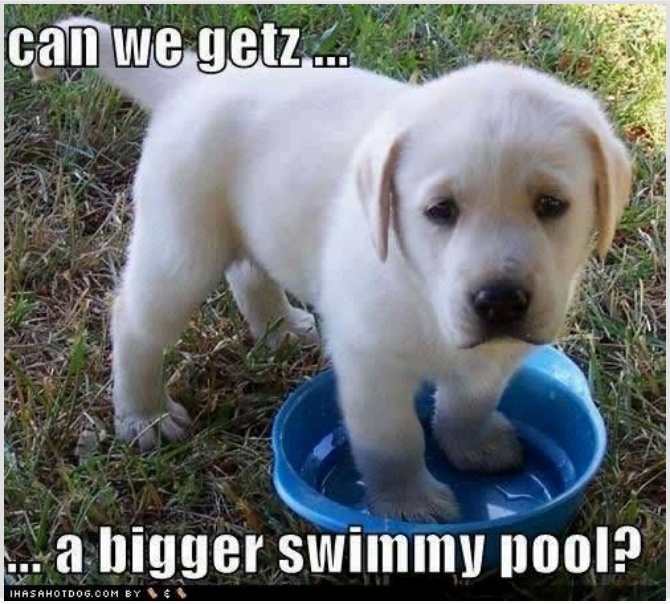


DROWNING & BURNS

JODIE GERDIN DVM DACVP AUSTRALIA 2018

DROWNING

OVERVIEW: DROWNING

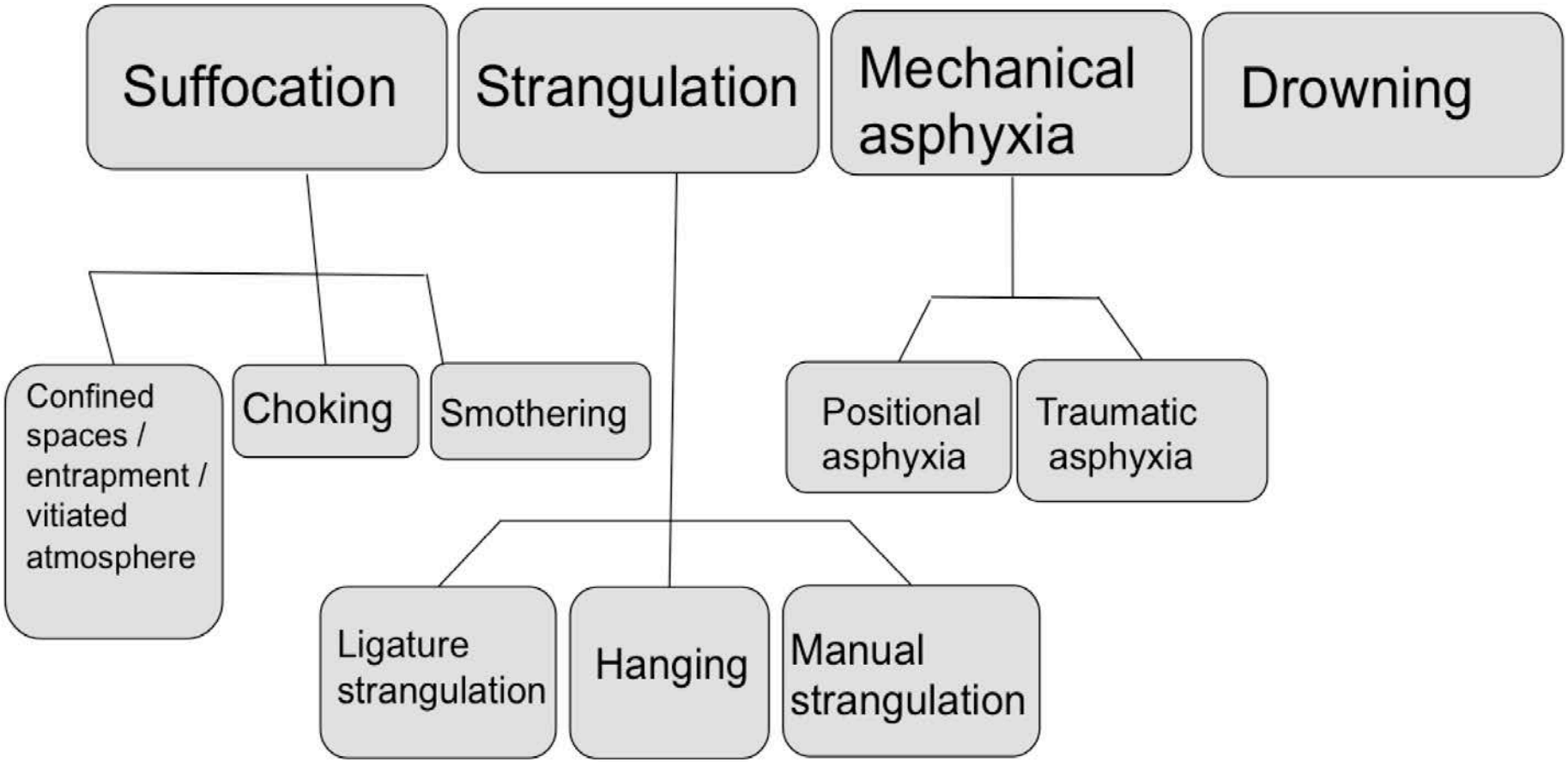
- Definitions
- Nx findings
- Histo findings

ASPHYXIA

- An umbrella term for death due to body-wide lack of oxygen (hypoxia/ anoxia)
  - **Asphyxia is a *mechanism of death***, not a COD
  - Previously terminology inconsistent, recent review/ standardization (Sauvageau 2012)
  - Asphyxia is classified into 4 broad categories:

1. **Suffocation**
2. **Strangulation**
3. **Mechanical asphyxia**
4. **Drowning**

Types of Asphyxia



DROWNING DEFINITION

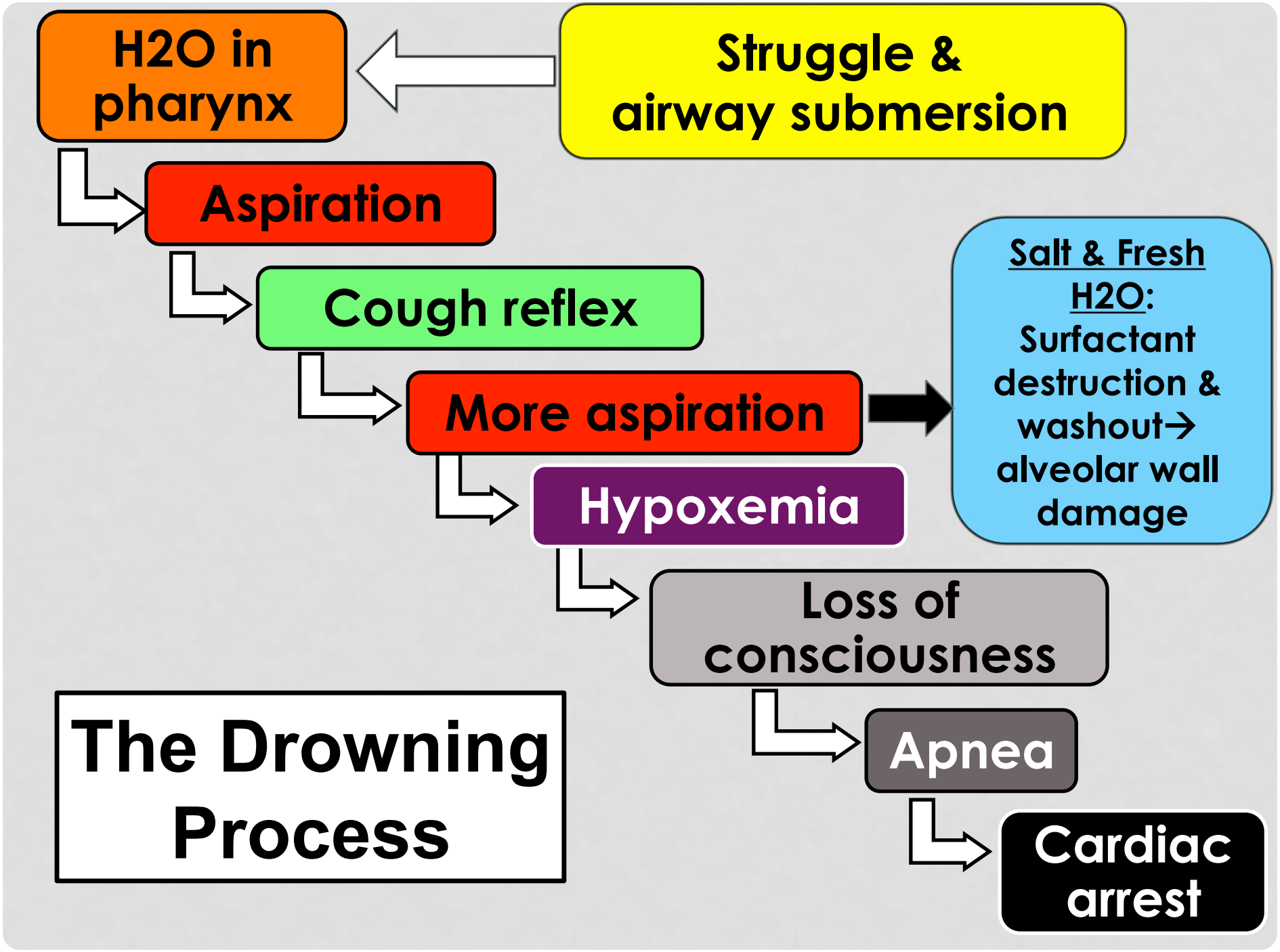
- **Fatal respiratory impairment from submersion / immersion, with the airway covered by liquid***
  - A liquid/air interface is present at the entrance of the airway, preventing breathing air
    - **Not** "filling the respiratory tract with liquid"
  - Small amounts of liquid can RARELY cause drowning
  - Drowning after any H2O-related activities
    - Playing in pools, sprinklers, lakes, streams, baths, etc.

*World Congress on Drowning 2002

DEFUNCT DEFINITIONS

- **Non-fatal drowning**
  - Water aspirated→ rescue → survives
- **Fatal drowning**
  - Water aspiration→ rescue → dies

- **No longer used:**
  - Active & Passive drowning, Dry & Wet drowning, Near-drowning, Secondary drowning
- Confusing terminology arose due to drowning victims with few/mild initial respiratory signs
  - Most signs are immediate, nearly all in 8 hrs, up to 24 hours later


H2O in pharynx
Struggle & airway submersion
Aspiration
Cough reflex
More aspiration
Salt & Fresh H2O: Surfactant destruction & washout→ alveolar wall damage
Hypoxemia
Loss of consciousness
Apnea
Cardiac arrest
The Drowning Process

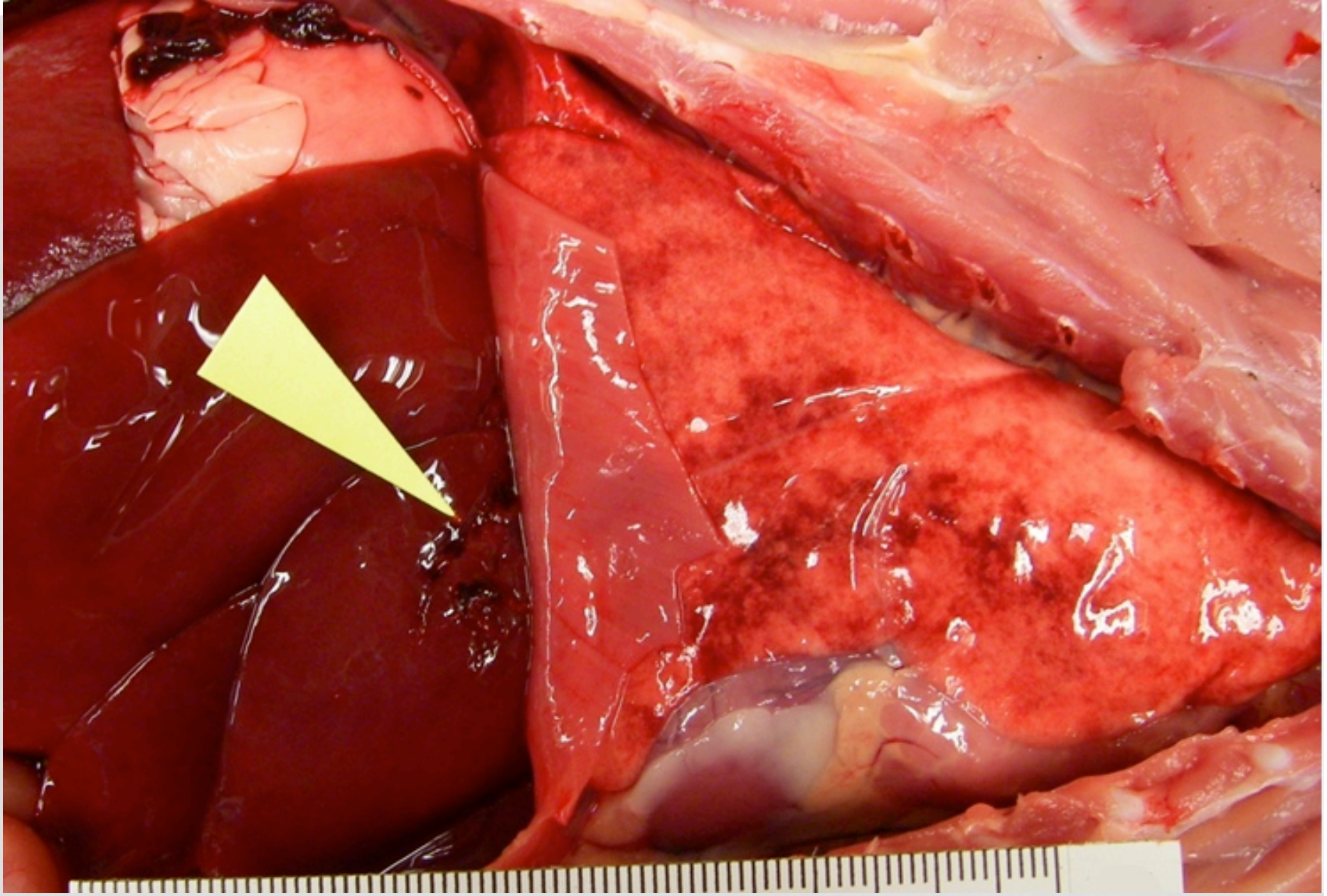
DROWNING: NX GOALS

- If Hx of exposure to liquid, consider drowning
- For bodies is found in H20, determine:
  - **Animal alive or dead at the time of submersion**
    - Not all bodies recovered from H20 drowned;
      - Often, bodies are ***disposed of*** **in water**
      - Death due to something else while in water
    - Rule in/out drowning, other CODs
  - **Contributing illness making submersion fatal**
    - Seizures, ataxia, blindness, etc.

DROWNING: NX FINDINGS

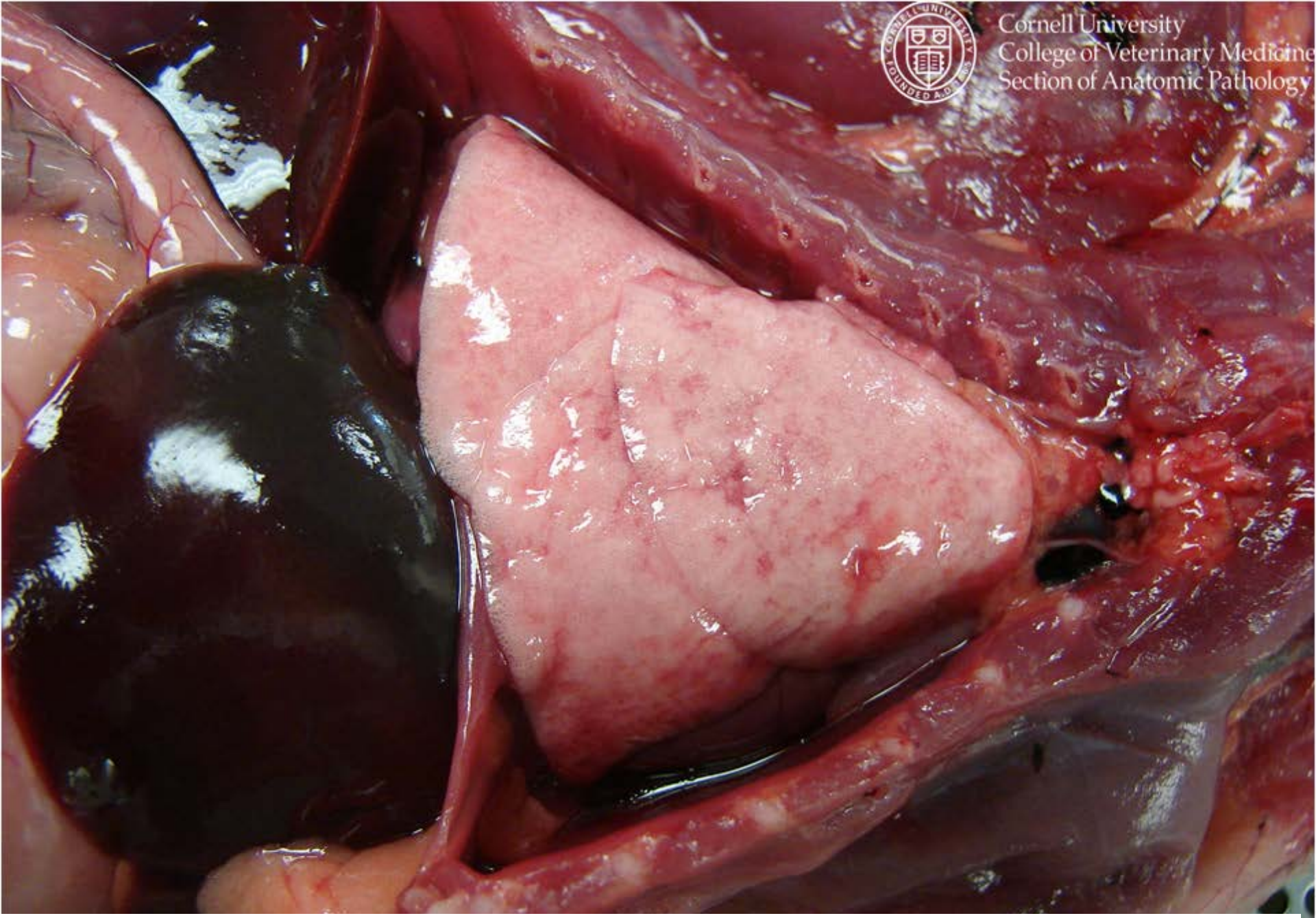
- Body wet ("spiked" haircoat)
- **Foam / froth in upper airways**
  - Mix of aspirated H2O, mucus, & surfactant
- **Emphysematous & edematous lungs**
  - Soggy (edema) and/ or crepitant (emphysema)
  - +/- Rib impressions
  - Copious fluid exudes from the cut surface
- Multifocal, **patchy, red** areas in lungs
  - Due to congestion, atelectasis, & hemorrhage
  - ***If no significant pulmonary edema*, ascribing the COD to drowning is unwise**
- Water, mud, sand, plant matter in alveoli or stomach

Drowned wallaby. Wet hair coat looks “spiked”.
(Also head trauma)

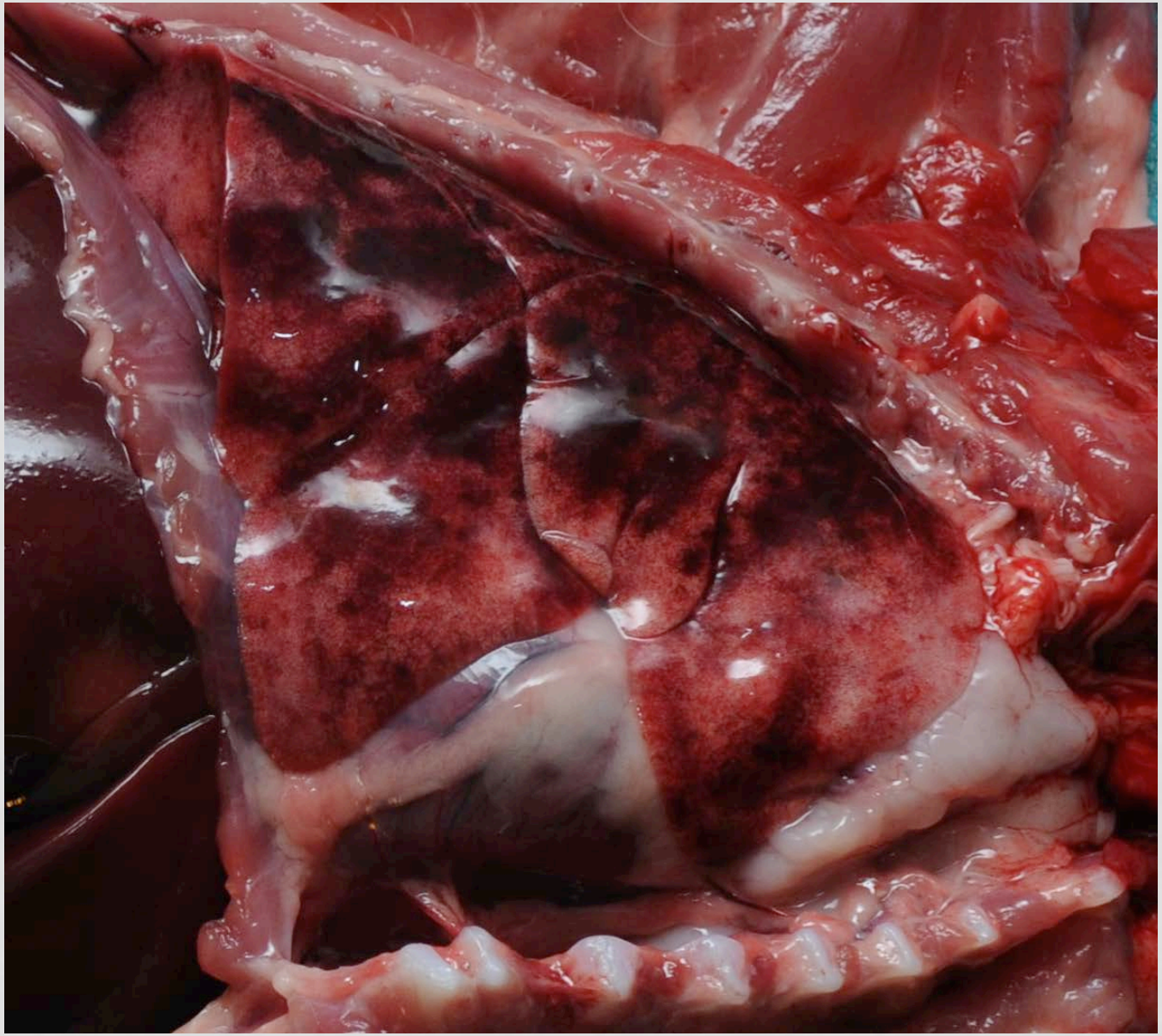


Drowned cat with liver fracture. Lungs have not collapsed, & small scattered areas of hemorrhage.

Drowned raccoon. Lungs are look “full” & failed to collapse.



Drowned squirrel. Lungs hyper-inflated, failed to collapse.

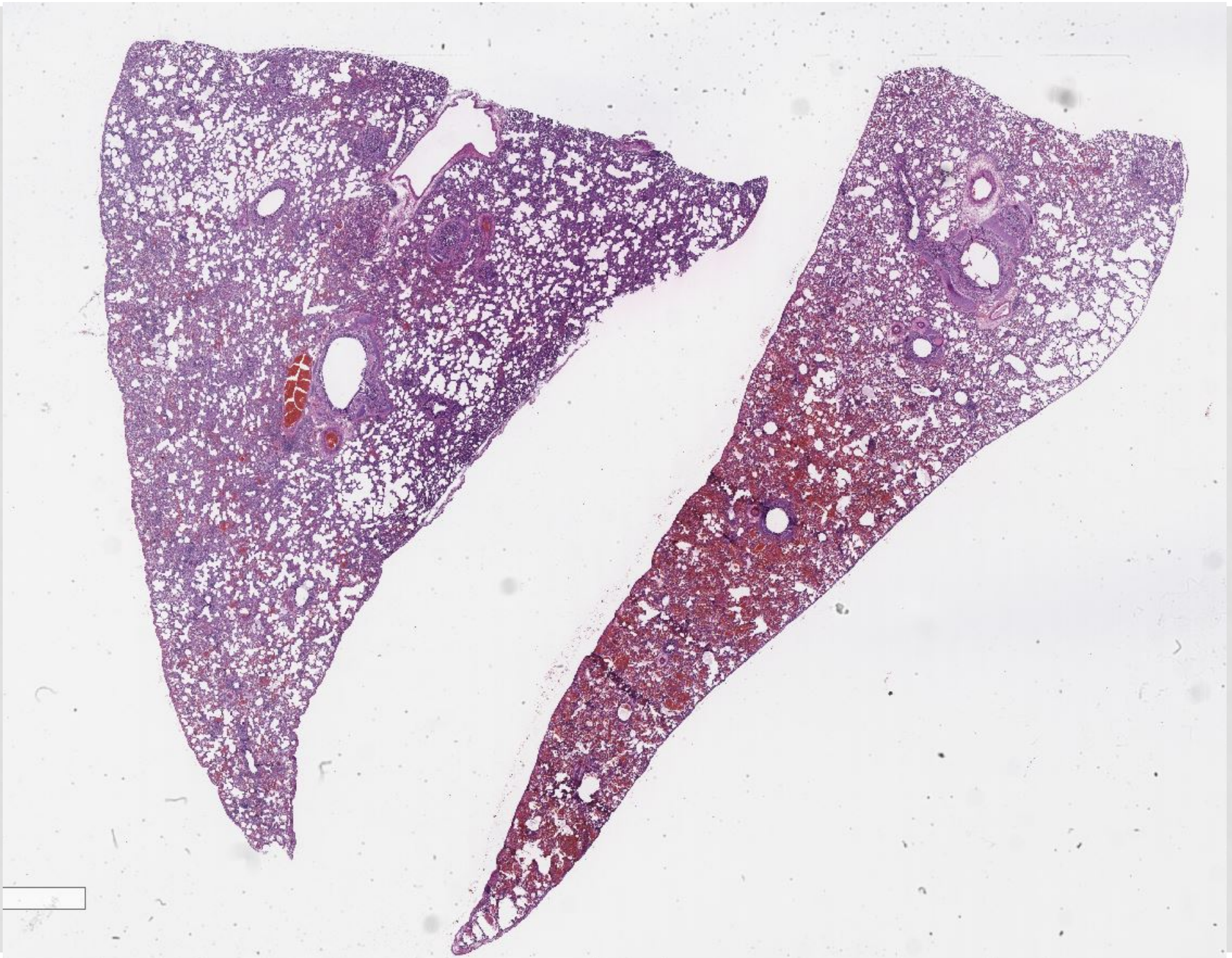


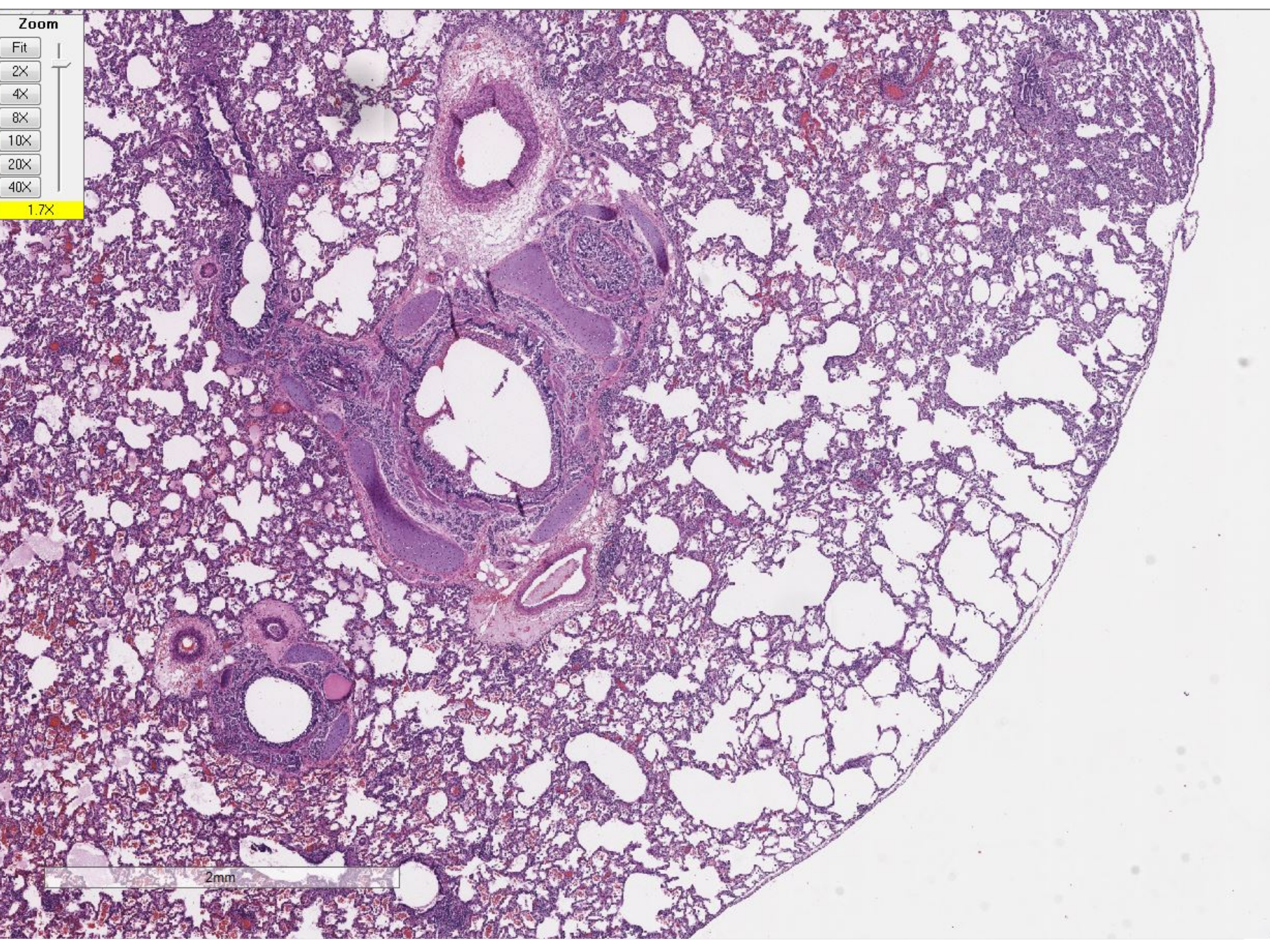
Drowned dog. Multifocal areas of congestion / hemorrhage & failure to collapse.

DROWNING: HISTOLOGY

- H2O does **not** passively seep into the **deep lung tissue** in deceased or unconscious people– ***Aspiration requires active ventilation***

- **HISTO**:
  - Alveolar edema & hemorrhage
  - Expansion / coalescing alveolar spaces with torn (blunted/ clubbed) alveolar walls
    - AKA Emphysematous change
  - Foreign material (plant, sand, etc.) in airways
    - Especially in terminal /deeper airways




Zoom
Fit
2X
4X
8X
10X
20X
40X
1.7X
2mm

Lung, drowned cat. Unidentified foreign material in bronchioles.

EXCEPTION: DIVING ANIMALS

- Lunged species that spend a significant % of time in water rarely if ever aspirate, even though drowning is certain based on circumstances (caught in nets, etc.) – **JG opinion/ communication**
  - Ex: Seals, sea turtles, otter…
- These animals may never involuntarily aspirate (gasp); larynx stays closed→ hypoxia→ death
- COD is **suffocation**

BURNS

OVERVIEW: BURNS

- Classification of burns
  - Depth
  - Cause / 6 types
- **Nx goals**
  - Assess depth & estimate the extent
- How to evaluate burned / charred remains

BURNS

- Burn = Wound due to excessive heat
- Severity depends on:
  - **Temperature**
  - **Duration** of exposure
  - Ability of the tissue to **dissipate** heat

SKIN BURN DEPTH

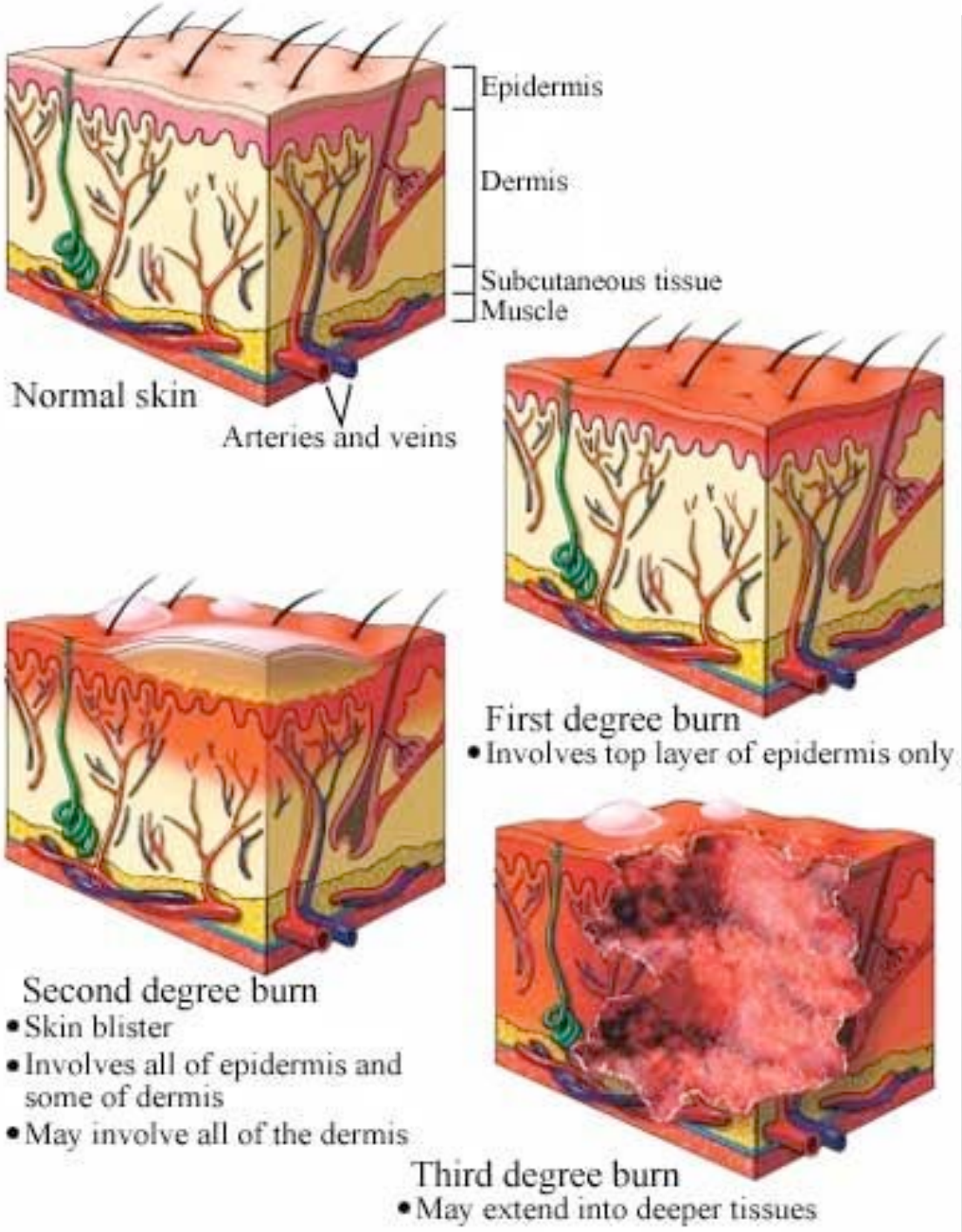
- #1 organ burned
- Classified by **thickness** (degree)
- **Superficial** (1st degree)
  - Some/all epidermis → erythema
- **Partial thickness** (2nd degree):
  - Entire epidermis & some/all dermis → blisters, skin necrosis
- **Full thickness** (3rd & 4th degree)
  - Epidermis & dermis plus some/all SQ → charred tissue, exposure of fat & muscle
  - Painless (nerves dead)

Normal

Partial

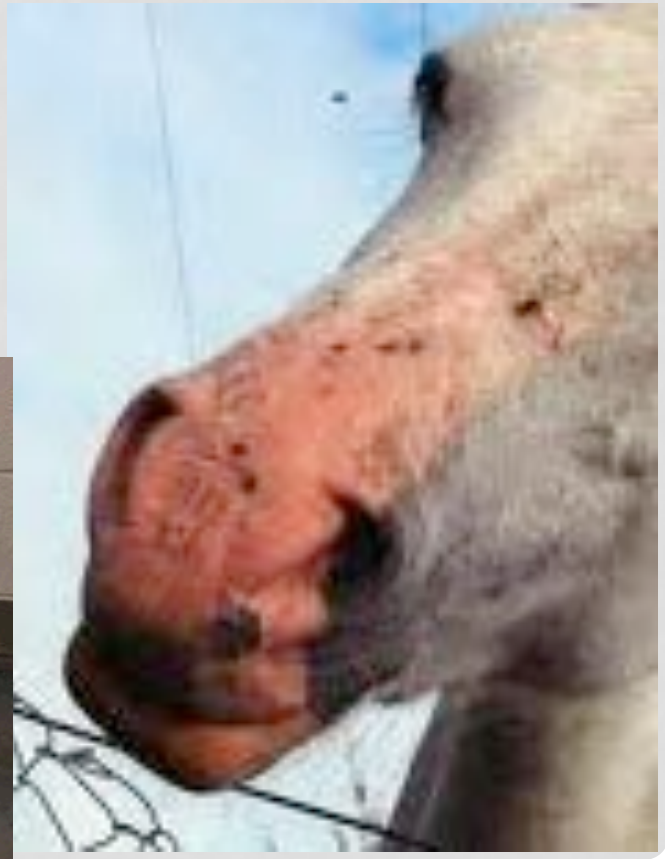
Superficial

Full thickness



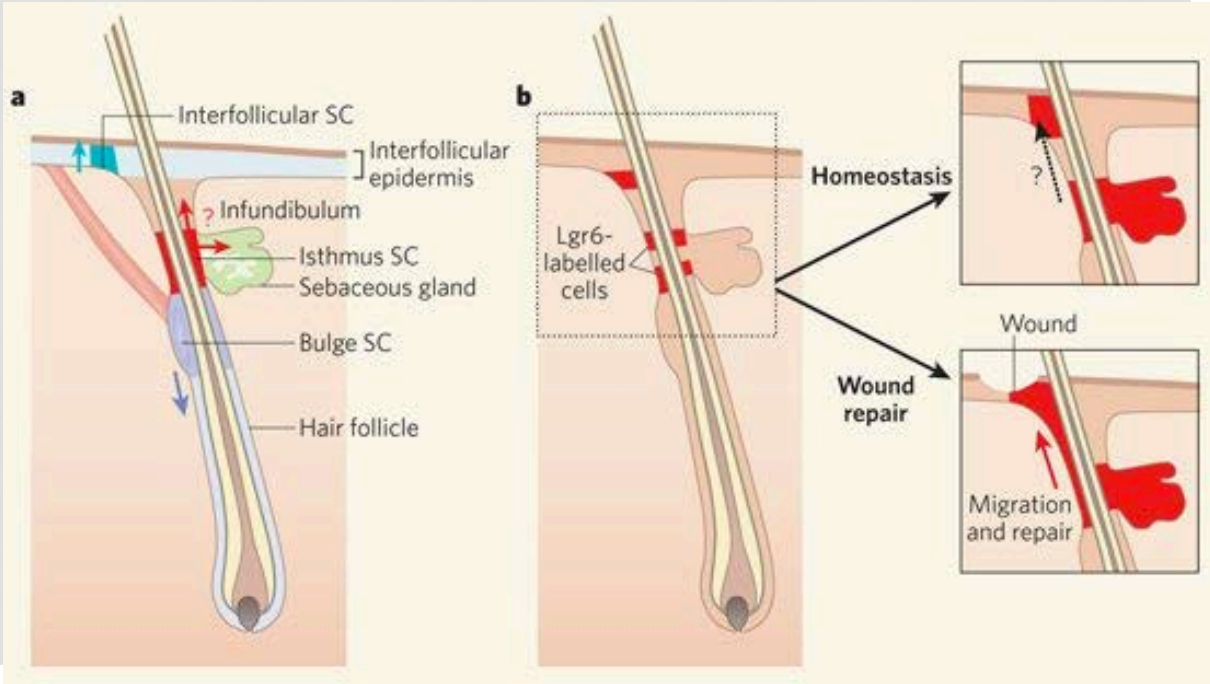
SUPERFICIAL BURNS

- **Epidermis only**
  - Red +/- swollen (erythema & edema)
  - Mildly painful
  - **Do not scar**. No injury to basement membrane / stem cells



PARTIAL THICKNESS BURNS

- **Entire epidermis + some Dermis injured**
  - Ooze blood/ serum→ Scab; Humans blister
  - +/- Scar, +/- Alopecia
    - Depends on whether stem cells were injured
  - Painful



FULL THICKNESS BURNS

- **All of epidermis & entire dermis injured**
  - **SQ exposed** (3rd degree) **+/- injured** (4th degree)
  - Not painful (nerves dead)
  - No re-epithelialization→ **Scar**
  - +/- **Eschar** = dry, black scab of necrotic skin from burns

EVALUATING BURNS

- **Rate depth based on worst-affected area**
- Often challenging; most are a mix of depths
- Full extent often peaks several days after exposure
- Histo may be helpful to determine depth

Dog. Burn depth (thickness)?

Partial thickness / 2nd degree

Dog. Depth (thickness)?

Dog. Full thickness burn, cause unknown.
An eschar is present.

BURN TYPES: EXAMPLES

1. **Scalds**
   - Ex: Garden hoses left in the sun
2. **Fire/ flame**
   - Ex: House fires
3. **Electrical**
   - Ex: Electrical cords
4. **Contact**
   - Ex: Heat rocks, Car mufflers, Brands
5. **Radiation**
   - Ex: Sunburns (UV), microwaves, Radiation Tx
6. **Chemical burns**
   - Ex: Petro-chemical burns, Severe contact dermatitis

CIGARETTE BURNS

- Purposeful burns made by holding the cigarette perpendicular to skin→
  ~1.0 cm diameter round crater, well-defined edge
- Accidental brushing up against a cigarette → "Comet" lesion: Round spot & tapering tail

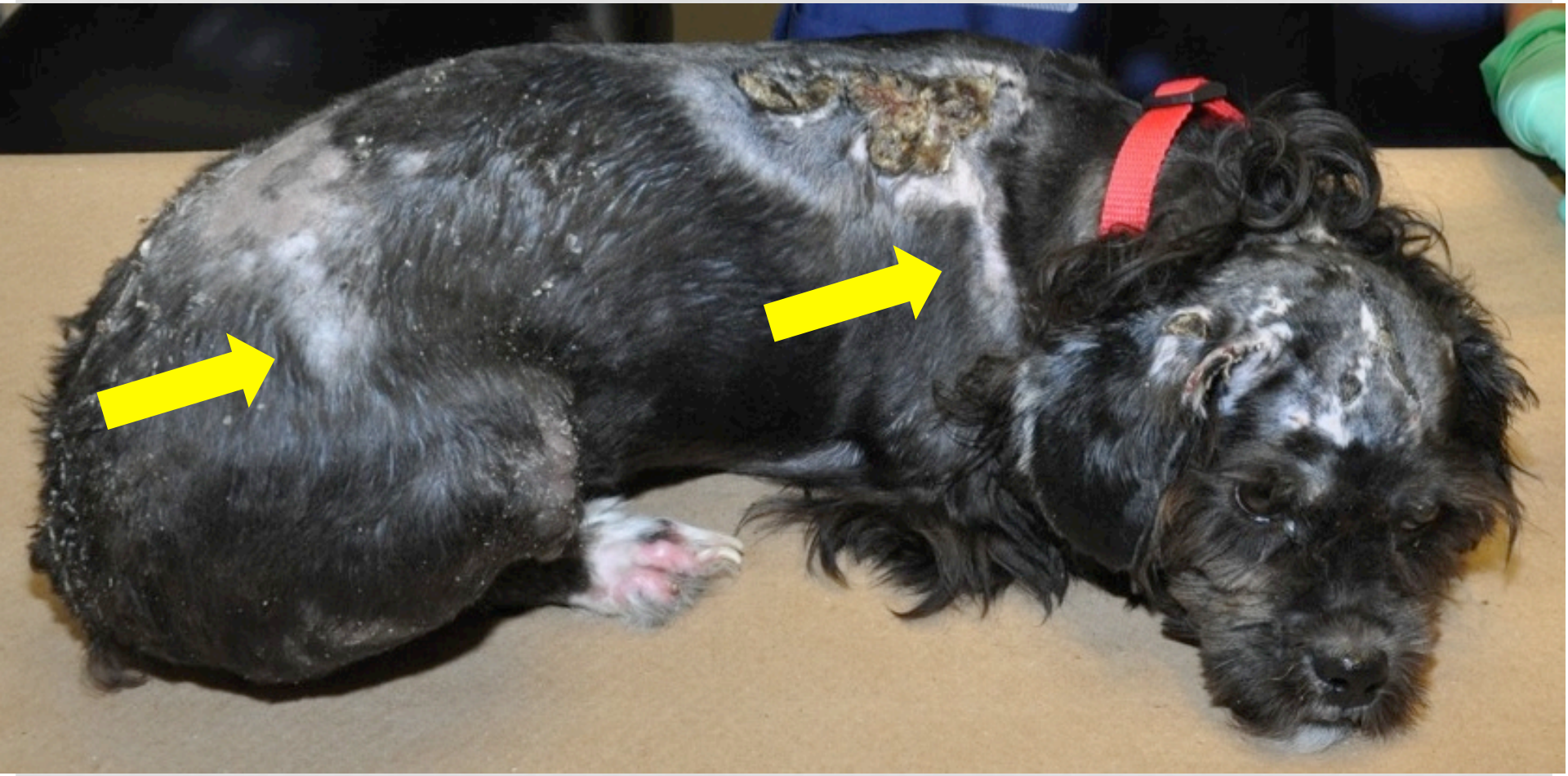
SCALDS

- Contact with ***wet heat***
  - Ex: Boiling H2O, steam, etc.
- Pattern
  - 1 or more usually coalescing burns, ***often on dorsum***
  - Margins irregular, elongated dorsal to ventral (gravity)
    - Severity lessens ventrally (liquid cools & drips off)
  - Tiny satellite burns d/t Drips & Splashes
- Even superficial scalds can produce significant scarring
- No ***singeing*** of hair

Photos courtesy Dr. Robert Reisman, ASPCA

Healing scald with peripheral re-epithelialization.

Photos courtesy Dr. Robert Reisman, ASPCA



Healing scald with peripheral re-epithelialization.
Note dorsal distribution &“splash / drip” pattern (arrows).

CONTACT BURNS

- A hot surface directly contacts the body
  - Ex: Heat rocks, Car mufflers, Brands, irons, etc.
- **Dog. Contact burn (hot pavement)**
- **Thickness?**

CONTACT BURNS

- A hot surface directly contacts the body
  - Ex: Heat lamps / heat rocks, Car mufflers, Brands
- **Dog. Contact burn (hot pavement)**
- **Partial thickness**

ELECTRICAL BURNS

- May cause focal or **branching (arborizing) skin lesions**
  - Ex: Cautery, bit electrical cords, & lightning
- High voltage: Central crater w/brown-yellow margin
  - **May be see in combo w/ flame burn if the hair coat catches on fire**
- Low voltage: No lesions OR Central chalky white crater with erythema
- Electricity causes distinct histological changes
  - "Windblown" (elongated) nuclei

Electric collar (invisible fence) collar wound- NOT A BURN.
Pressure necrosis. No gross signs of a burn.

MICROWAVE BURNS

- Microwaves heat water, inc. water in tissues
  - Tissue with a high H2O content reaches a higher temp than tissues with less water
- Primarily affects **skin, muscle & internal organs**; **spares SQ fat** (contains little water)
- Well-demarcated & unevenly distributed
  - Focal "hot spots" where 1 tissue abuts another
- **The severity of the injuries corresponds to the duration of exposure**

MICROWAVE BURNS

- 2008 Munro: Fatal feline cases
  - Flexure of the forelimbs at the carpus with or without ex-sheathing of the claws (~**pugilistic posture**)
  - Fragility of the skin +/- splitting with sharp, well delineated, edges
  - Crumpling &reddening of the tips of the ears
  - Congestion of all lung lobes
  - Internal organs readily disintegrate & have the odor of cooked chicken
  - ***Absence*** of singed hair

Woman killed cat for eating her goldfish by putting it in a microwave.
(Sentence: Jail-14 weeks)

https://www.express.co.uk/news/uk/464624/Woman-jailed-for-14-weeks-after-putting-cat-in-microwave

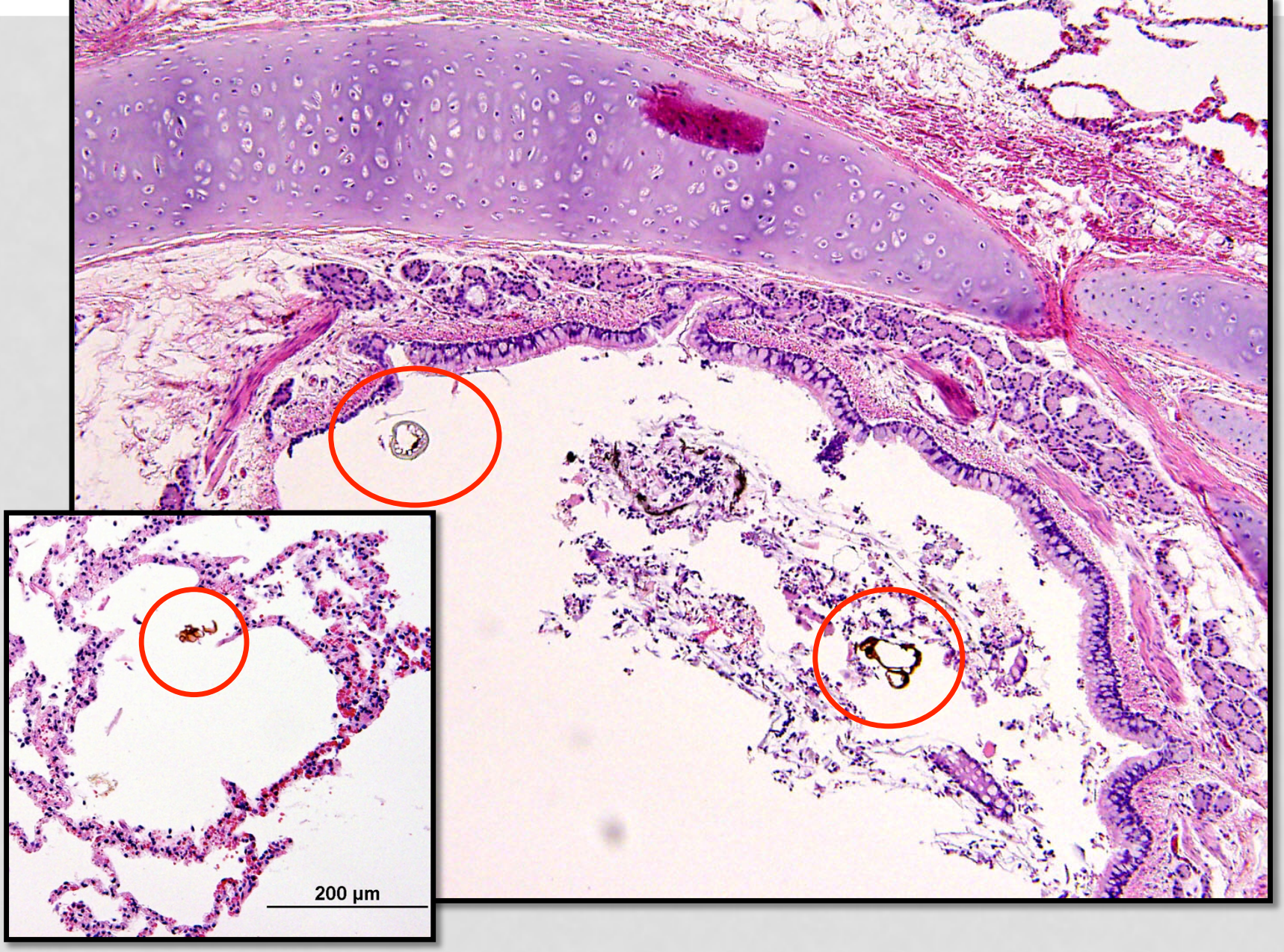
FIRES & FLAME BURNS

- Skin is in direct contact with a flame
  - Severity depends on duration of exposure
    - ***Singes*** hair, then ***chars*** skin, nails, & deeper tissues
  - F**lash burns**-- sudden ignition / explosion of a volatile substance (accelerants)
    - Produces a uniform burn (1st or 2nd degree) on all exposed areas & singes the hair

Singed whiskers.
Only seen with fire / flame burns.

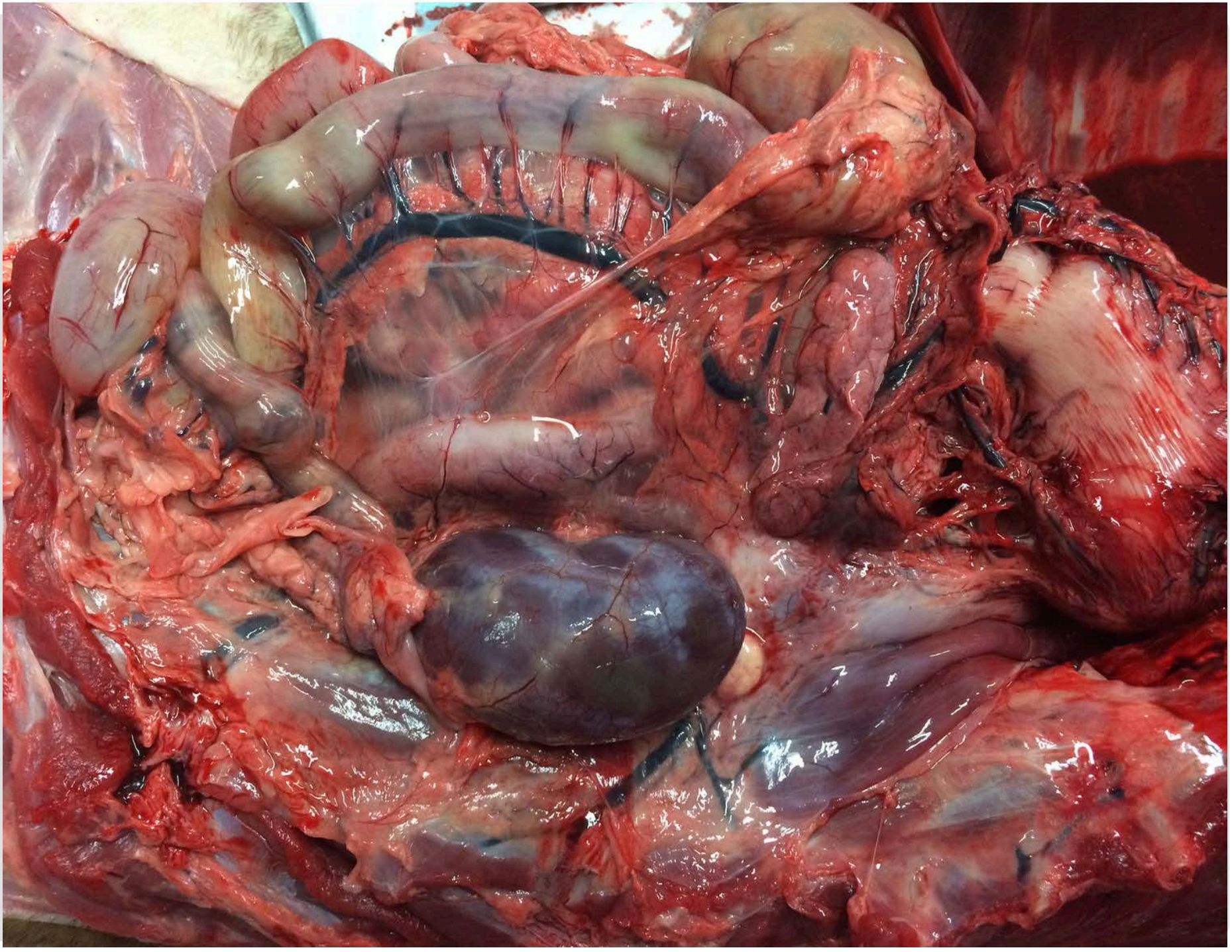
Flash Burn. Cat doused with lighter fluid & set on fire. Even **singeing, charring** & contraction of the skin (heat). Found alive but quickly euthanized.

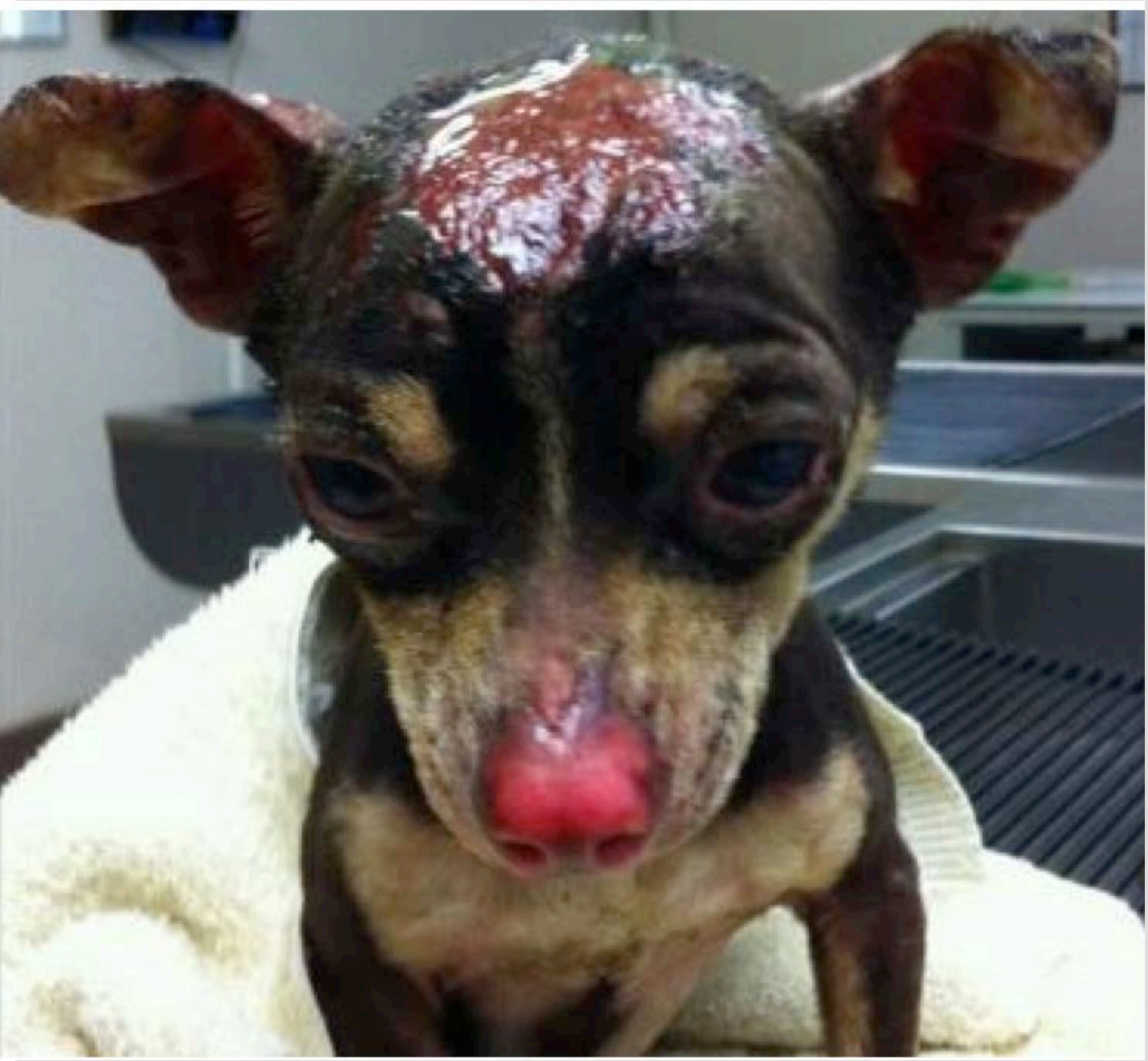
Cat; body burned on a fire after death
in an attempt to dispose of the body/ destroy evidence.
Well delineated areas of singed hair.



Burned cat, section of lung. Small pieces burned hair in the bronchi & alveolar spaces (circled).

Young Pit Bull put in oven. Not a fire / flame burn, but similar?





Dog that was in a house fire with thermal burns.

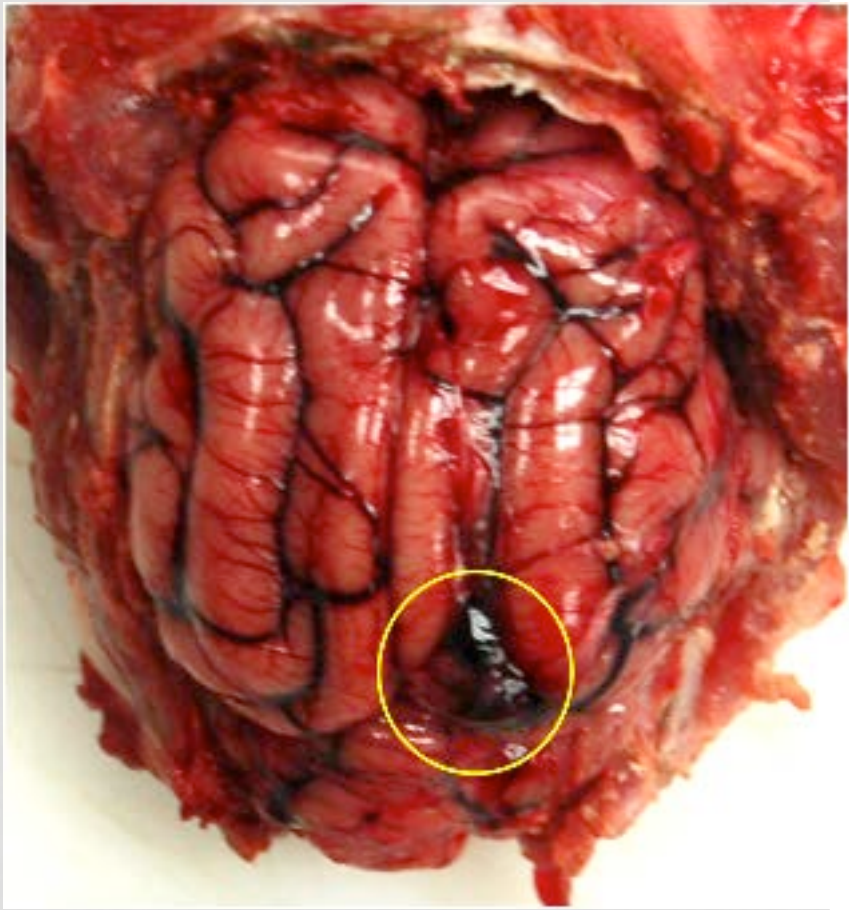
Toxic epidermal necrolysis (TEN) in a dog & cat.
Similar “clown-face” appearance to flame burns.
Function of thinness of skin?
Lack of improvement with supportive care, lack of accelerant odor, & histo of the affected areas differentiate TEN from burns.

BURNED REMAINS: NX GOALS

- **Was death due to fire, or was the body burned?**
  - **Soot in upper airway =** Evidence of smoke inhalation ("vital change") = proves animal was alive to inhale smoke
    - Have area set aside for examination of pluck
    - Avoid cross contamination of soot on body into organs
      - Use new/ clean gloves & clean knife to get histo samples
  - **+/-Accelerant testing**
  - **+/- Blood carbon monoxide [CO] (standard in people)**
    - **Look for cherry red livor** mortis
    - CO-Hb is ***very*** stable with no exposure to light
      - Test likely valid for days
      - EDTA heart blood sample
      - Human lab?

BURNED REMAINS: ARTIFACTS

- Artifacts of extreme heat:
  - **Bone Fx** including skull
  - **Epidural hematomas**
  - **Skin splitting**
  - "**Pugilistic posture**" flexion of the elbows & carpi
- Internal organs typically preserved



Brain of burned cat with small epidural hematoma

FIRES: ACCELERANT TESTING

- Animals ***not*** spontaneously combustible; Accelerants must be used
- ***Collect ASAP!***
  - Accelerants (volatiles) evaporate quickly
- Collect anything that smells
  - Ex: collars, haired skin
- Collect least-burned areas
  - Accelerant least–consumed
- Clean metal or glass container

Dog in house fire (hind end). **Pugilistic posture**: Flexion of the hips, stifles & digits & extension of hocks, due to heat contraction of collagen in muscle & tendons.

Dog (same as previous). Flexed shoulders, elbows & carpi, contracture of skin & curled back lips. Well delineated area of spared skin & hair (white patch). Tracheal ulceration (thermal injury)→ COD= smoke inhalation.

CHEMICAL BURNS

- Strong acids & alkalis cause **direct cell damage**
- Severity depends on the agent, strength / concentration, & duration of contact
  - Alkaline agents (pH greater than 11.5) tend to produce more severe (full thickness) injury compared to acids
- Gross lesions resemble other burns, especially scalds
- Predominantly **skin**
  - **Tissue necrosis**
  - +/- Blistering (people)
  - More superficial compared to thermal burns

CHEMICAL BURNS

- Ddx chemical from thermal difficult
  - Histo *might* help
    - Heat "wicked" by hairs, disproportionate damage to follicles
  - Chemical residue - Odor or liquid itself
- Ddx accidental from purposeful may be difficult
  - Hx / investigation dependent
  - Severe irritant contact dermatitis
    - Idiosyncratic reactions to topical Rx, especially flea/tick preparations

Suspected chemical burn with ventral distribution: Paws, rump, elbows, from sitting/walking in the chemical, & mouth from licking it off.

Photos courtesy Dr. Robert Reisman, ASPCA

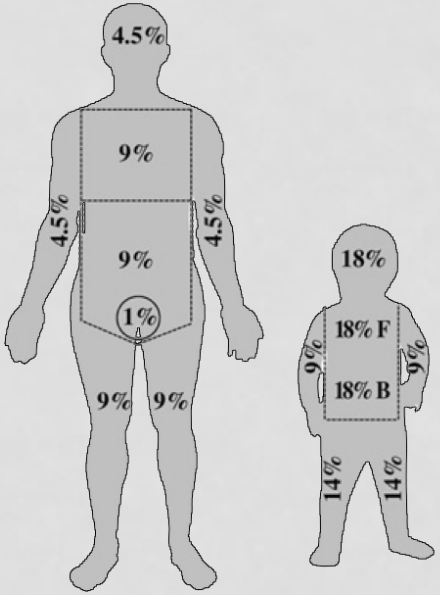
LEFT: Severe irritant contact dermatitis from a reaction to topical flea/ tick medication (right).

RIGHT: Scald caused by garden hose.

The dorsal midline burn is a common pattern, seen with a wide variety of accidental & purposeful causes. Determining the cause without a history may be impossible.

ESTIMATING % AFFECTED

- "Rule of 9s" not accurate for other species
- How many credit cards does it take to cover the burn?
  - Determine Body Surface Area based on weight -- standard conversion charts (as for chemo)



$$\%\ \text{TBSA burn} = \frac{\text{number of cards} \times 0.45}{m^2}$$

% BSA = [# cards x 0.45] / total BSA

EXAMPLE: 6kg dog; 22 card burn

$$\%\text{BSA burned} = \frac{22 \times 0.45}{0.33\text{m}^2} = 30\%$$

Conversion Tables for Weight to Body Surface Area

DOG

$BSA\ (m^2) = 0.101 \times BW(kg)^{2/3}$

kg	m^2
0.5	0.06
1	0.10
2	0.15
3	0.20
4	0.25
5	0.29
6	0.33
7	0.36
8	0.40
9	0.43
10	0.46
11	0.49
12	0.52
13	0.55
14	0.58
15	0.60
16	0.63
17	0.66
18	0.69
19	0.71
20	0.74
21	0.76
22	0.78
23	0.81
24	0.83
25	0.85

kg	m^2
26	0.88
27	0.90
28	0.92
29	0.94
30	0.96
31	0.99
32	1.01
33	1.03
34	1.05
35	1.07
36	1.09
37	1.11
38	1.13
39	1.15
40	1.17
41	1.19
42	1.21
43	1.23
44	1.25
45	1.26
46	1.28
47	1.30
48	1.32
49	1.34
50	1.36
55	1.46

CAT

$BSA\ (m^2) = 0.100 \times BW(kg)^{2/3}$

kg	m^2
0.5	0.060
1.0	0.100
1.5	0.134
2.0	0.159
2.5	0.184
3.0	0.208

kg	m^2
3.5	0.231
4.0	0.252
4.5	0.273
5.0	0.292
5.5	0.311
6.0	0.330

BURNS: NX GOALS

1. **Document location(s) affected**
   - Remember to check oral cavity
2. **Estimate % body surface affected**
3. **Assess the depth**
4. **Diagnostic features**
   - Eschar, blisters, "splashes"

Healing obscures

5. **Cause of death = Burn**
   - ID type (if possible): Scalding, Contact, Flame, Electrical, Microwave, & Chemical

- ***Does the burn fit with the explanation?***

SUMMARY

- 6 types of Burns:
  - Scalding, Contact, Flame, Electrical, Microwave, & Chemical
- Burns should be described in terms of:
  1. Depth: superficial, partial, complete thickness
  2. Extent: % total body surface area affected
  3. Distribution (Pattern): Anatomic location(s), drips/ splashes?
  4. Features of the burn: singed or charred tissue, or eschar
- Animals exposed to fires – evaluate for exposure to:
  - Smoke/ fumes & Carbon monoxide
  - Exposure to heat.
- Consider accelerant testing

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