury all non-disinfectable/reusable materials in grave**

# Gravesite overview

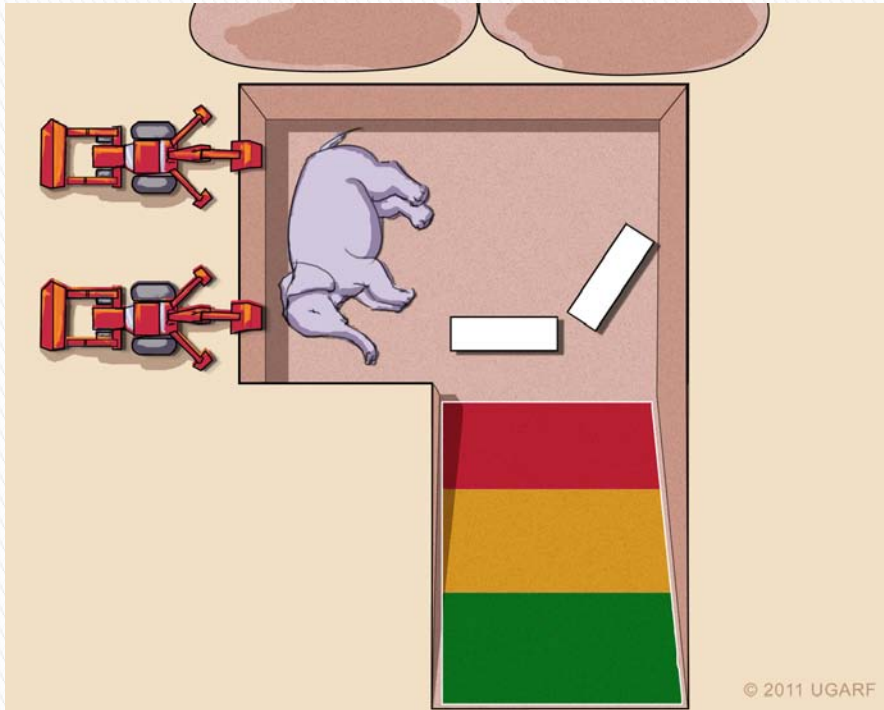


Gravesite with ramp

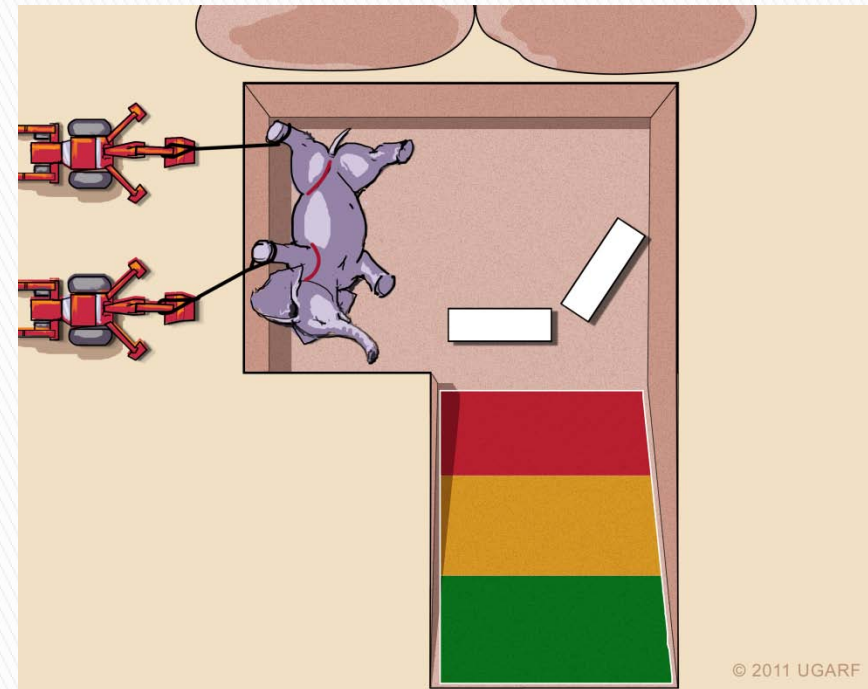
- ▶ Move on platform
- ▶ Plastic lining around site and down edges
- ▶ Tables on edge (if not TB suspect)
- ▶ Tables inside grave (if TB suspect)
- ▶ Plastic cover on tables
- ▶ Red–yellow–green zones
  - during procedure
  - at clean up
  - bury contaminated on site



# Gravesite orientation/ clean up zones



**Heavy equipment needed**



**Move animal to site  
Manipulate during/after procedure**

# Basic Approach

- ▶ **Assess risk/choose PPE for dissection team/processor/”helpers”**
- ▶ **General exam, dissection, abdominal tissue exam/collection**
- ▶ **Distance/dismiss non-essential personnel until thoracic cavity entered and declared “OK” by “thoracic team” members with PAPRs**
- ▶ **Approach thoracic cavity through diaphragm (Montali protocol for TB suspect)**
- ▶ **Or disarticulate ribs manually (BBC video) ?**

# Modifications:

## Granulomas found during necropsy/ TB suspect/TB positive

- ▶ Distance/dismiss non-essential personnel
- ▶ PAPRs for dissection team + processor(s)
- ▶ N95s +/- face shields for “helpers”
- ▶ Tissue collection inside grave (tables)
- ▶ Re-prioritize tissue collection/reduce time of exposure
- ▶ May divide cranial/caudal teams for speed
- ▶ Avoid power tools


# TB or Not TB ? That is the question “Careful Examination of Respiratory System”

- ▶ We do not use acid fast staining at site (time, technique, few bacilli in *Mtb*)
- ▶ Trunk -> pharynx -> trachea -> lungs + lymph nodes
- ▶ Normal elephant LNs inapparent
- ▶ Tonsillar regions, submandibular, tracheobronchial, regional tracheal and thoracic LN priority
- ▶ All LN (mesenteric, perirenal, reproductive) if evidence of advanced pulmonary TB

# “Careful Examination of Respiratory System”

- ▶ Palpate lobes of both lungs thoroughly
- ▶ Sample all areas
- ▶ Subdivide tissues : Formalin and Fresh
- ▶ NUMEROUS (5 or more) sections of suspicious lesions
- ▶ Take and label matching samples  
(Granuloma #1 A, 1 B, etc) for histo–culture–PCR
- ▶ Submit lung and LN samples for culture if ruling out mycobacterial infection even if no lesions are evident


# Tissue Check Lists – laminate/use dry erase pens



### Elephant Tissue Check List

Name: \_\_\_\_\_ Date: \_\_\_\_\_ FEMALE

Asian Elephant  African Elephant



**FORMALIN** (UGA, SSP)

<p><b>SKIN and APPENDAGES</b></p> <p><input type="checkbox"/> SKIN</p> <p><input type="checkbox"/> TEMPORAL GLAND R / L</p> <p><input type="checkbox"/> EAR R / L</p> <p><b>DIGESTIVE SYSTEM</b></p> <p><input type="checkbox"/> TONGUE</p> <p><input type="checkbox"/> SALIVARY GLAND</p> <p><input type="checkbox"/> ESOPHAGUS</p> <p><input type="checkbox"/> LIVER</p> <p><input type="checkbox"/> HEPATIC BILE DUCT</p> <p><input type="checkbox"/> OMENTUM</p> <p><b>Stomach</b></p> <p><input type="checkbox"/> CARDIA</p> <p><input type="checkbox"/> PYLORUS</p> <p><input type="checkbox"/> FUNDUS</p> <p><b>Intestines</b></p> <p><input type="checkbox"/> DUODENUM</p> <p><input type="checkbox"/> JEJUNUM</p> <p><input type="checkbox"/> ILEUM</p> <p><input type="checkbox"/> CECUM</p> <p><input type="checkbox"/> COLON</p> <p><input type="checkbox"/> RECTUM</p> <p><b>URINARY SYSTEM</b></p> <p><input type="checkbox"/> URINARY BLADDER</p> <p><input type="checkbox"/> URETER</p> <p><input type="checkbox"/> KIDNEY R / L</p> <p><b>RESPIRATORY SYSTEM</b></p> <p><input type="checkbox"/> TRUNK</p> <p><input type="checkbox"/> TRACHEA</p> <p><b>Lung</b></p> <p><input type="checkbox"/> CRANIAL R / L</p> <p><input type="checkbox"/> MIDDLE R / L</p>	<p><input type="checkbox"/> CAUDAL R / L</p> <p><b>CIRCULATORY SYSTEM</b></p> <p><b>Heart</b></p> <p><input type="checkbox"/> ATRIUM R / L</p> <p><input type="checkbox"/> VENTRICLE R / L</p> <p><input type="checkbox"/> APEX</p> <p><input type="checkbox"/> SEPTUM</p> <p><input type="checkbox"/> MITRAL VALVE</p> <p><input type="checkbox"/> TRICUSPID VALVE</p> <p><input type="checkbox"/> PULMONARY SEMILUNAR VALVE</p> <p><input type="checkbox"/> AORTIC SEMILUNAR VALVE</p> <p><input type="checkbox"/> PAPILLARY MUSCLE</p> <p><input type="checkbox"/> AORTA</p> <p><b>NERVOUS SYSTEM</b></p> <p><input type="checkbox"/> SCIATIC NERVE</p> <p><input type="checkbox"/> BRAIN</p> <p><b>ENDOCRINE SYSTEM</b></p> <p><input type="checkbox"/> THYROID R / L</p> <p><input type="checkbox"/> PARATHYROID R / L</p> <p><input type="checkbox"/> ADRENAL R / L</p> <p><input type="checkbox"/> PANCREAS</p> <p><input type="checkbox"/> PITUITARY</p> <p><b>HEMATOPOIETIC SYSTEM</b></p> <p><input type="checkbox"/> TONSIL</p> <p><input type="checkbox"/> THYMUS</p> <p><input type="checkbox"/> SPLEEN</p> <p><input type="checkbox"/> BONE MARROW</p> <p><input type="checkbox"/> HEMAL NODE</p> <p><b>Lymph Nodes</b></p> <p><input type="checkbox"/> MESENTERIC</p> <p><input type="checkbox"/> SUBSCAPULAR R / L</p> <p><input type="checkbox"/> SUBMANDIBULAR R / L</p>	<p><input type="checkbox"/> _____</p> <p><input type="checkbox"/> _____</p> <p><input type="checkbox"/> _____</p> <p><input type="checkbox"/> _____</p> <p><b>SKELETAL MUSCLE</b></p> <p><input type="checkbox"/> DIAPHRAGM</p> <p><input type="checkbox"/> MM HINDLIMB R / L</p> <p><input type="checkbox"/> MM FORELIMB R / L</p> <p><input type="checkbox"/> _____</p> <p><input type="checkbox"/> _____</p> <p><b>REPRODUCTIVE TRACT</b> <small>DR. MUNKSON</small></p> <p><input type="checkbox"/> MAMMARY R / L <input type="checkbox"/></p> <p><input type="checkbox"/> GLAND</p> <p><input type="checkbox"/> OVARY R / L <input type="checkbox"/></p> <p><input type="checkbox"/> UTERUS <input type="checkbox"/></p> <p><input type="checkbox"/> CERVIX <input type="checkbox"/></p> <p><input type="checkbox"/> VAGINA <input type="checkbox"/></p> <p><input type="checkbox"/> VESTIBULUM <input type="checkbox"/></p> <p><b>OTHER TISSUES</b></p> <p><input type="checkbox"/> EYE R / L</p> <p><input type="checkbox"/> BONE _____</p> <p><input type="checkbox"/> _____</p> <p><input type="checkbox"/> _____</p> <p><input type="checkbox"/> _____</p> <p><input type="checkbox"/> _____</p> <p><input type="checkbox"/> _____</p> <p><input type="checkbox"/> _____</p> <p><input type="checkbox"/> _____</p> <p><input type="checkbox"/> _____</p>
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### Elephant Tissue Check List

Name: \_\_\_\_\_ Date: \_\_\_\_\_ FEMALE

Asian Elephant  African Elephant



**FRESH TISSUES** (UGA, SSP)

<p><b>SKIN and APPENDAGES</b></p> <p><input type="checkbox"/> SKIN</p> <p><input type="checkbox"/> TEMPORAL GLAND R / L</p> <p><input type="checkbox"/> EAR R / L</p> <p><b>DIGESTIVE SYSTEM</b></p> <p><input type="checkbox"/> TONGUE</p> <p><input type="checkbox"/> SALIVARY GLAND</p> <p><input type="checkbox"/> ESOPHAGUS</p> <p><input type="checkbox"/> LIVER</p> <p><input type="checkbox"/> HEPATIC BILE DUCT</p> <p><input type="checkbox"/> OMENTUM</p> <p><b>Stomach</b></p> <p><input type="checkbox"/> CARDIA</p> <p><input type="checkbox"/> PYLORUS</p> <p><input type="checkbox"/> FUNDUS</p> <p><b>Intestines</b></p> <p><input type="checkbox"/> DUODENUM</p> <p><input type="checkbox"/> JEJUNUM</p> <p><input type="checkbox"/> ILEUM</p> <p><input type="checkbox"/> CECUM</p> <p><input type="checkbox"/> COLON</p> <p><input type="checkbox"/> RECTUM</p> <p><b>URINARY SYSTEM</b></p> <p><input type="checkbox"/> URINARY BLADDER</p> <p><input type="checkbox"/> URETER</p> <p><input type="checkbox"/> KIDNEY R / L</p> <p><b>RESPIRATORY SYSTEM</b></p> <p><input type="checkbox"/> TRUNK</p> <p><input type="checkbox"/> TRACHEA</p> <p><b>LUNG</b></p> <p><input type="checkbox"/> CRANIAL R / L</p> <p><input type="checkbox"/> MIDDLE R / L</p>	<p><input type="checkbox"/> CAUDAL R / L</p> <p><b>CIRCULATORY SYSTEM</b></p> <p><b>HEART</b></p> <p><input type="checkbox"/> ATRIUM R / L</p> <p><input type="checkbox"/> VENTRICLE R / L</p> <p><input type="checkbox"/> APEX</p> <p><input type="checkbox"/> SEPTUM</p> <p><input type="checkbox"/> MITRAL VALVE</p> <p><input type="checkbox"/> TRICUSPIDE VALVE</p> <p><input type="checkbox"/> PULMONAR SEMILUNAR VALVE</p> <p><input type="checkbox"/> AORTIC SEMILUNAR VALVE</p> <p><input type="checkbox"/> PAPILLARY MUSCLE</p> <p><input type="checkbox"/> AORTA</p> <p><b>NERVOUS SYSTEM</b></p> <p><input type="checkbox"/> SCIATIC NERVE</p> <p><input type="checkbox"/> BRAIN</p> <p><b>ENDOCRINE SYSTEM</b></p> <p><input type="checkbox"/> THYROID R / L</p> <p><input type="checkbox"/> PARATHYROID R / L</p> <p><input type="checkbox"/> ADRENAL R / L</p> <p><input type="checkbox"/> PANCREAS</p> <p><input type="checkbox"/> PITUITARY</p> <p><b>HEMATOPOIETIC SYSTEM</b></p> <p><input type="checkbox"/> TONSIL</p> <p><input type="checkbox"/> THYMUS</p> <p><input type="checkbox"/> SPLEEN</p> <p><input type="checkbox"/> BONE MARROW</p> <p><input type="checkbox"/> HEMAL NODE</p> <p><b>LYMPH NODES</b></p> <p><input type="checkbox"/> MESENTERIC</p> <p><input type="checkbox"/> SUBSCAPULAR R / L</p> <p><input type="checkbox"/> SUBMANDIBULAR R / L</p>	<p><input type="checkbox"/> RETROPHARYNGEAL</p> <p><input type="checkbox"/> TRACHEOBRONCHIAL</p> <p><input type="checkbox"/> _____</p> <p><input type="checkbox"/> _____</p> <p><b>SKELETAL MUSCLE</b></p> <p><input type="checkbox"/> DIAPHRAGM</p> <p><input type="checkbox"/> MM HINDLIMB R / L</p> <p><input type="checkbox"/> MM FORELIMB R / L</p> <p><input type="checkbox"/> _____</p> <p><input type="checkbox"/> _____</p> <p><b>REPRODUCTIVE TRACT</b> <small>DR. MUNKSON</small></p> <p><input type="checkbox"/> MAMMARY R / L <input type="checkbox"/></p> <p><input type="checkbox"/> GLAND</p> <p><input type="checkbox"/> OVARY R / L <input type="checkbox"/></p> <p><input type="checkbox"/> UTERUS <input type="checkbox"/></p> <p><input type="checkbox"/> CERVIX <input type="checkbox"/></p> <p><input type="checkbox"/> VAGINA <input type="checkbox"/></p> <p><input type="checkbox"/> VESTIBULUM <input type="checkbox"/></p> <p><b>OTHER TISSUES</b></p> <p><input type="checkbox"/> EYE R / L</p> <p><input type="checkbox"/> BONE _____</p> <p><input type="checkbox"/> SERUM</p> <p><input type="checkbox"/> _____</p> <p><input type="checkbox"/> _____</p> <p><input type="checkbox"/> _____</p> <p><input type="checkbox"/> _____</p> <p><input type="checkbox"/> _____</p> <p><input type="checkbox"/> _____</p> <p><input type="checkbox"/> _____</p> <p><input type="checkbox"/> _____</p>
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Formalin Tissue List

Fresh Tissue List

# Samples from dissection team (pathologist notes) for processing

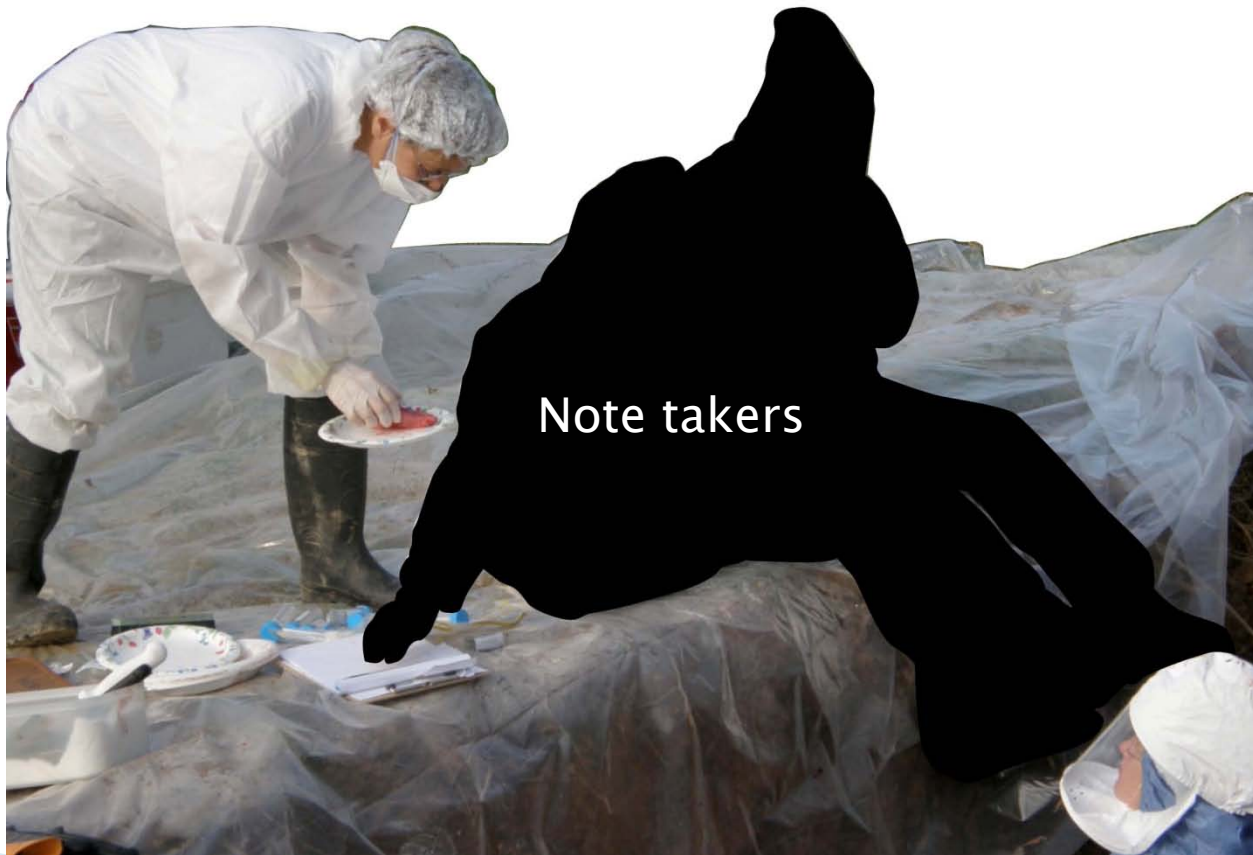


Identification



Abnormal findings,  
Directives for PCR, culture

# Passing tissue from pathologist to tissue processor





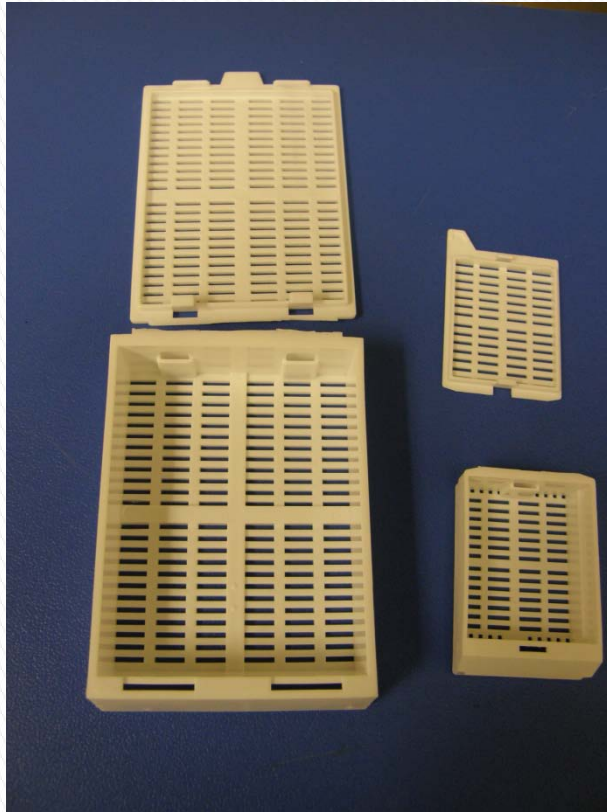
# Tissue processing: Formalin (double sets ?) Fresh ( # sets ?)



# Sample Collection

- ▶ Pieces of tissue (not swabs)
- ▶ Culture: multiple (~1–2 inch) pieces
- ▶ Tissue for formalin: ½ inch thick (maximum)
- ▶ 10 parts formalin: 1 part tissue ratio
- ▶ Collect from normal and abnormal (transition zones are best)

# Labelling tissues

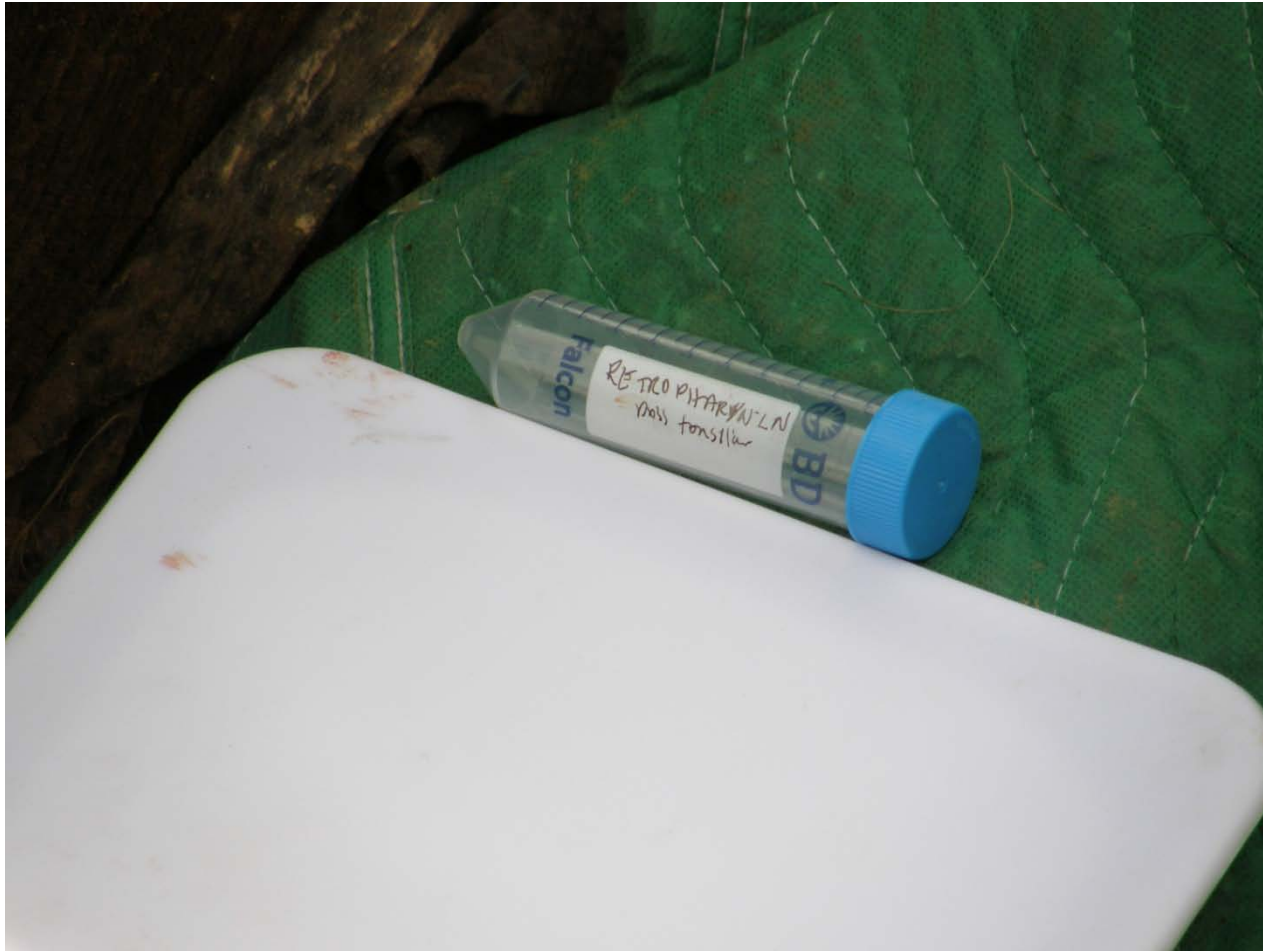


Mega Cassettes



Paper Laundry Tags

# Tubes for collection of fresh tissues



# Collection of fresh tissues

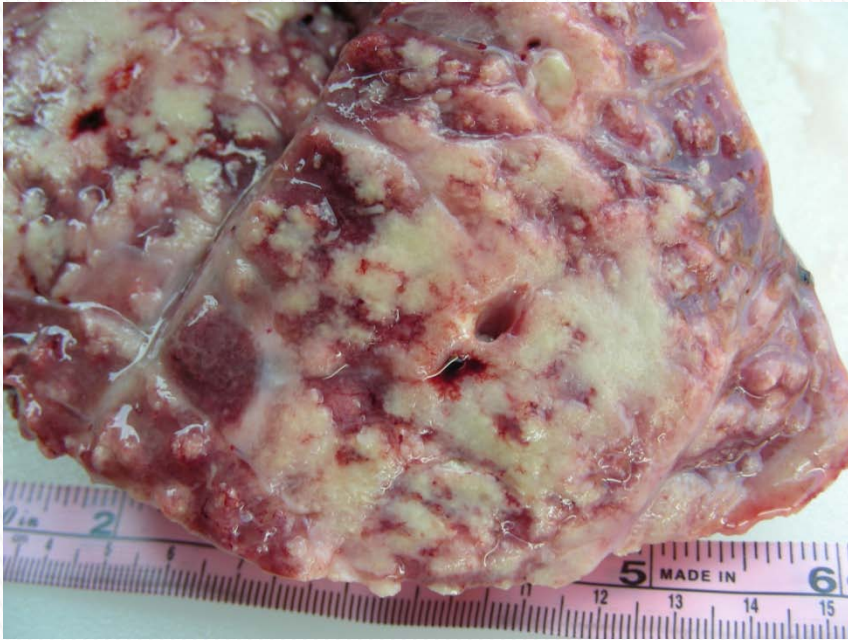


Whirl-paks

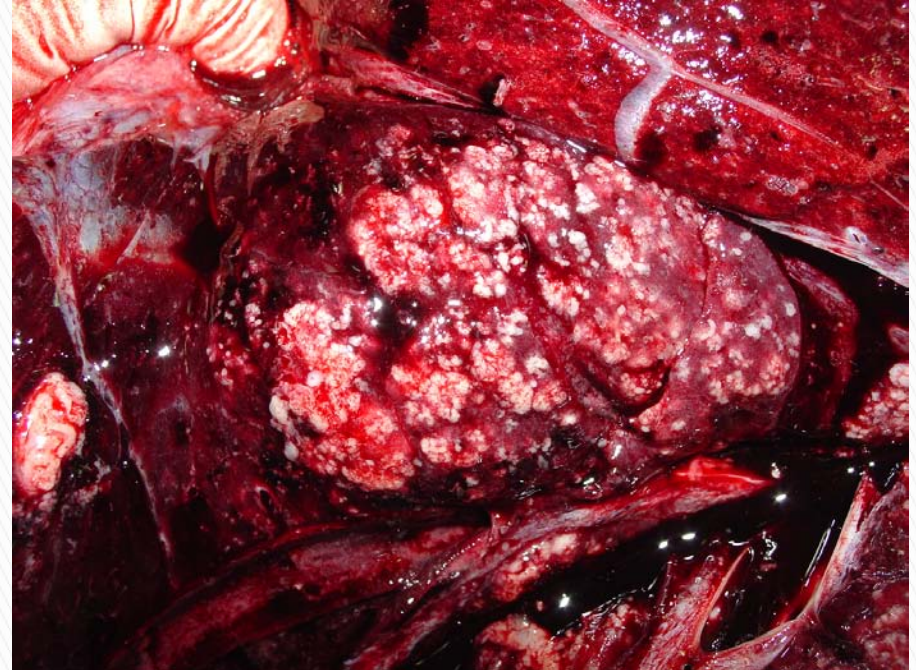


Chemical - proof pen

# Don't forget sampling for non-TB cultures, histopathology, PCR



TB



Not TB

# Clean up / Disinfection

- Tuberculocide outside containers
- Back out: Red/yellow/green zones
- Wipe/soak/contact time for removed disinfectables
- “Helpers” (masked) help degown
- Green zone: extra scrubs, boots
- Leave materials in grave
- Roll plastic *et al* into grave
- Fresh tissues – freezing/shipping
- Fresh tissues for non-TB culture ?
- Formalin tissues 7–14 days
- We cut in tissues while masked
- Process, read slides, issue report
- Storage of duplicate samples ?



# Acknowledgments

- ▶ UGA Exotic Animal Pathology Necropsy Team Members
- ▶ UGA – SAMS/Infectious Diseases Laboratory personnel
- ▶ UGA– Department of Pathology personnel
- ▶ Dr. Susan Mikota
- ▶ The Elephant Sanctuary in Tennessee
- ▶ Animals, caretakers, staff, management at client institutions
- ▶ Mr. William K. Carter, UGA–CVM Educational Resources
- ▶ Dr. Murray E. Fowler
- ▶ Dr. Linda J. Lowenstine
- ▶ Dr. Richard J. Montali



QUESTIONS ?

