Freckle

on

Her

walk

PICKLE

THE

PUG
PUG
PUG

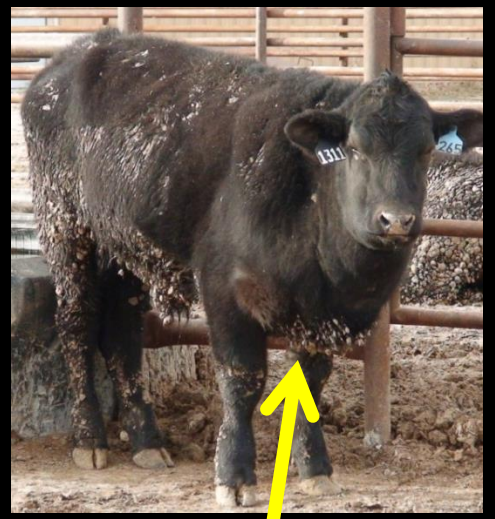
The Newest Holt Family Member

Tugg Pug Pug

Roo

The Newest Newest Holt Family Member

Bovine High Mountain Disease



3000 feet

"Brisket Disease"

Feedlot Cardiac Failure

Pulmonary Hypertension

BIF

Calgary, Canada

2023

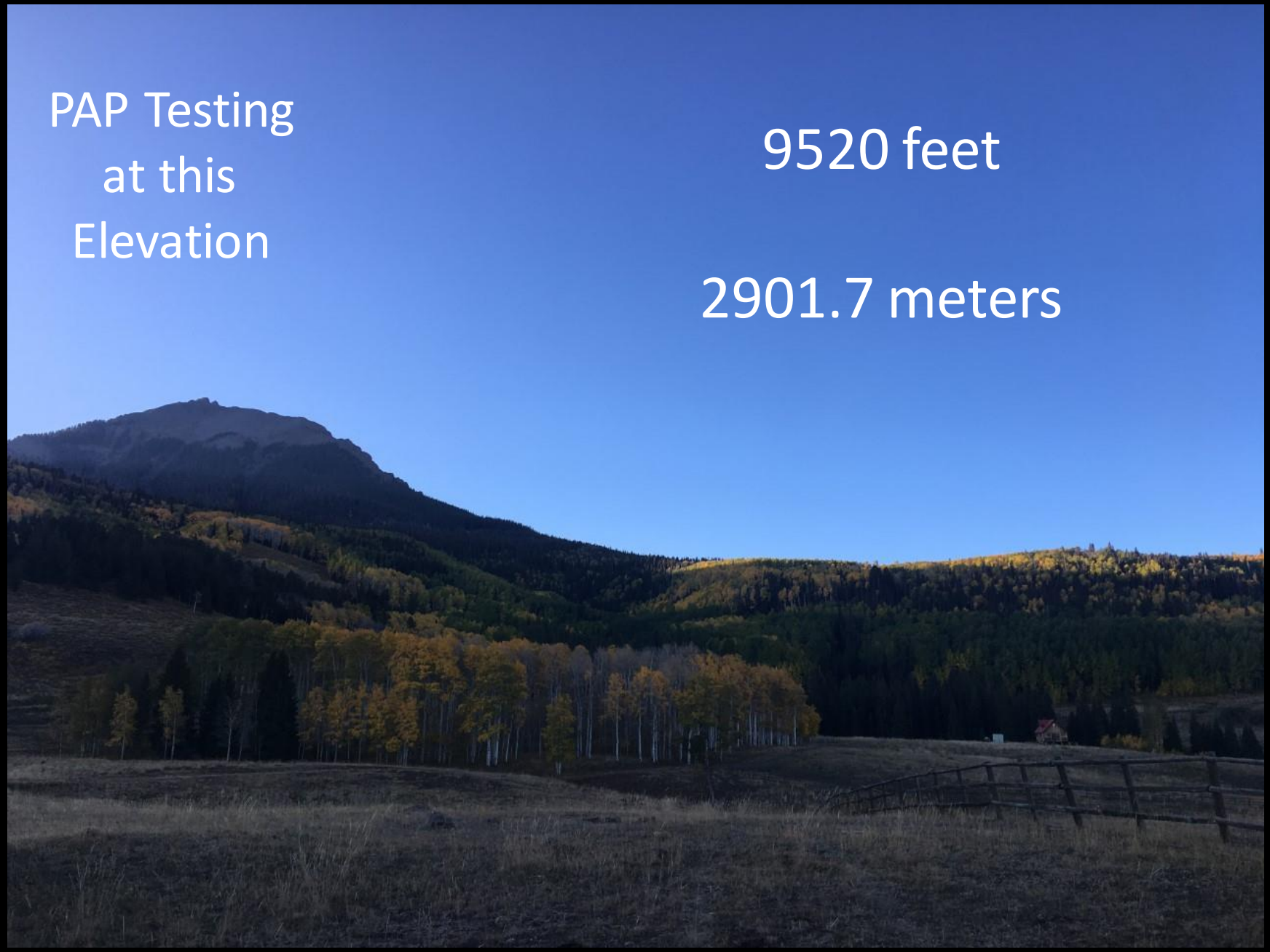
Obesity

Coronary Vascular Disease?

8000 feet

Tim Holt, DVM

1913-First Formal Description of “Dropsy of High Altitude”


PAP Testing
at this
Elevation
9520 feet
2901.7 meters

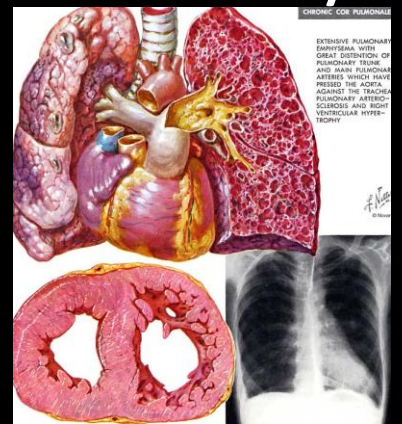
Bovine High Mountain Disease
Vs.
Feedlot Cardiac Death

Alamosa Colorado
8000 feet

Nebraska Feedlot
3000 Feet

Background
Pulmonary Hypertension
Human Aspect

- Hypoxic pulmonary hypertension is the most common cause of cor pulmonale.
- Occurs with alveolar hypoxia, in conditions such as emphysema, sleep apnea. A specialized cause is generalized alveolar hypoxia of altitude, high altitude pulmonary hypertension.
- Early human research



PH and the WHO Classification

The bovine model recapitulates important features of Group III PH, the second largest group of PH human patients (Gretta)

- Group I pulmonary arterial hypertension, Congenital (PAH)
- Group II PH due to left heart disease
- Group III PH due to lung diseases and/or chronic hypoxia
- Group IV chronic pulmonary thromboembolic PH
- Group V PH with unclear multifactorial mechanisms

Pathophysiology BHMD

Most Critical Part Genetics Environmental

Don't Forget Donnie

Another Genetic Aspect, To Die or Not to Die

Alveolar Hypoxia

Pulmonary Vasoconstriction

Pulmonary Remodeling

Pulmonary Hypertension

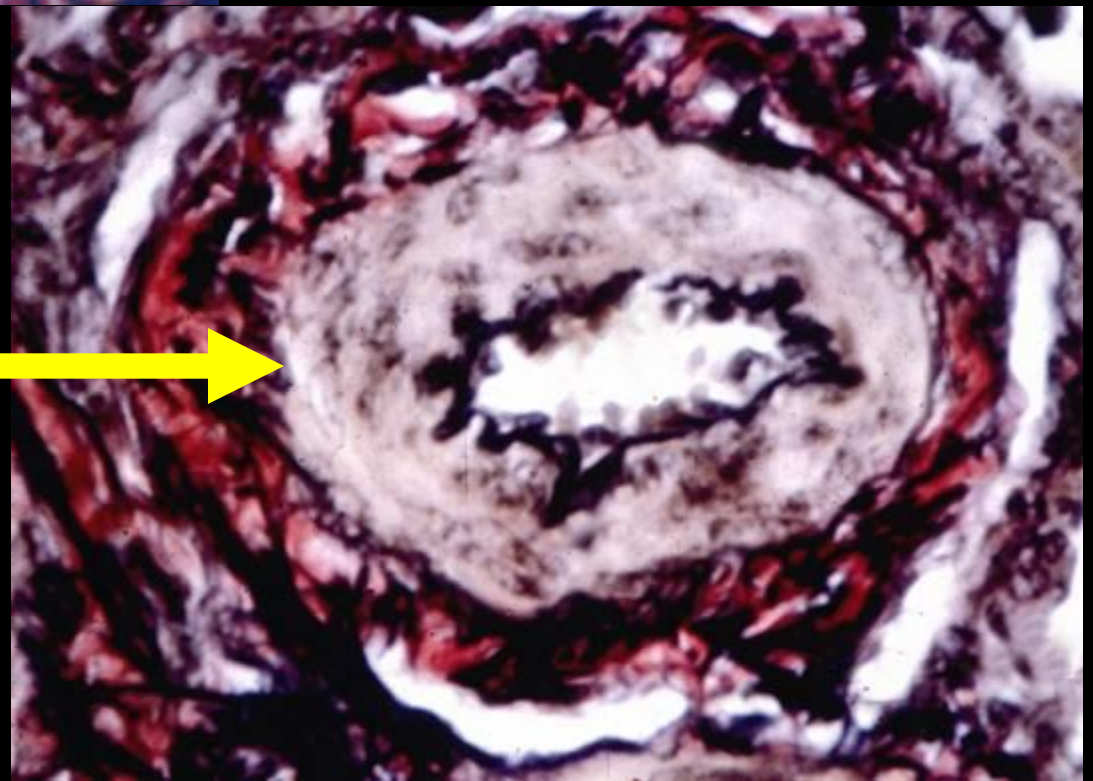
Right Ventricular Hypertrophy

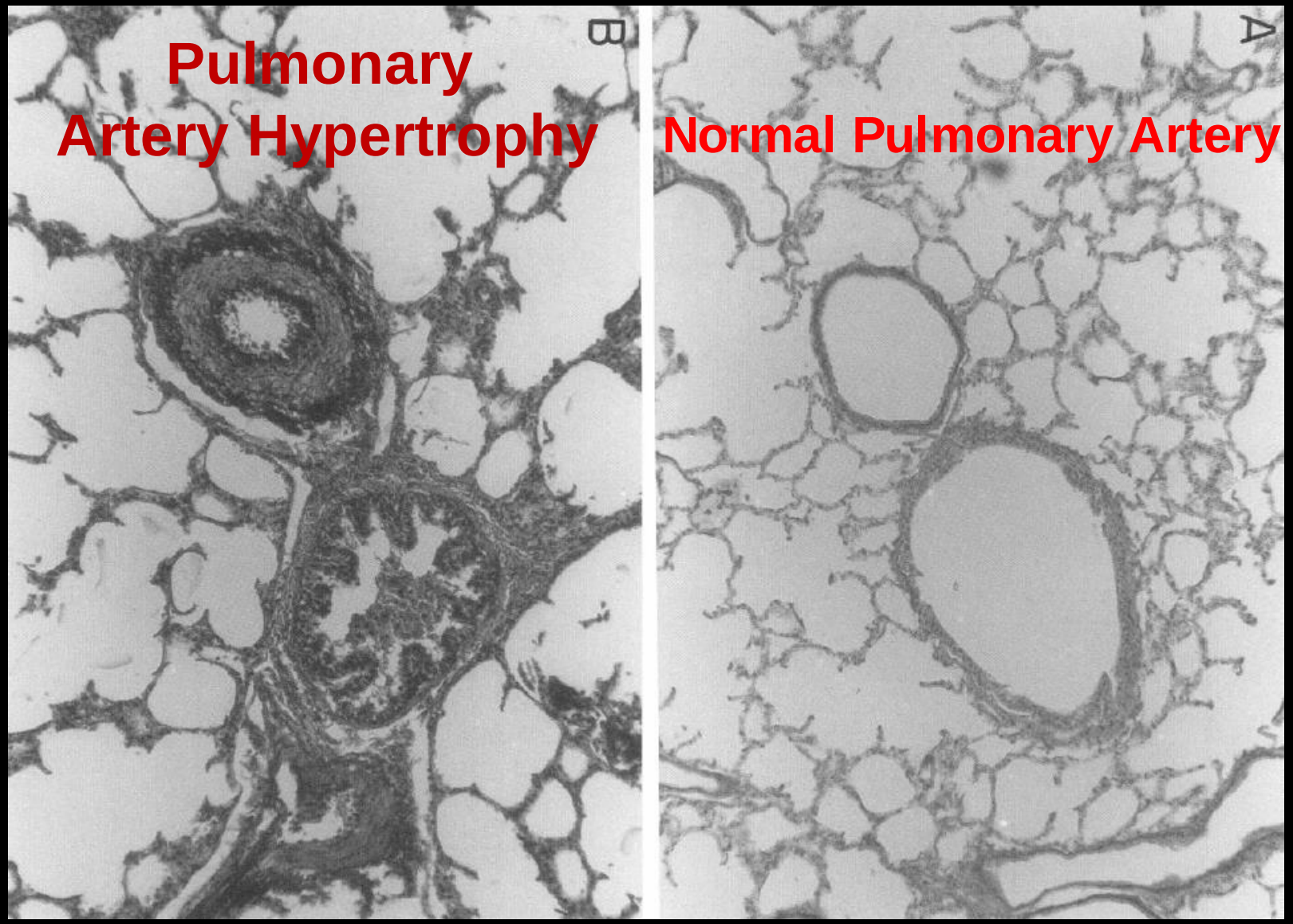
Right Ventricular Dilation

Right Heart Congestive Failure

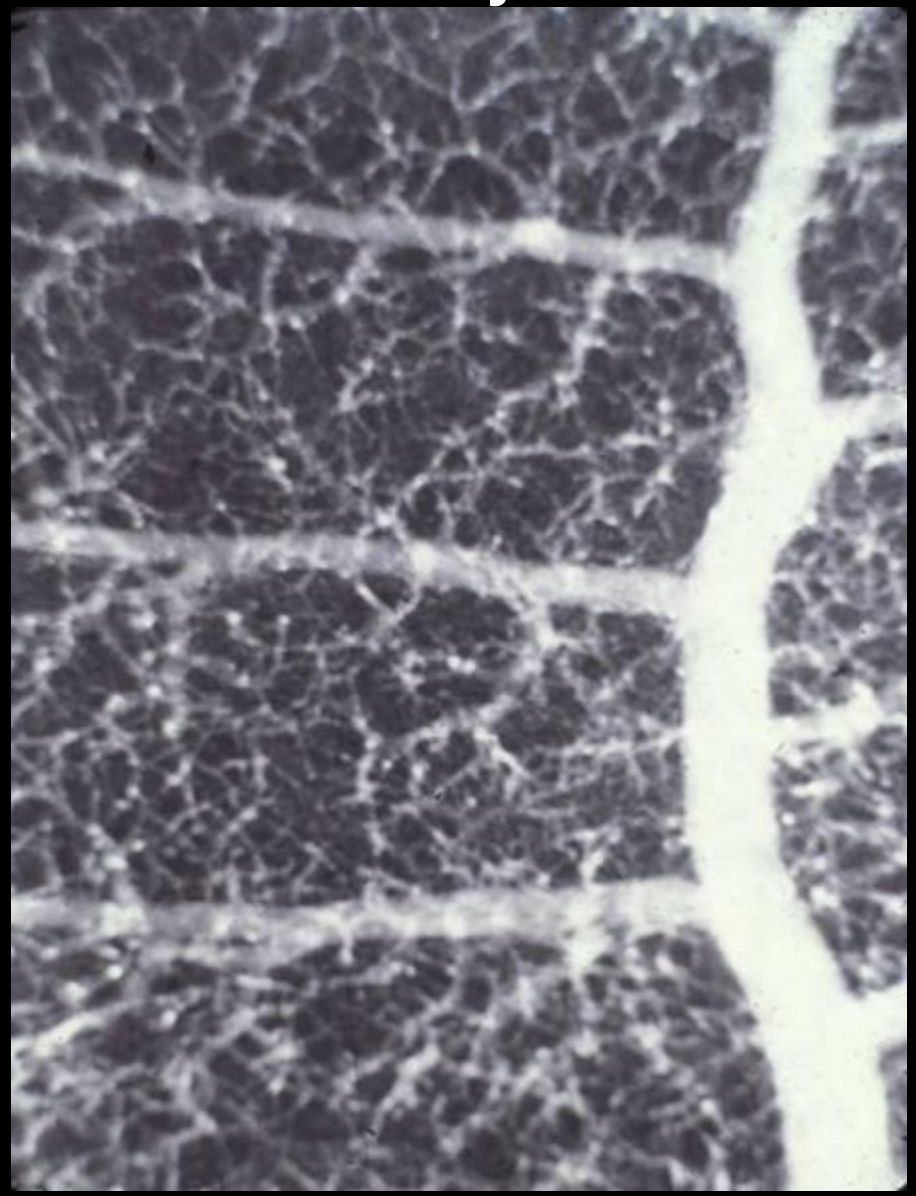
Normal
Pulmonary Artery
PAP=40mmHg

Hypertrophy of
Pulmonary Artery
Smooth Muscle
PAP=80mmHg




Pulmonary
Artery Hypertrophy
B
Normal Pulmonary Artery
A

40 mmHg PAP
(Normal)
Pulmonary Vasculature



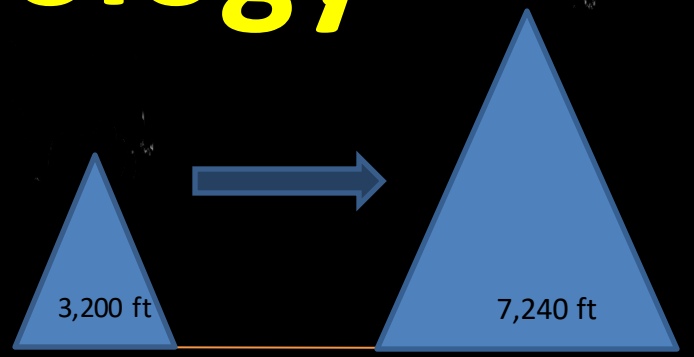
80 mmHg PAP
(Vasoconstriction)
Pulmonary Hypertension

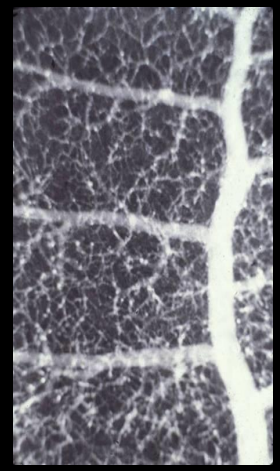
Pathophysiology

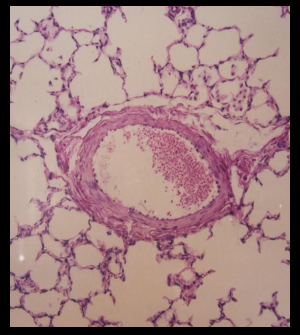
1. Alveolar hypoxia
   Altitude

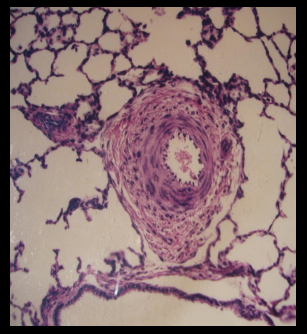
2. Pulmonary arterial vasoconstriction and shunting

3. Pulmonary arterial remodeling and arterial smooth muscle hypertrophy



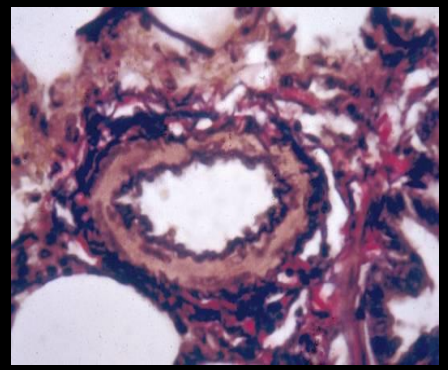


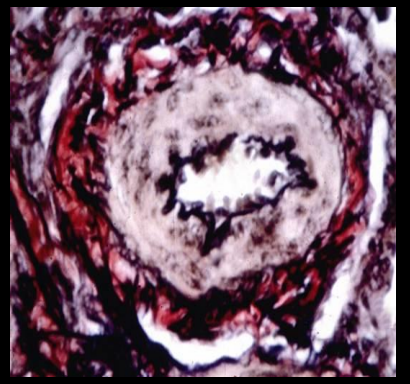




Pathophysiology

4. Pulmonary hypertension





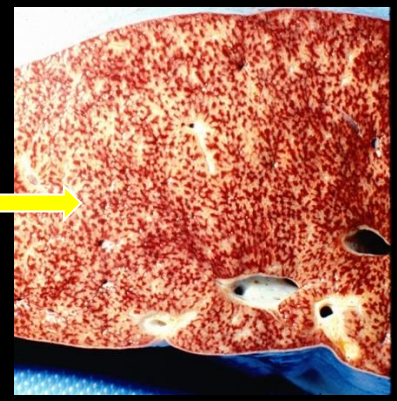
5. Right ventricular hypertrophy

Enlarged Right Ventricle

6. Right ventricular dilation

7. Right congestive heart failure

Congested Liver
"Nutmeg Liver"



Clinical Signs

Congestive Right Heart Failure
BHMD, Feedlot Cardiac Death

-Lethargy, weakness, collapse

-Jugular Distention/Pulsation

-Diarrhea

-Subcutaneous Edema

- Brisket Region
- Intermandibular
- Ventral Abdomen

-Fluid Within

- Abdomen
- Thorax
- Pericardium

-Bulging eyes

-Death

Jugular Distension, BHMD
27% Death Loss in One Year
117/435 calves >$100,000.00 Loss

Wyoming Ranch
Elevation
7200 feet Home Ranch

All Calf losses Out of
Two Sire Groups

Photo:
Thank you, Dr. Knight

Variation in Response to **Hypoxia**

Hyper-Reactive

Bovine, Porcine

Moderate-Reactive

Equine, (Humans)

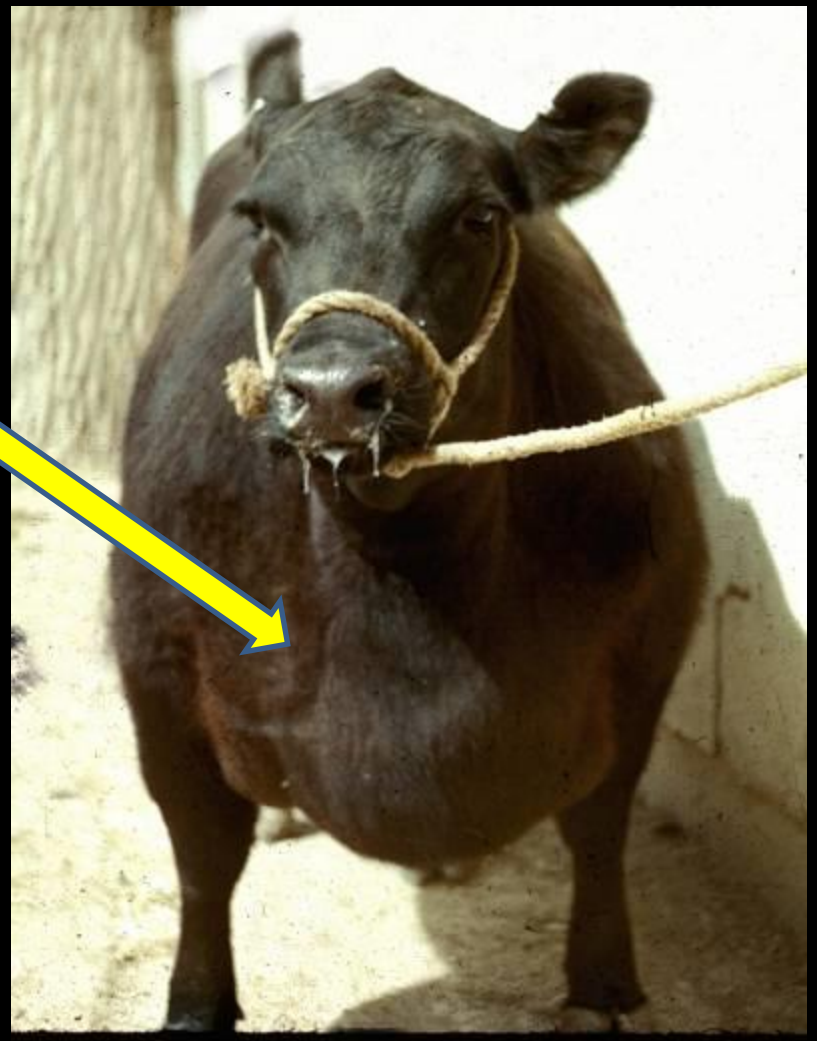
Hypo-Reactive

Ovine, Caprine, Canine,

Llama, Alpaca

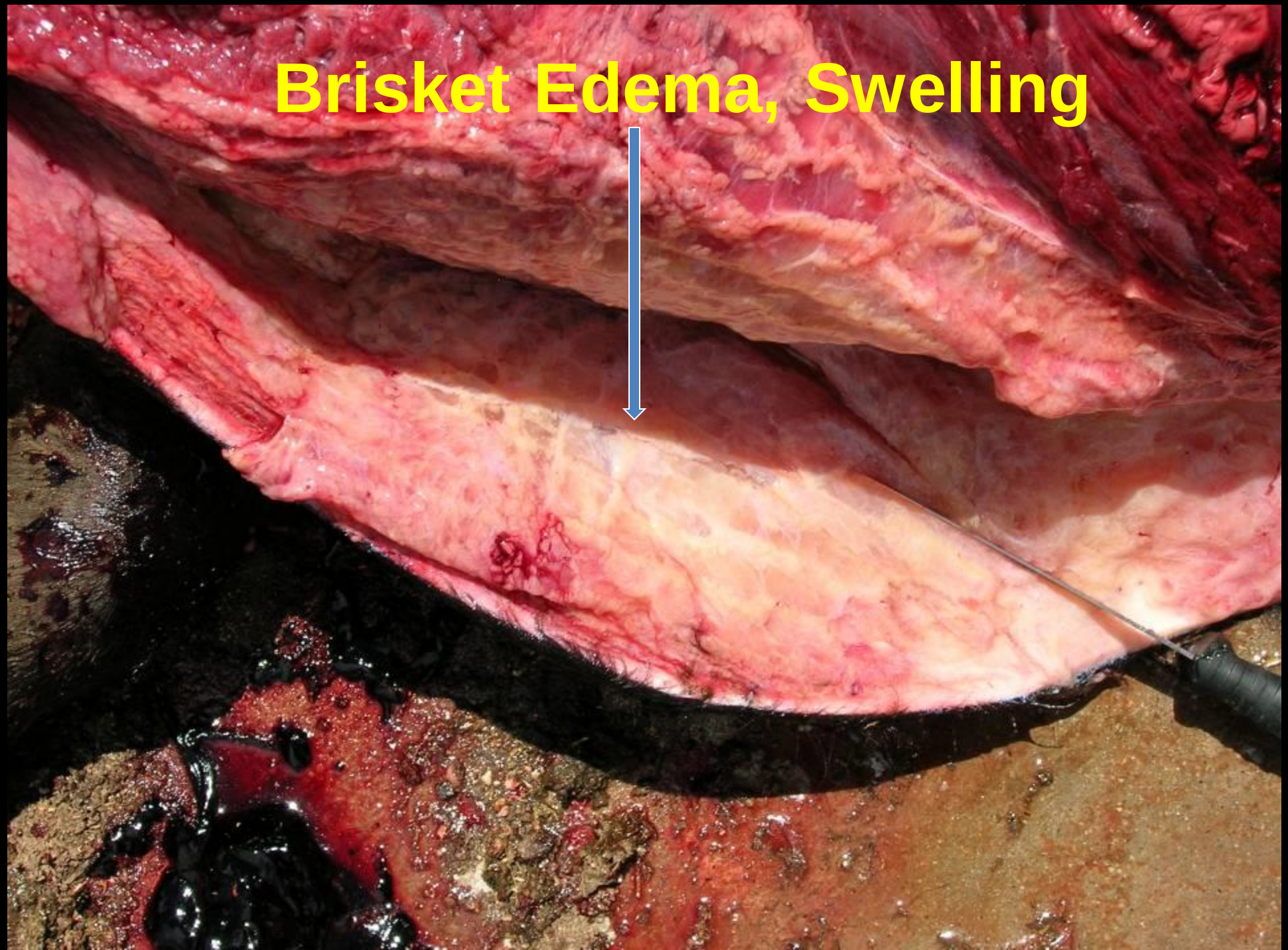
YAK!!!

Breed Susceptibility ?

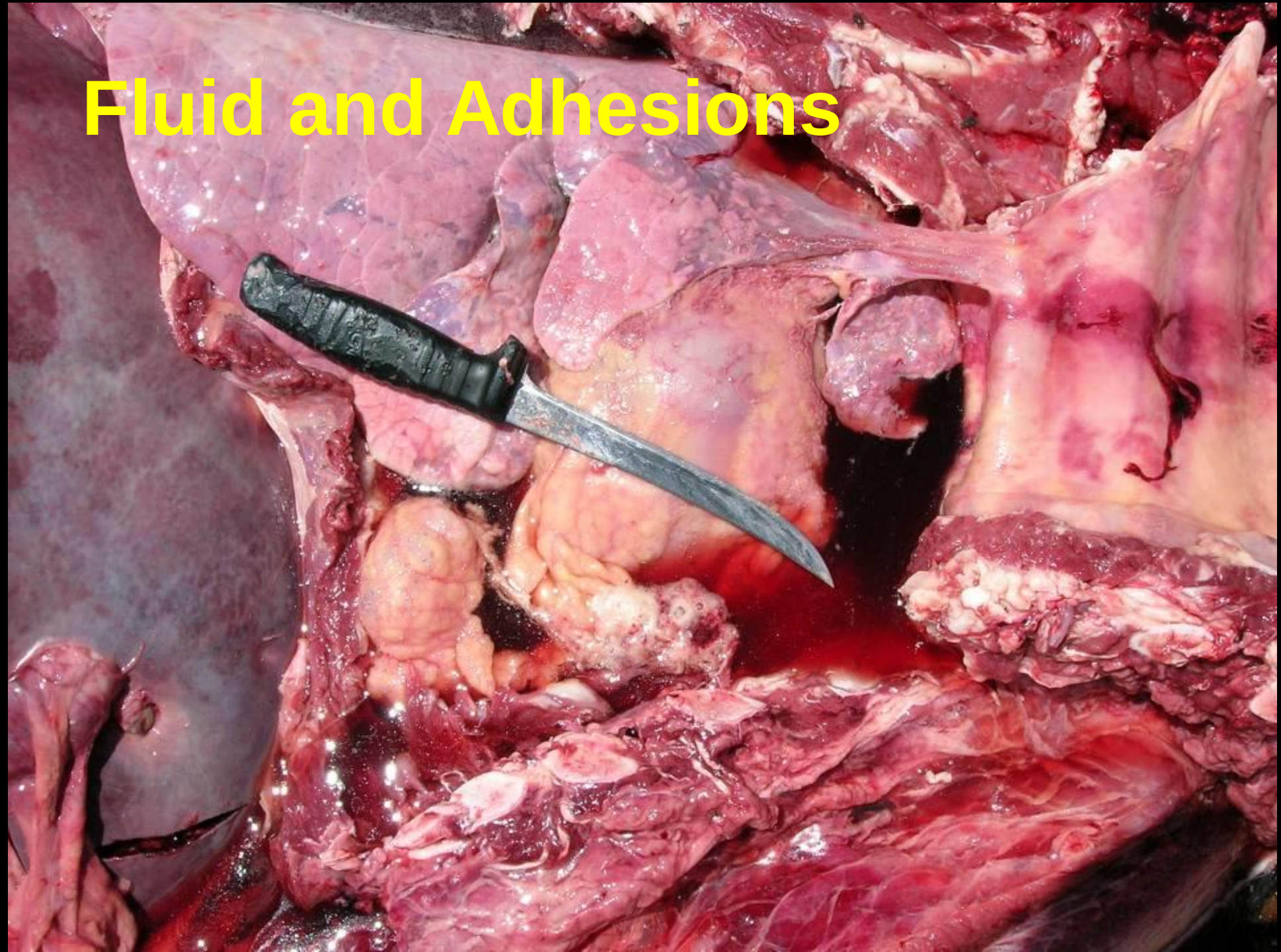


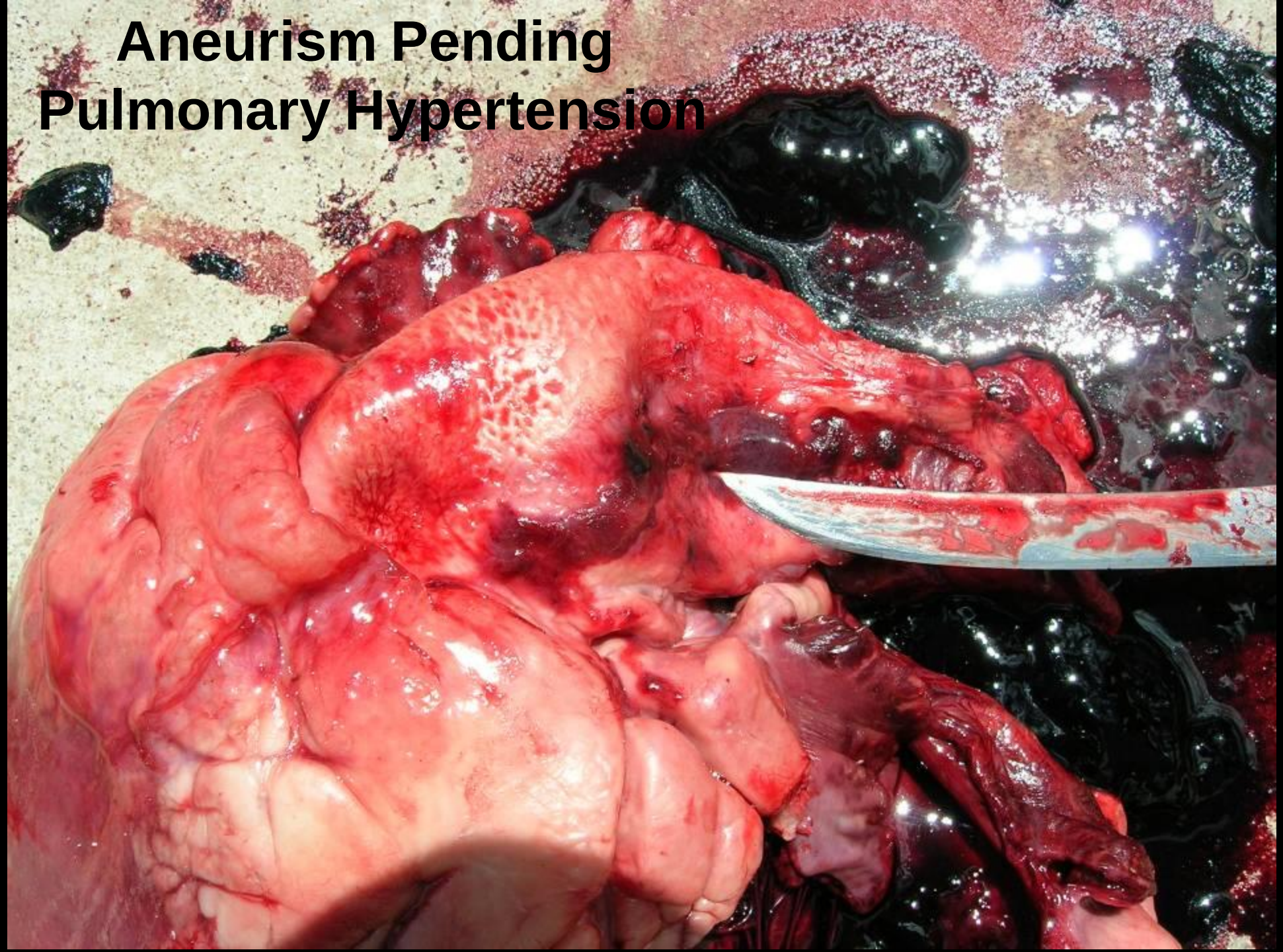

Very Near Death
Necropsy

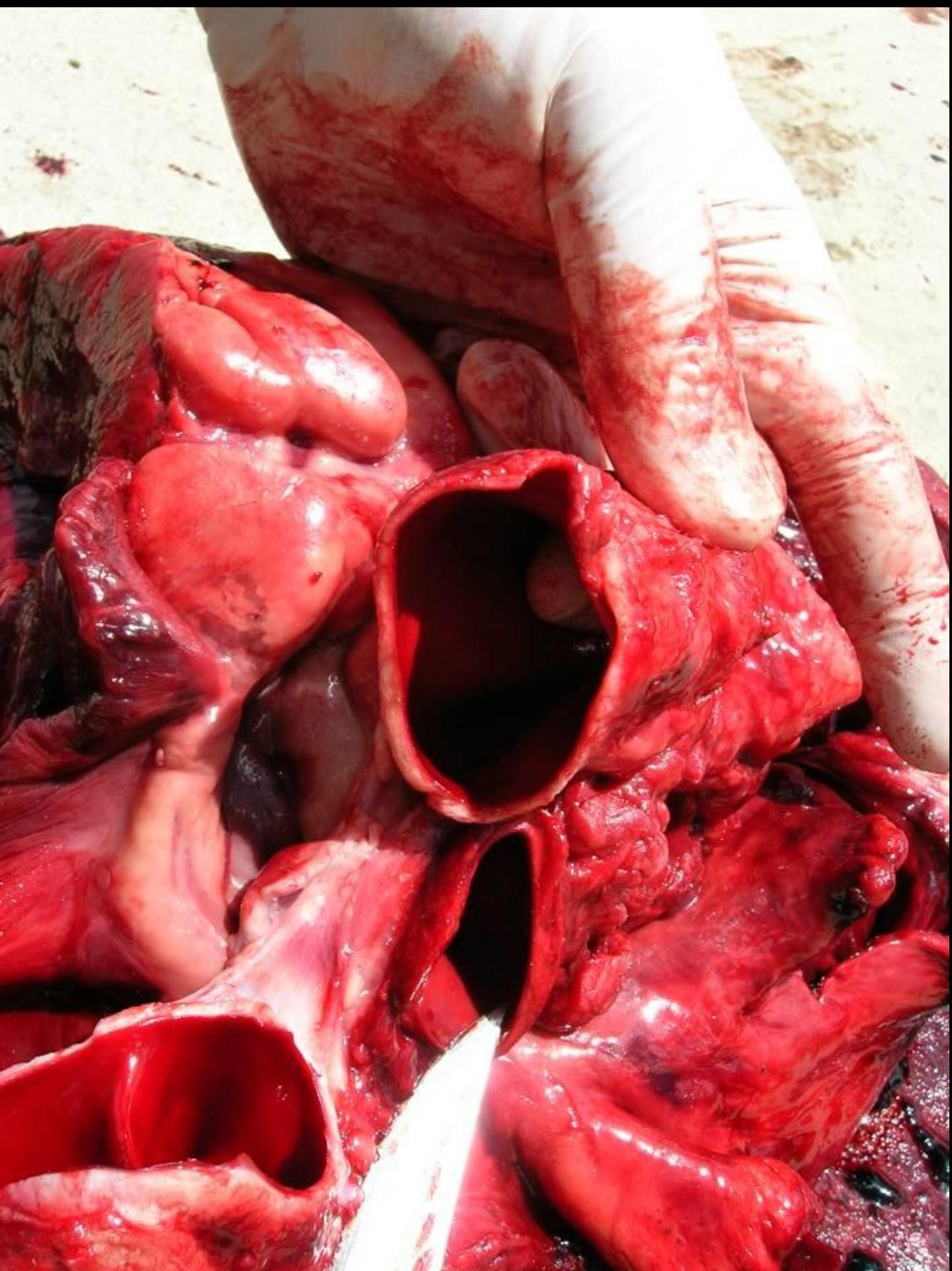
Necropsy of Clinical Case Of Bovine High Mountain Disease


Brisket Edema, Swelling

Fluid and Adhesions

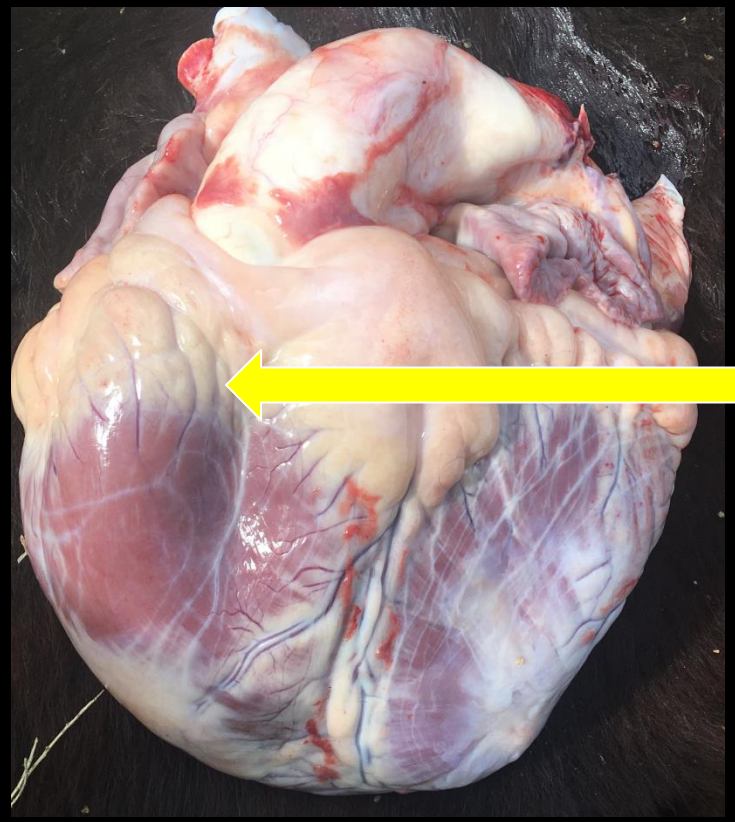



Aneurism Pending
Pulmonary Hypertension



Congested
Liver
Swollen
Rounded Edges

Necropsy Findings

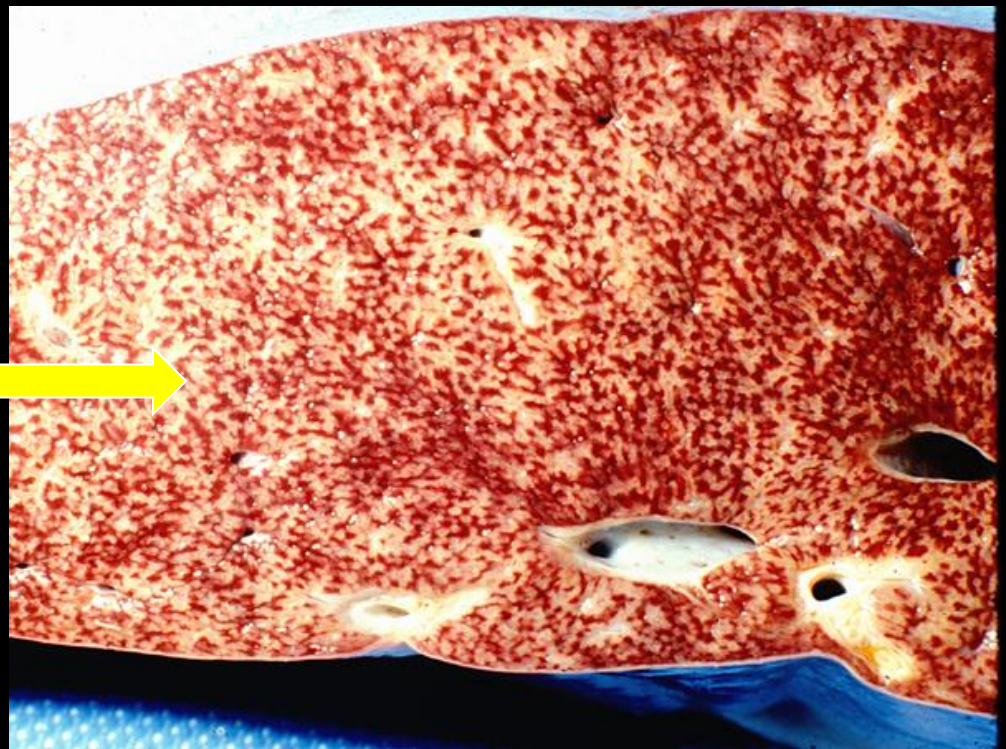


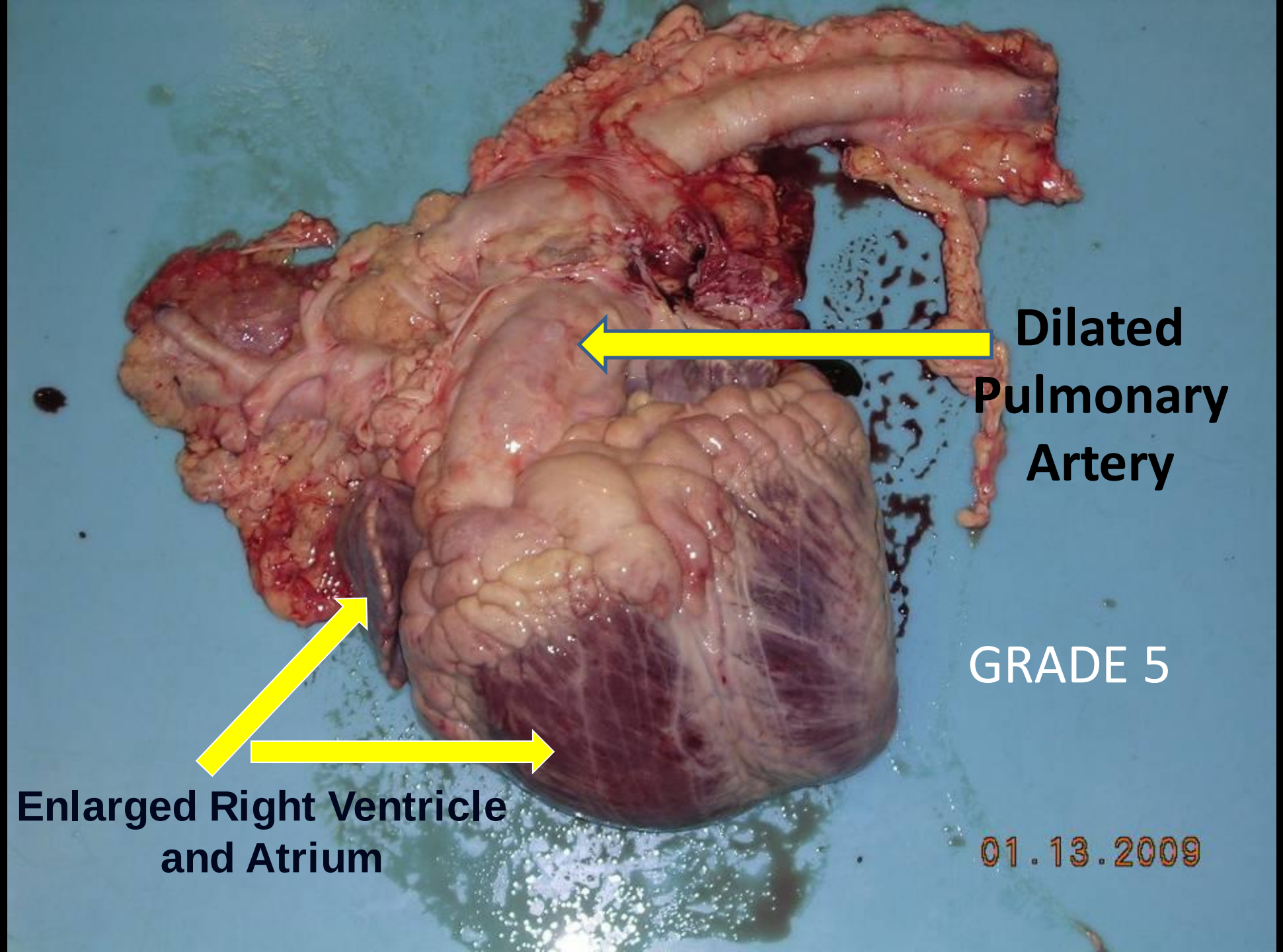
Enlarged Right Ventricle

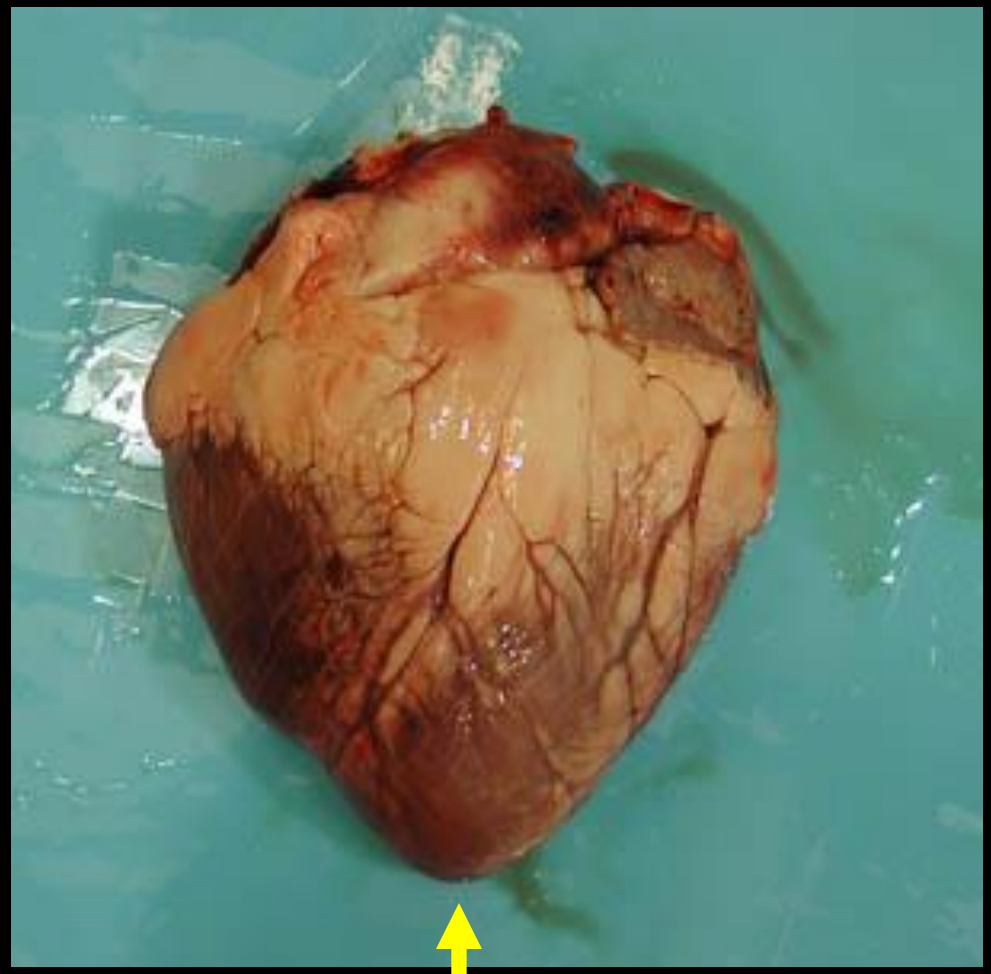
GRADE 5

Cardiac Collapse

Congested Liver
"Nutmeg Liver"

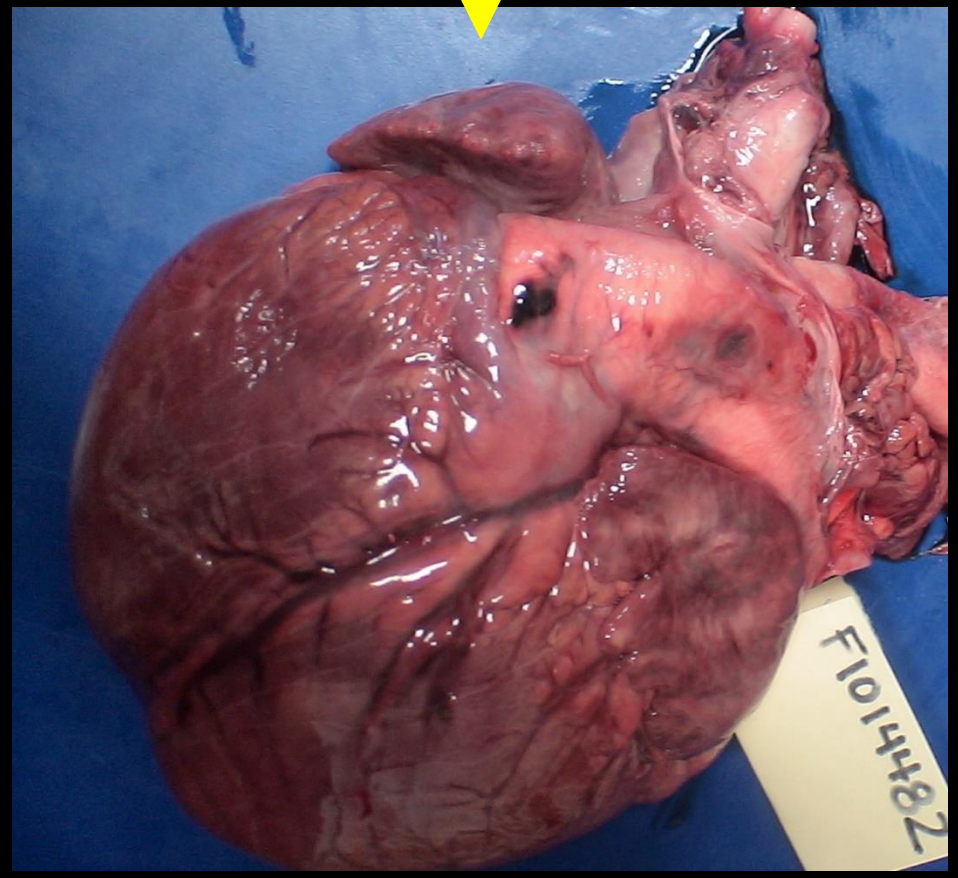


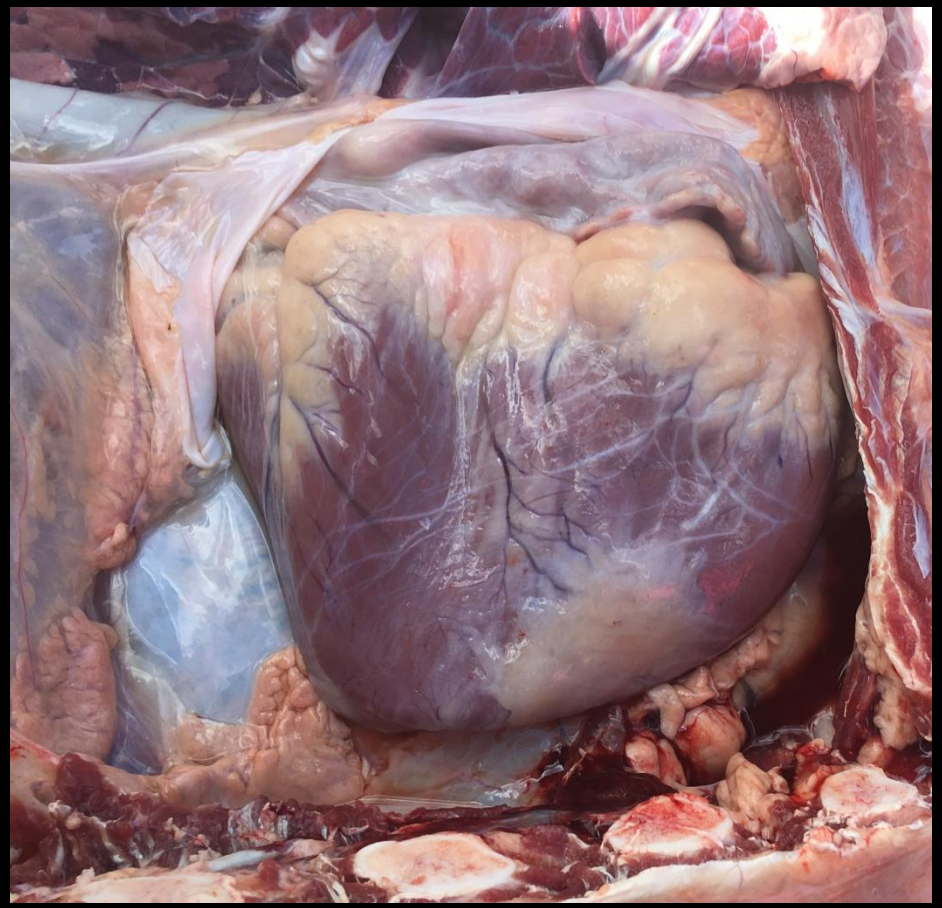

Dilated Pulmonary Artery
GRADE 5
Enlarged Right Ventricle and Atrium
01.13.2009



Grade 1—Normal Heart

Grade 4—Heart, Severe Cardiac Disease



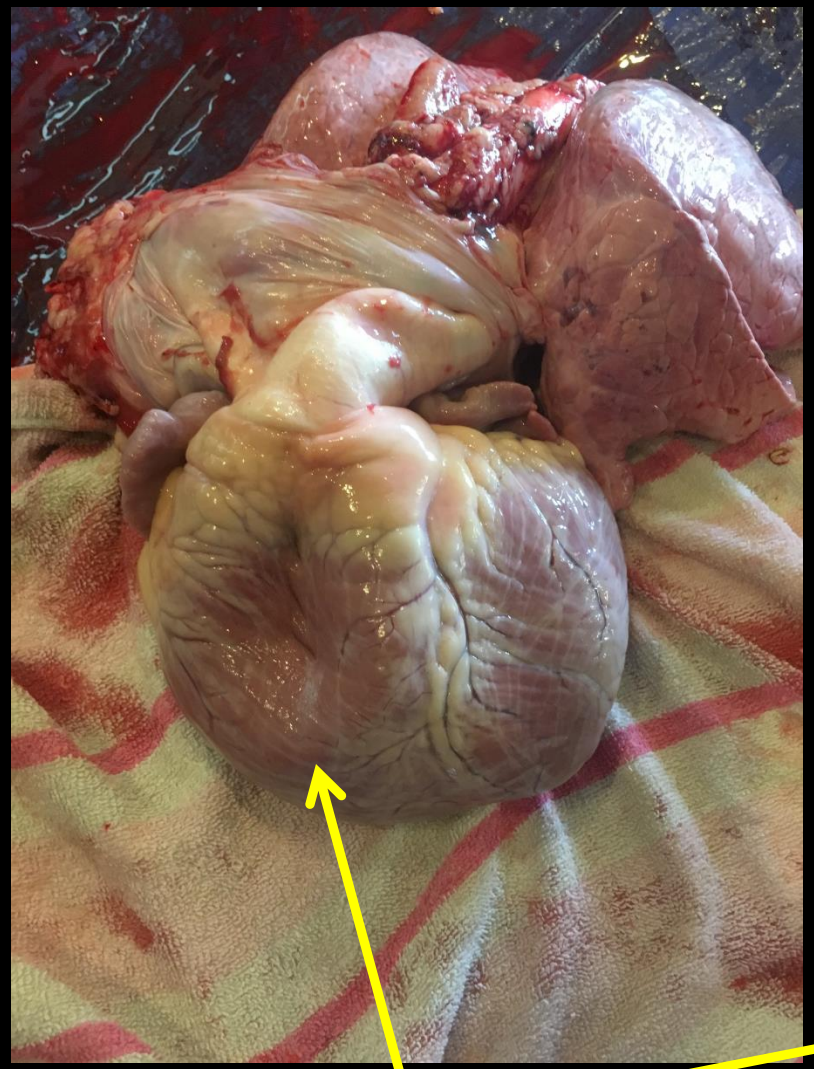


Grade 5 Heart

Complete Cardiac Collapse

Can we use cardiac anatomical Changes to track Cardiac disease

ABSOLUTELY



Dilation

To

Hypertrophy


1487
65377

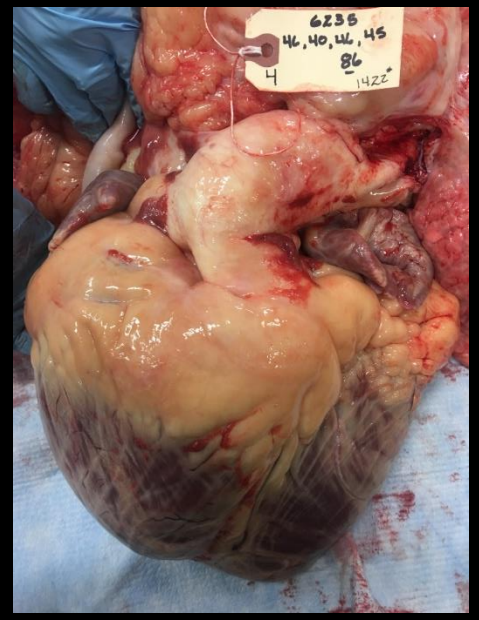
Why do the Heart Scoring?

Estimated loss of $250,000.00 per feedlot, incidence continues to rise and is increasing even now

Etiology **genetic driven**, growth, performance area in which to control loss, selection, etc

PAP score has a positive correlation
to
Higher Heart
scores thus

Pulmonary Hypertension



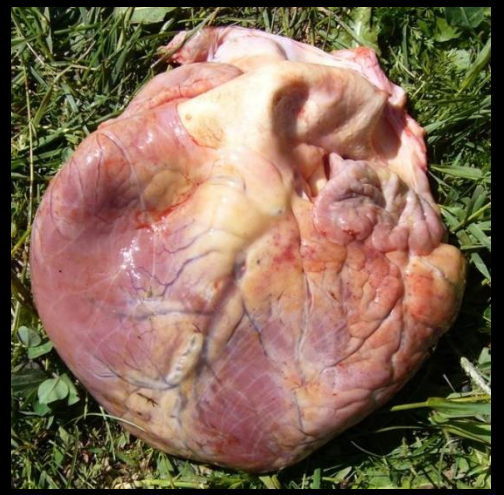
Why do the Heart Scoring

*Evaluate relationship between healthy heart scores and abnormal heart scores by evaluating phenotypic differences seen in fattening cattle

*Better understand the relationship of heart scores in the estimation of heritability for the trait

Genetics vs. Phenotypic

CSU study in genetics
USMARC study, phenotype
Simplot Genetics



High Altitude Disease

- **Condition affecting cattle at altitudes of >5,000 ft.**
- **Pulmonary arterioles begins to constrict and thicken in response to low oxygen being transported.**
- **Selecting bulls with lower PAP has been successful in producing progeny with lower PAP scores thus more adapted to elevation.**

Feedlot Heart Disease

- Condition affecting feedlot cattle at low to moderate altitudes.
- Direct cause is currently unknown, but these individuals experience heart remodeling similar to animals experiencing brisket disease.

HYPOXIA

PAP is currently used as a decision factor for culling animals in the herd who display high PAP at early ages.

Kukor et al., 2021

Heart Fat Score

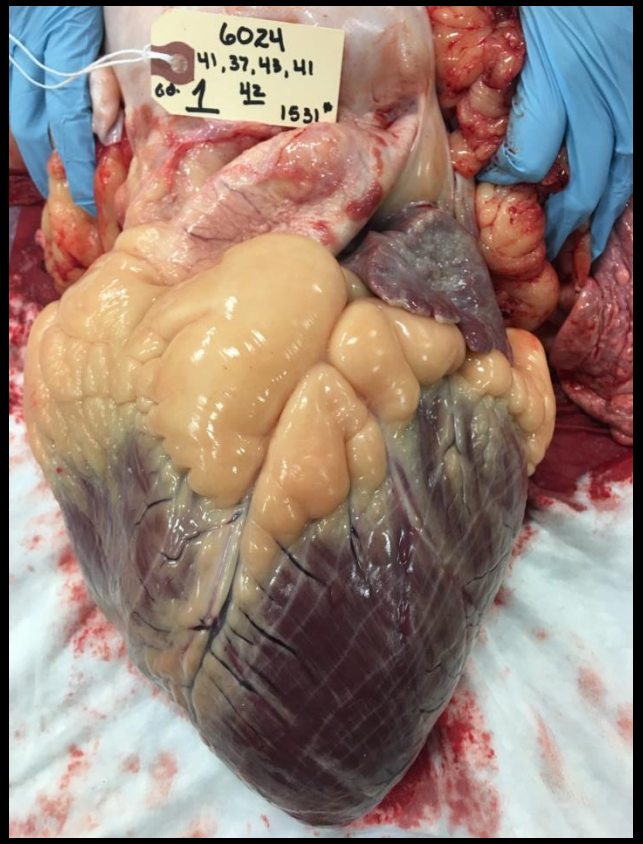
- *Epicardial fat has been shown to have relationships with pulmonary hypertension in humans.

1 2 3

Kukor et al., 2021

Tracking and Evaluating Incidence of Cardiac Failure

Gross Visual
External Cardiac Evaluation
Grading system
1-5



GRADE: 1, Normal Heart

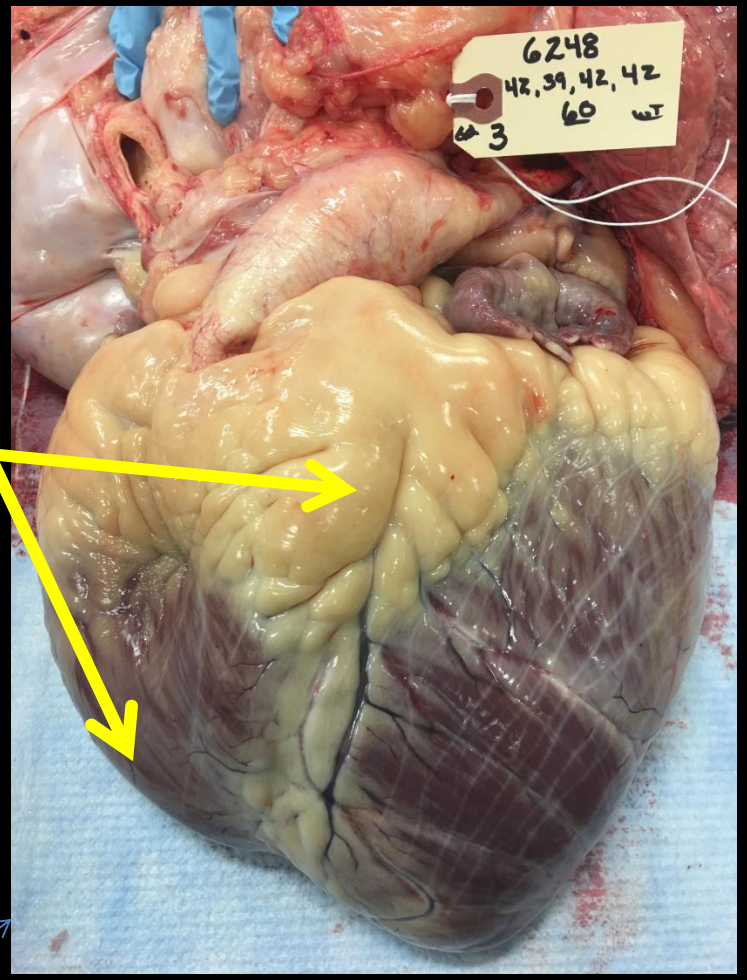
-Normal conical shape
-Normal left ventricle apex, easily visible
-Right ventricle smaller than left and in normal portion, fitting on the side of left ventricle
-Normal Atrial Anatomy, right atrium smaller than left
-No clinical evidence of infarction or aneurysm pending, no thinning of vessel wall
-Normal Pulmonary Artery size
-May appear as 2 but with rigor may develop and shrink to 1

Gross Visual
External Cardiac Evaluation
Grading system
1-5

GRADE: 2, Mild Change

-Normal conical shape
-blunting of left ventricle apex, visible but losing apex point
-Right ventricle becoming larger than left, right ventricle becoming pronounced.
-Right Atrium beginning to enlarge, same size or slightly larger than left.
-No clinical evidence of infarction or aneurysm pending, no thinning of vessel wall
-Pulmonary artery beginning to show mild enlargement.
-Cardiac muscle when palpated is stiff and suggestive of hypertrophy and loss of lumen space, may be biventricular
-2+, Right Ventricle enlarged but not complete reverse D, flaccid

Gross Visual
External Cardiac Evaluation
Grading system
1-5



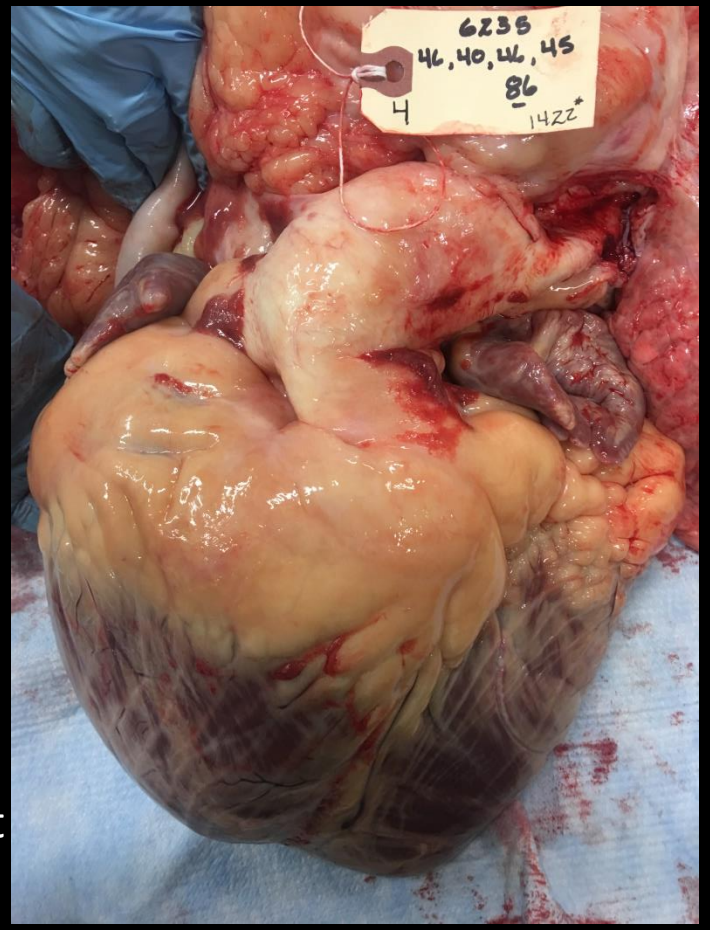
GRADE: 3, Moderate Change

-Beginning to lose conical shape
-Blunting of left ventricle apex, visible but losing apex point and deviating, beginning of reverse "D"
-Right ventricle larger than left, right ventricle becoming more pronounced.
-Right Atrium enlarged, Atrium larger than left
-Can be clinical evidence of infarction or aneurysm pending, thinning of vessel wall apparent
-Pulmonary artery enlarged.
-Cardiac muscle when palpated is stiff and suggestive of hypertrophy and loss of lumen space, may be biventricular, after removal muscle may be severely flaccid

Gross Visual
External Cardiac Evaluation
Grading system
1-5

GRADE: 4, Severe Changes

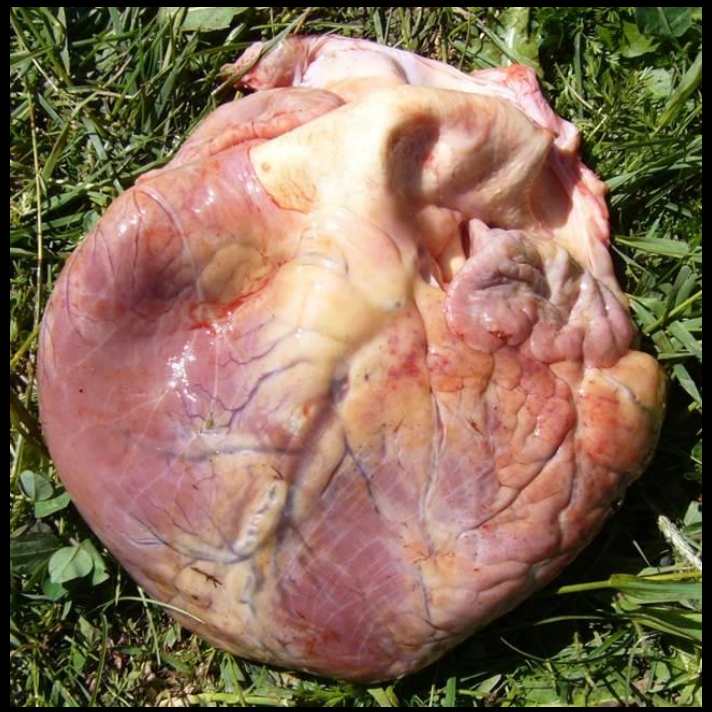
-Lose of cardiac conical shape
-Left ventricle apex has been lost due to ventricular rounding. Reverse "D" is apparent.
-Right ventricle larger than left, right ventricle becoming more pronounced and taking on rounding shape.
-Right Atrium enlarged, Atrium larger than left and remains congested
-Can be clinical evidence of infarction or aneurysm pending, thinning of vessel wall apparent
-Pulmonary artery enlarged greatly.
-Cardiac muscle when palpated is becoming soft and without shape but still has some muscle tone.



Gross Visual
External Cardiac Evaluation
Grading system
1-5

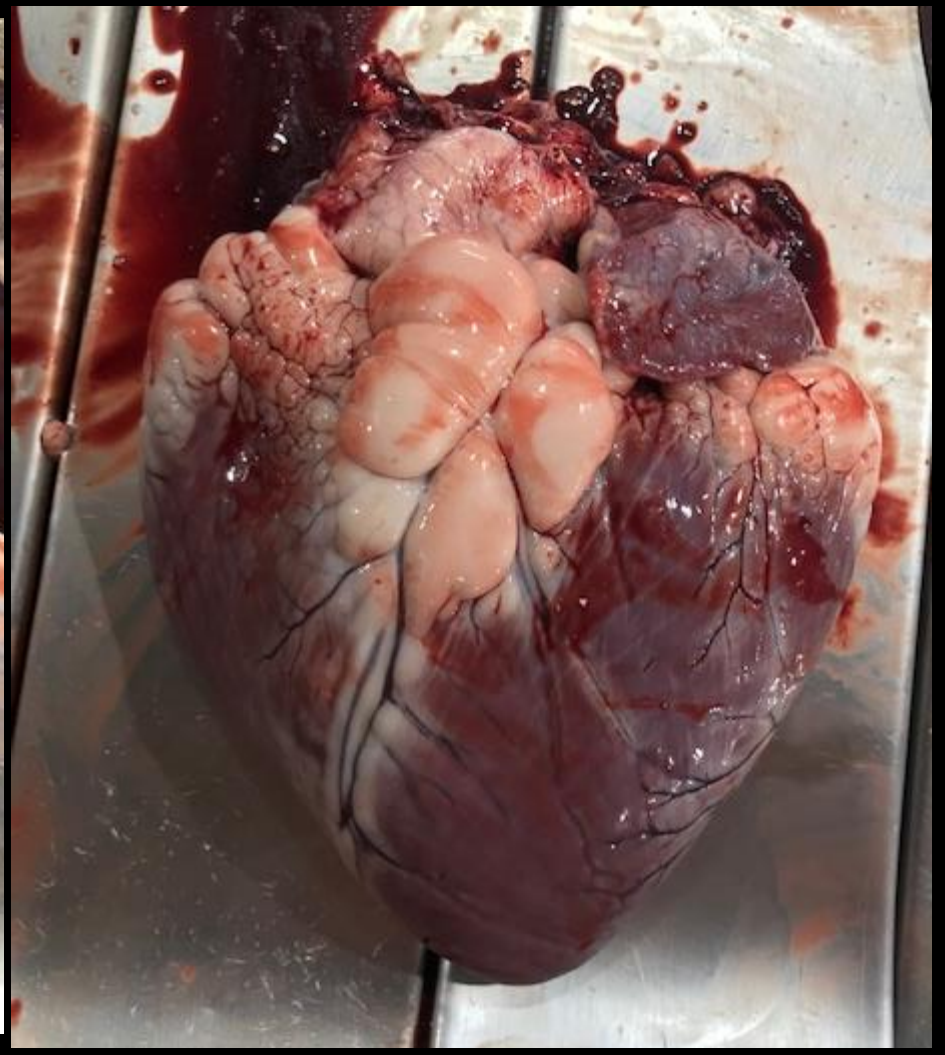
GRADE: 5, Severe Changes, flaccid heart

-Loss of cardiac conical shape, severe
-Left ventricle apex has been lost due to ventricular rounding. Reverse "D" is apparent.
-Right ventricle larger than left, right ventricle becoming more pronounced and taking on rounding shape.
-Right Atrium enlarged, Atrium larger than left and remains congested.
-Can be clinical evidence of infarction or aneurysm pending, thinning of vessel wall apparent
-Pulmonary artery enlarged greatly.
-Cardiac muscle when palpated is soft and without shape, there is no muscle tone and heart lays flat.

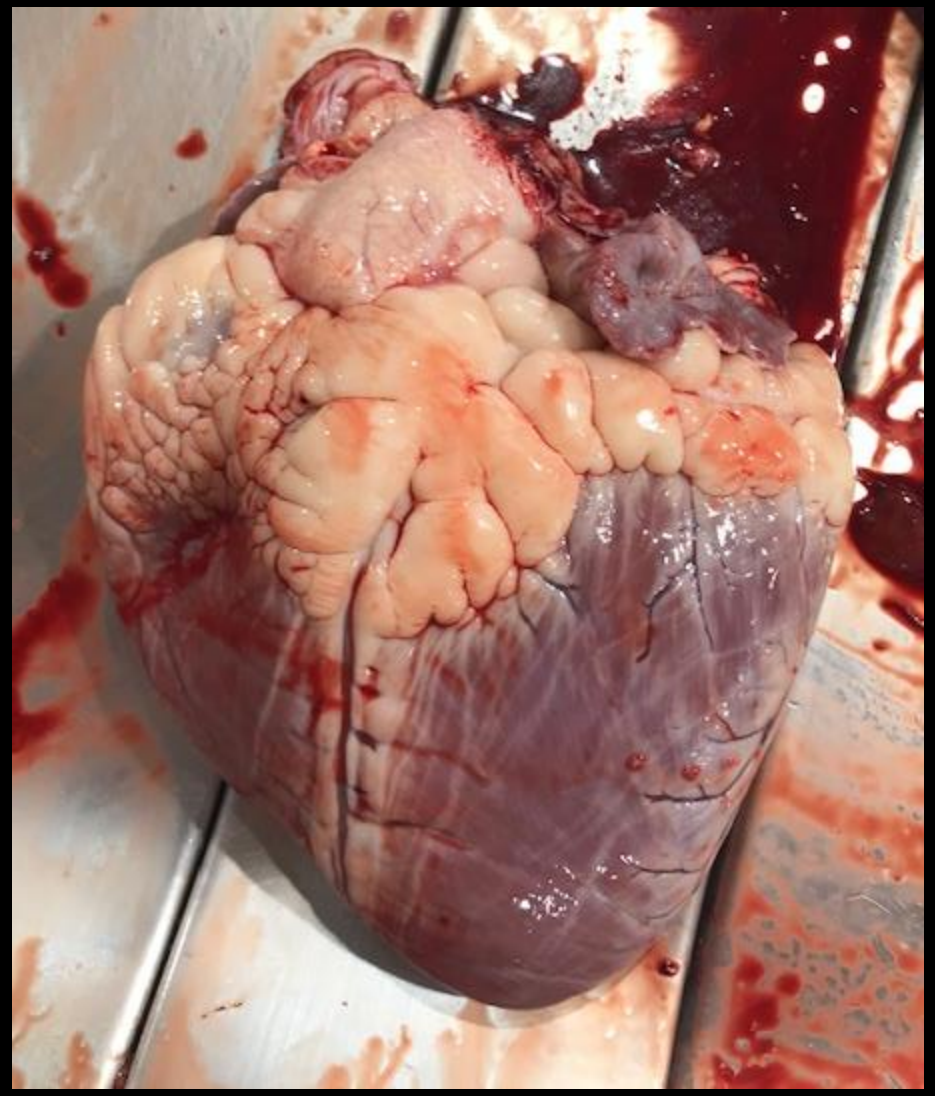


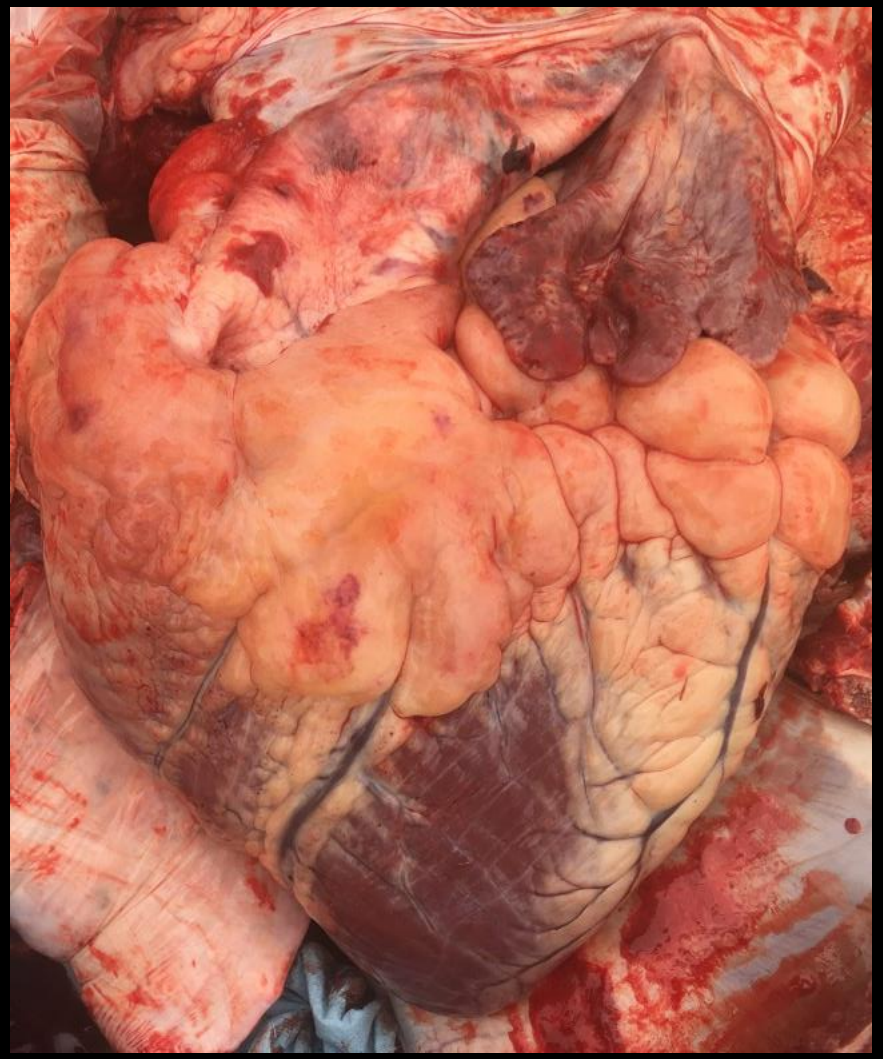
Examples of Grade 1

Examples of Grade 2

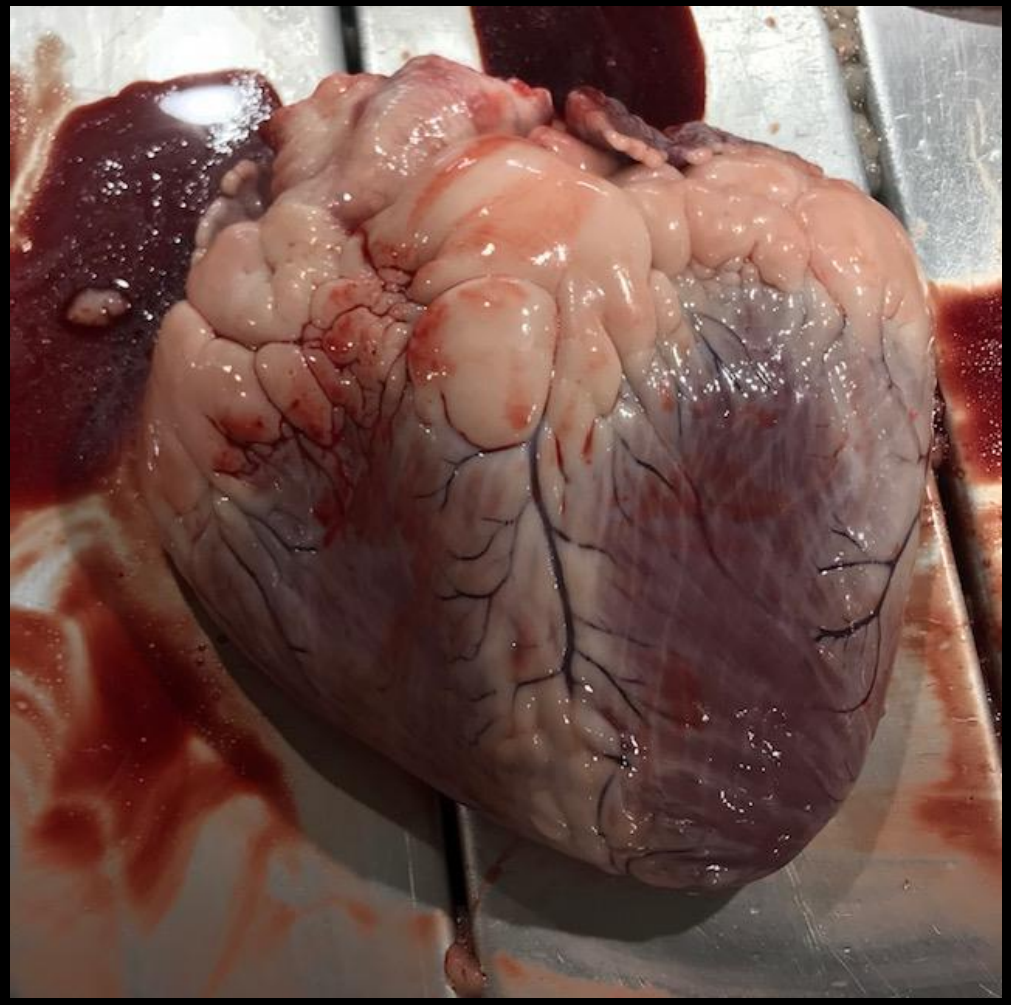


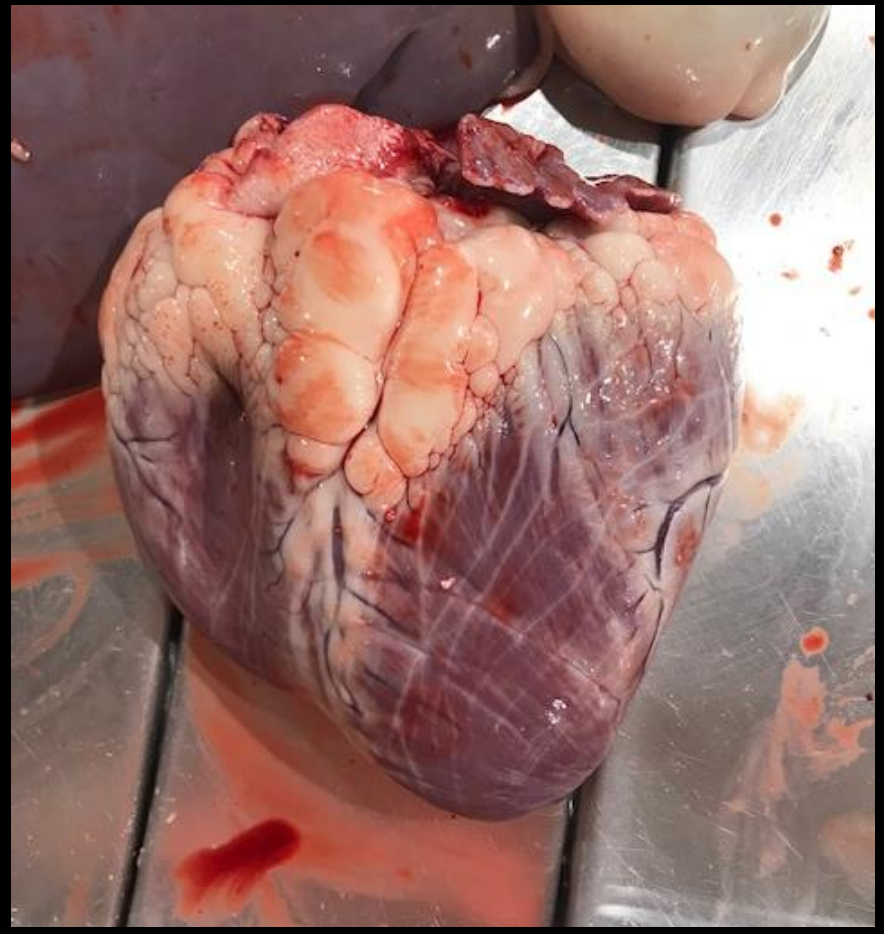
Examples of Grade 3



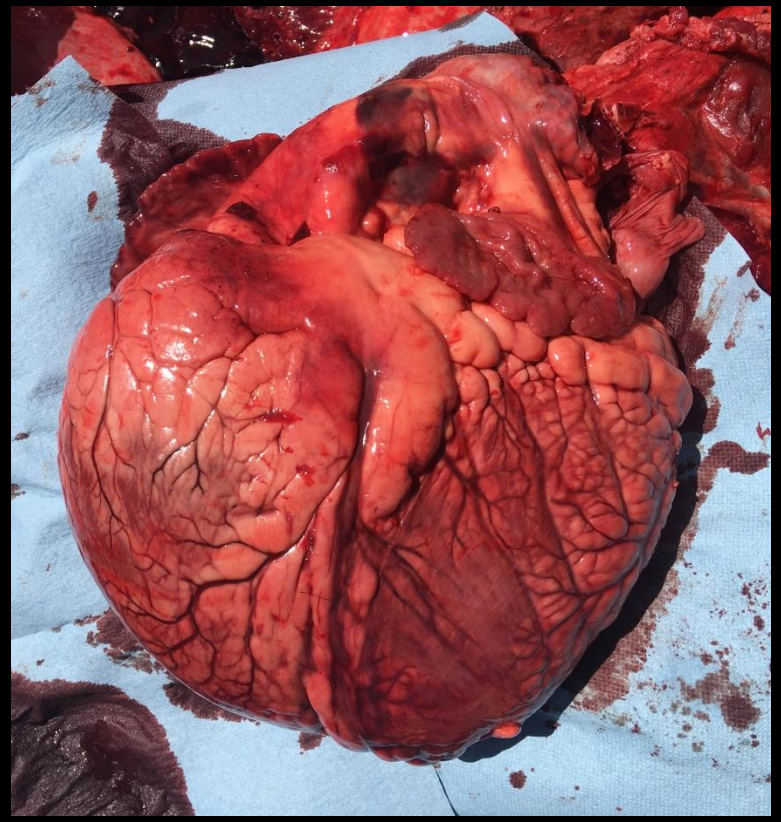


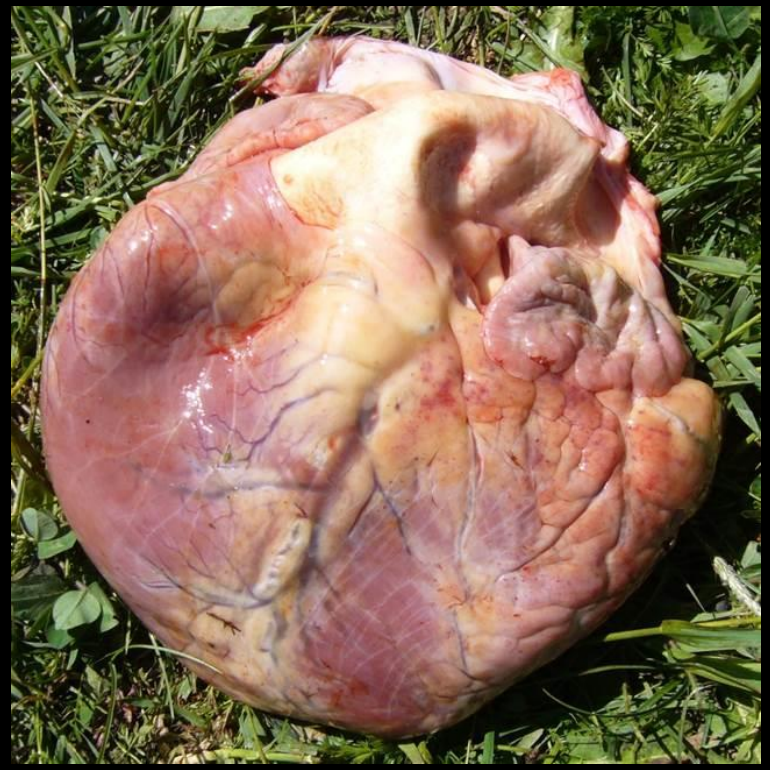
Examples of Grade 4



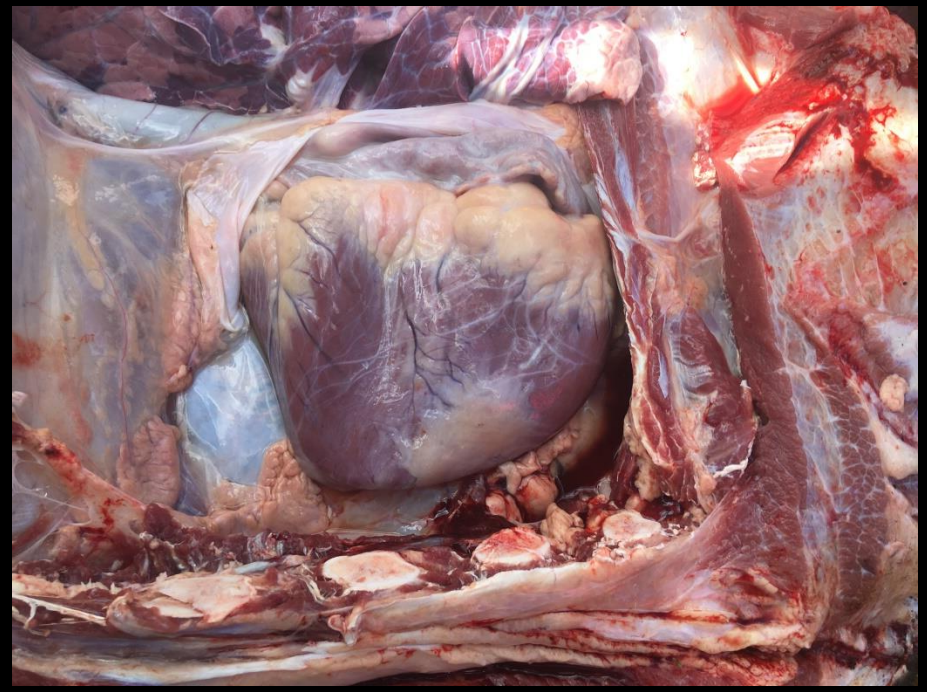


Examples of Grade 5

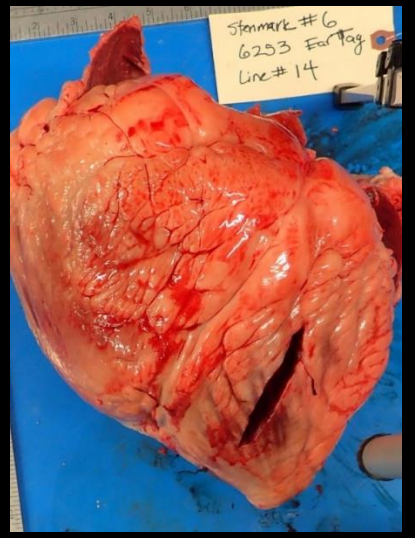




Examples of Grade 5



Heart Scores Summary
Thus far



Results thus far:

*High Heart Scores correlate with
High Heart Fat Scores

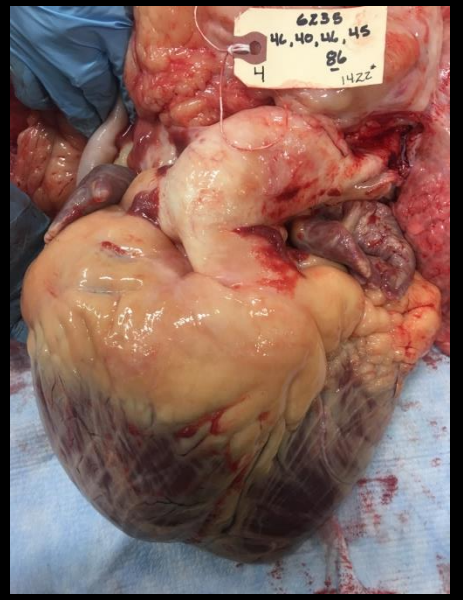
*There is a high correlation to sire groups

Conclusions:

Significant score effect, 56 sires accounted for

66% ; scored 1,2 normal

34% ; 3 plus, significant cardiac remodeling



PAP Testing Adventures

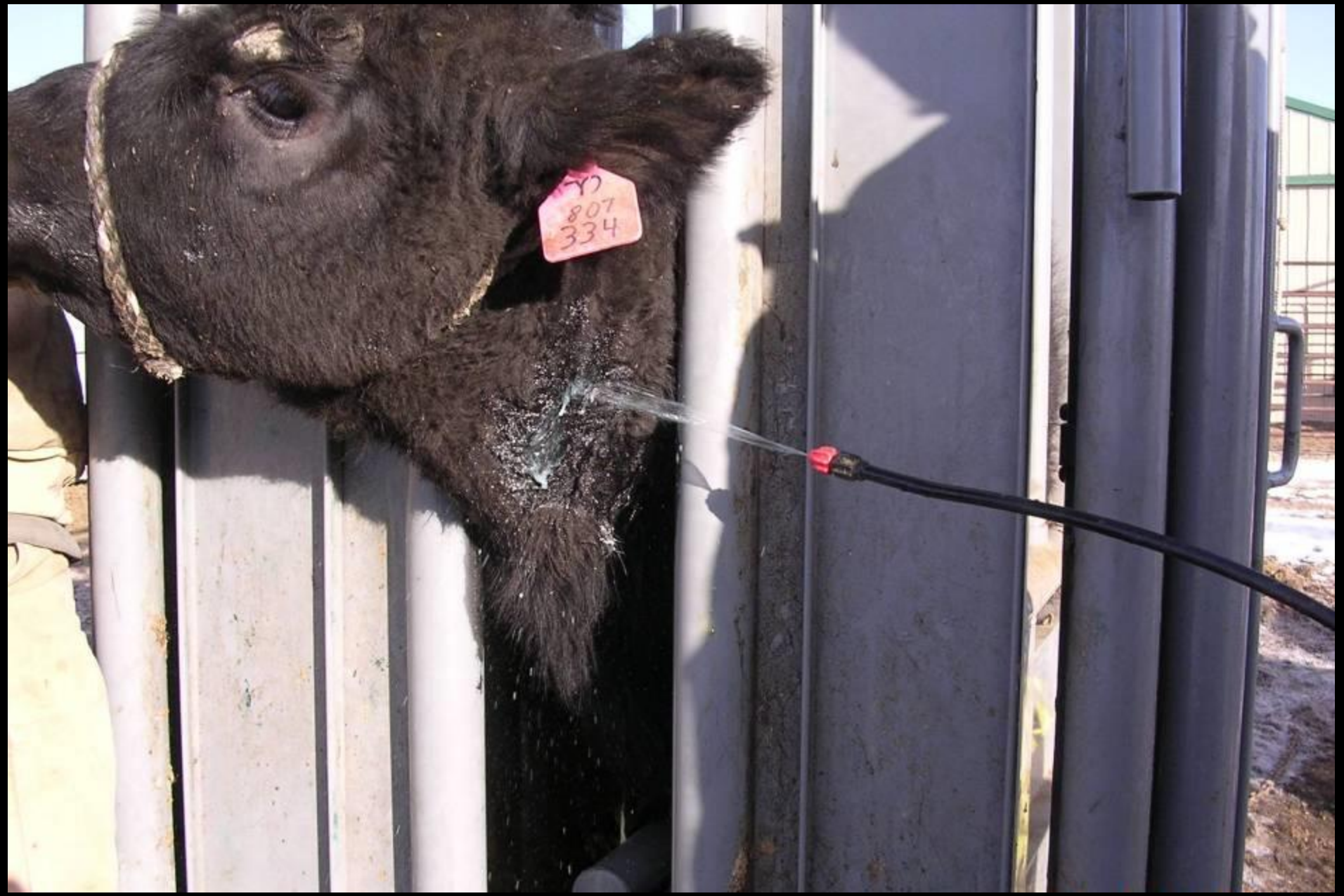
- 1980 in Gunnison/Hesperus Colorado
- 1980-Present, >492,000 head
- Ambient Temps **-42** degrees to **115** degrees.
- Numerous Breeds with high Pap's in all
- Elevations from sea level to 14,300 feet

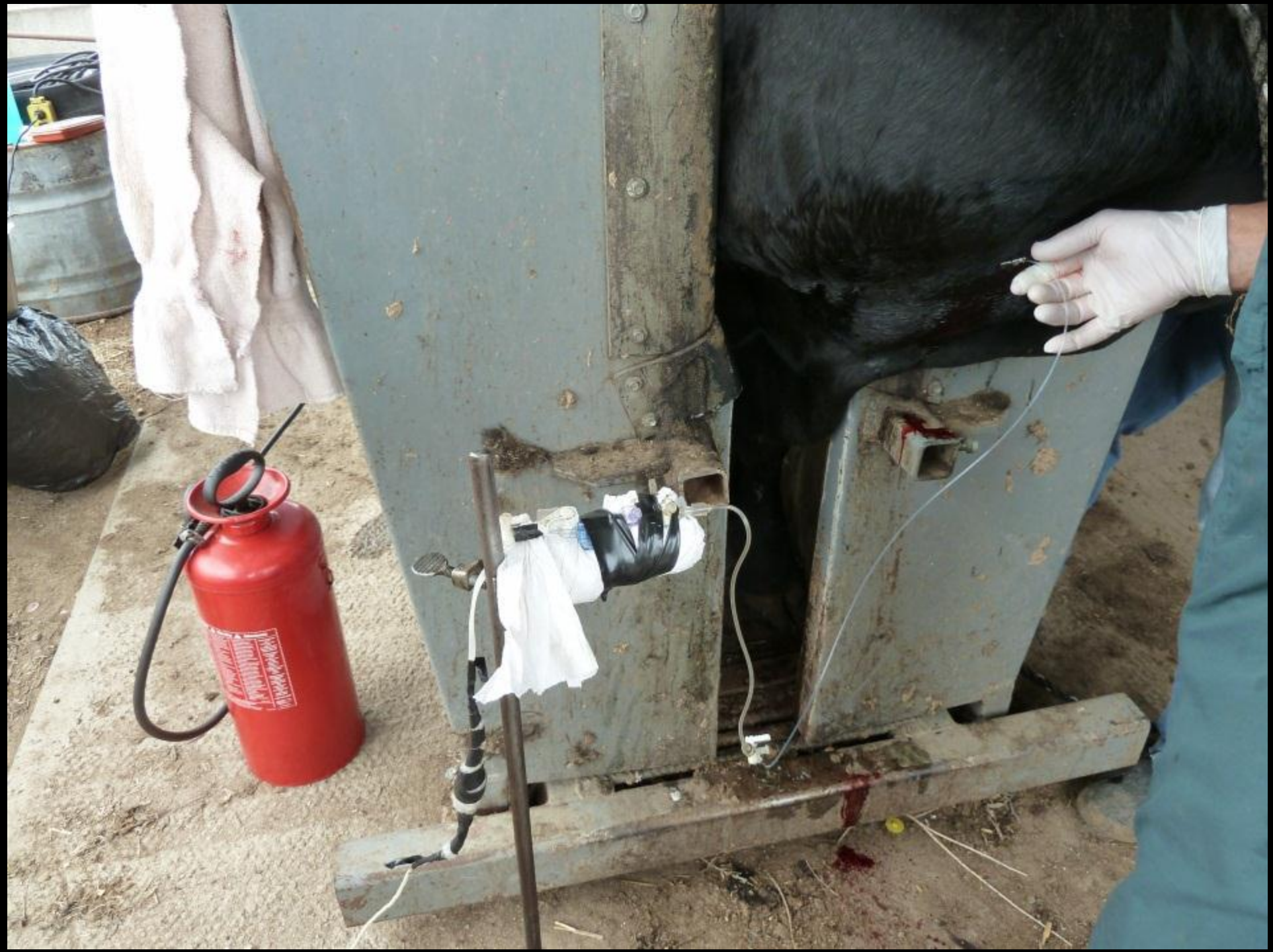

Minus 12 degrees F
7800 Feet Elevation


REDDY HEATER

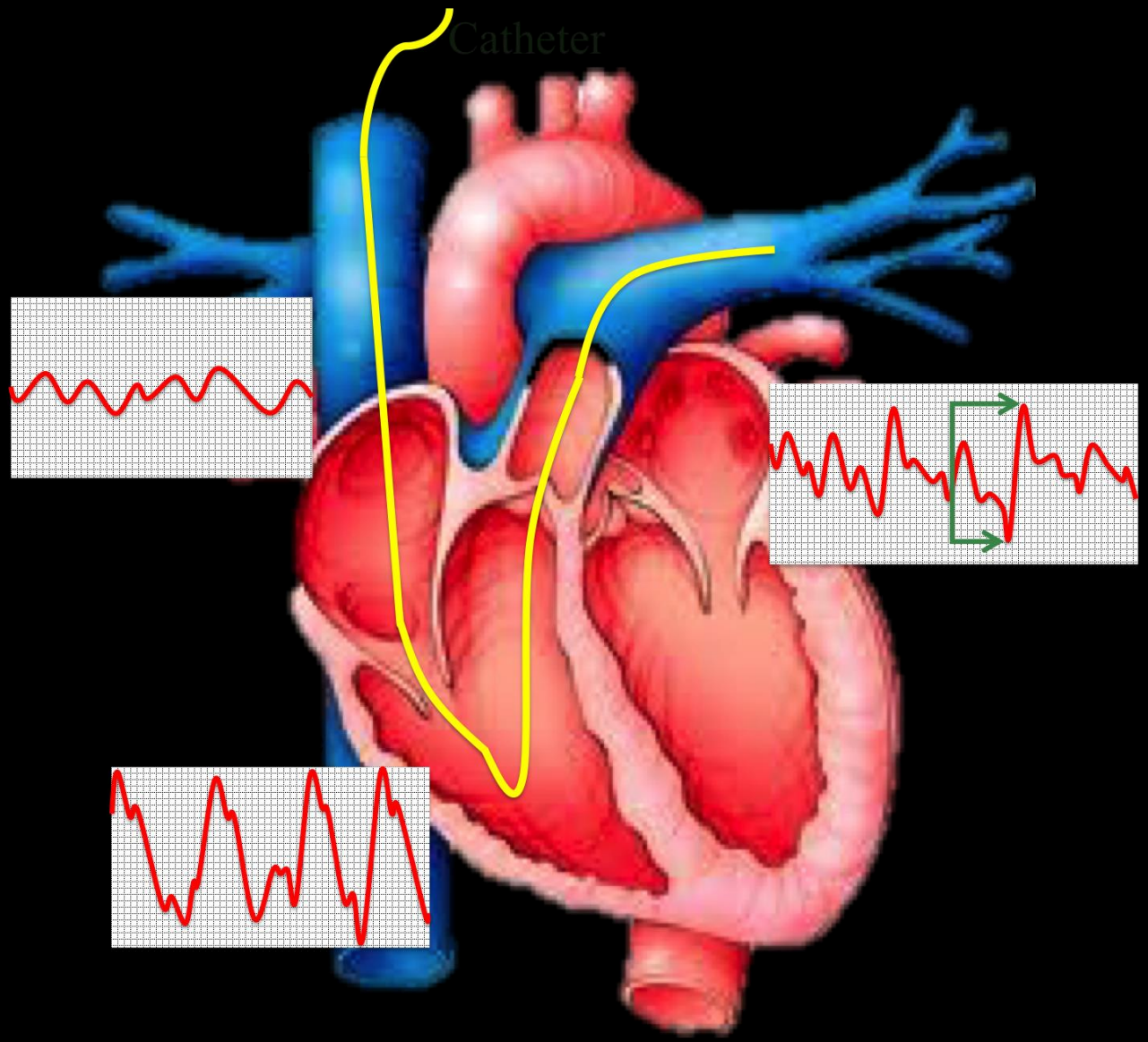

LET'S
DO
THIS.

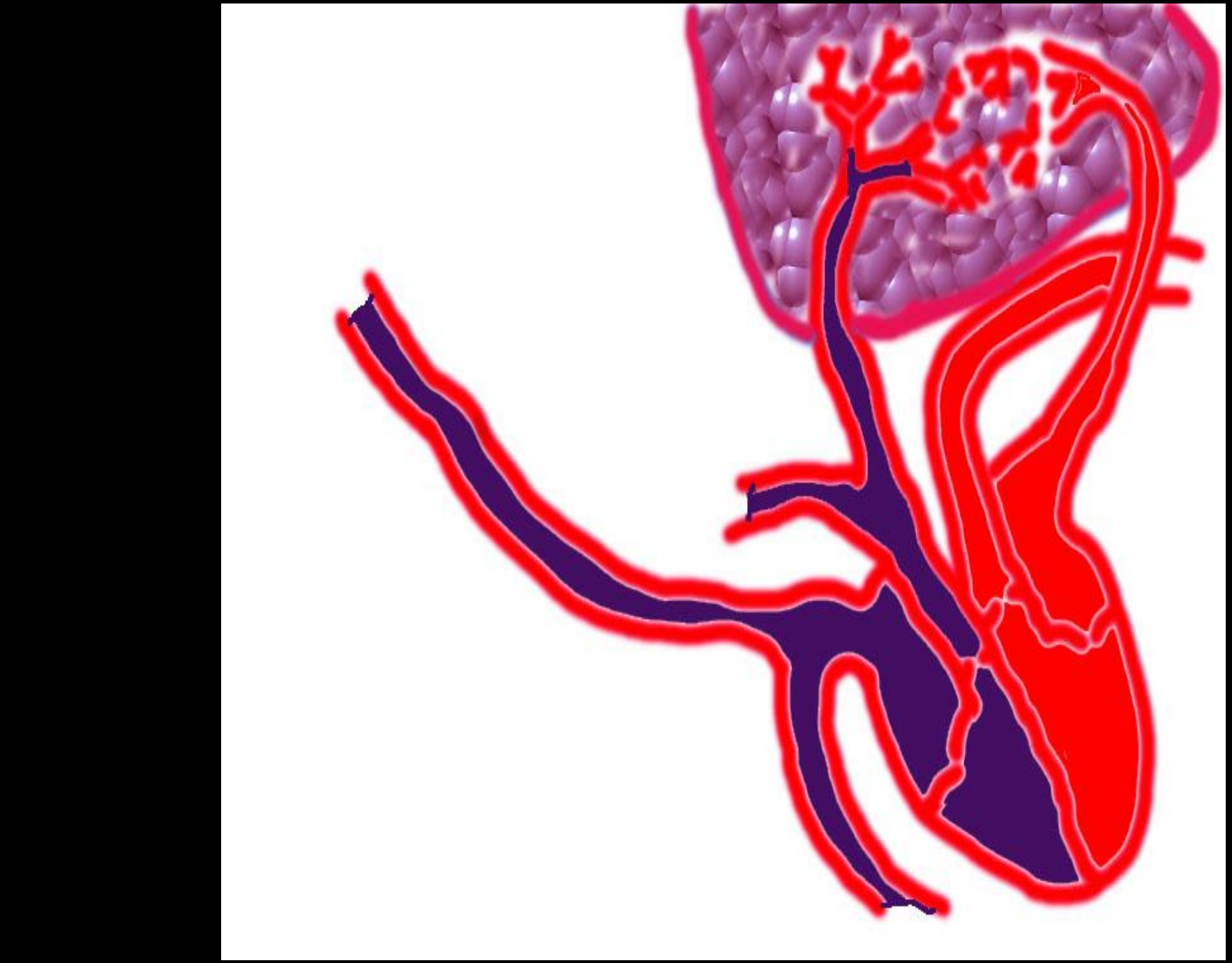

Rides

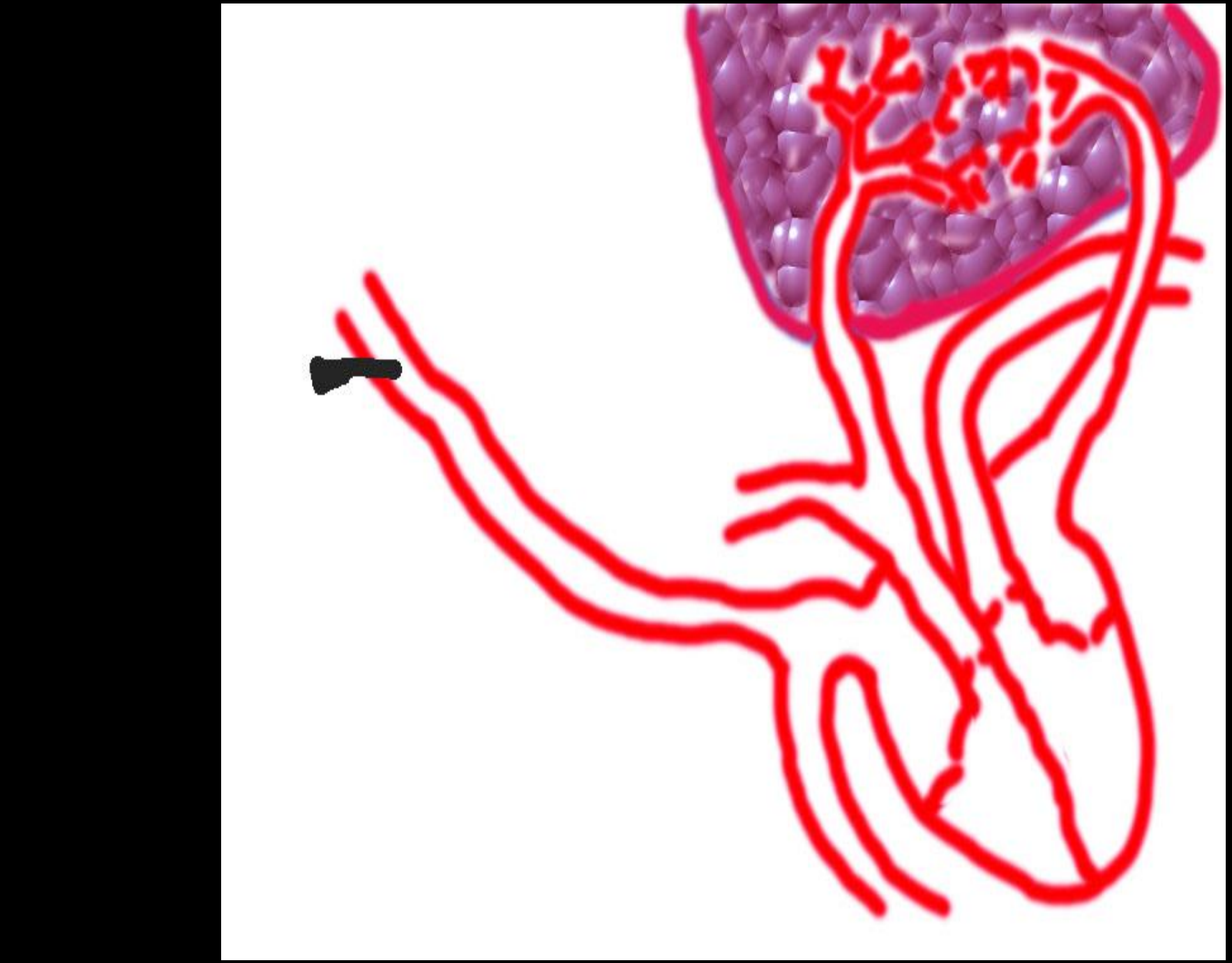

807
334

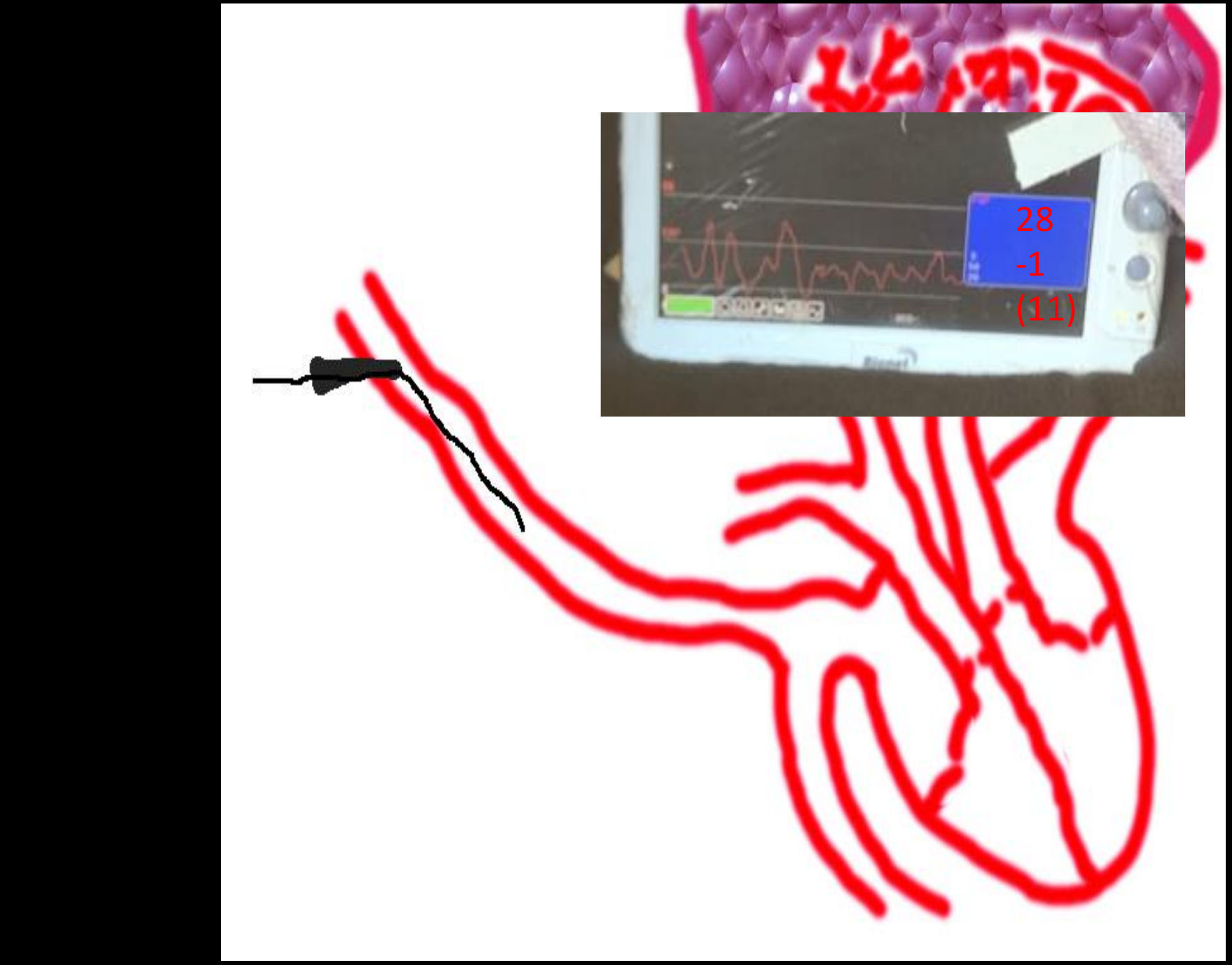


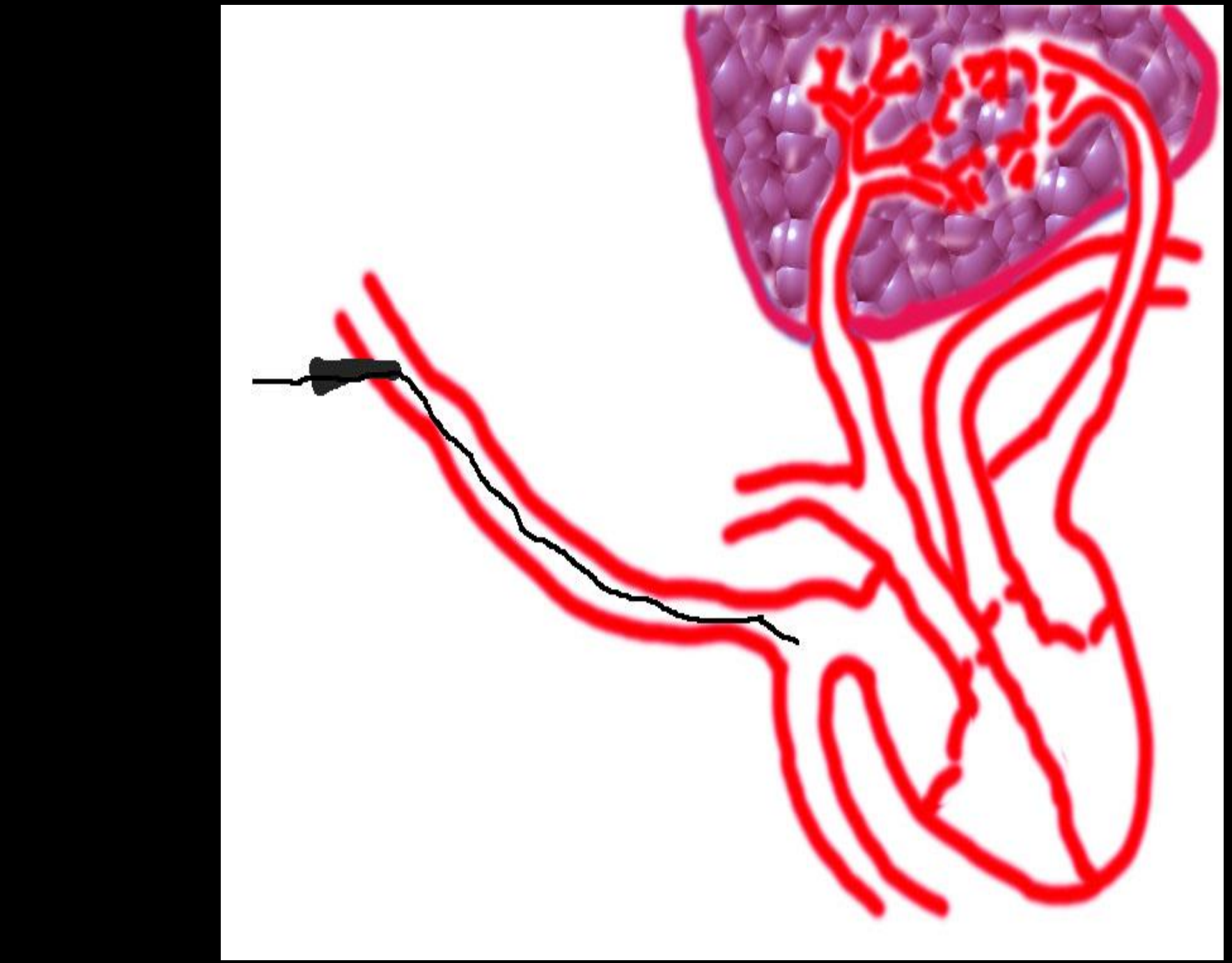
PAP Measurement Catheter Location



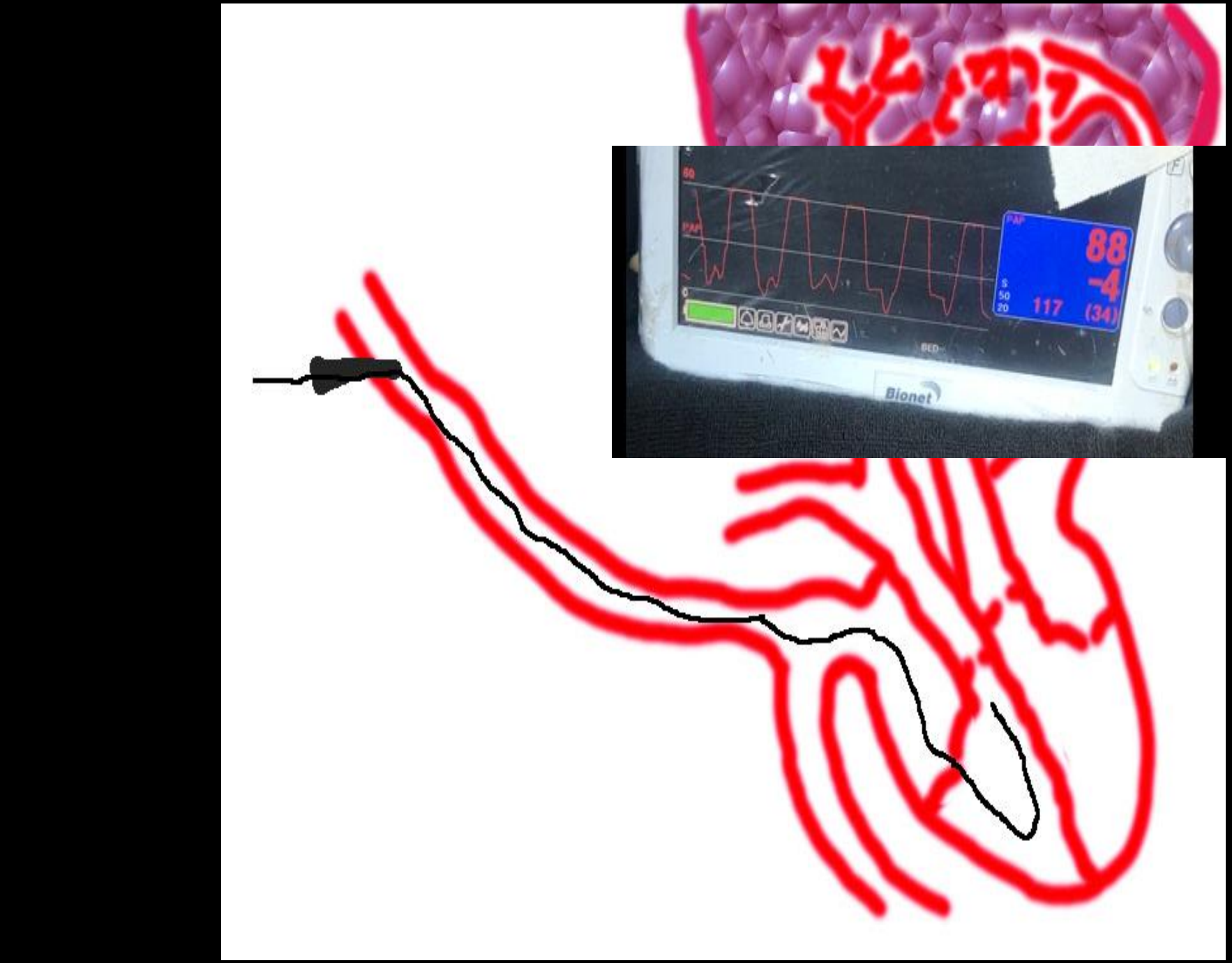


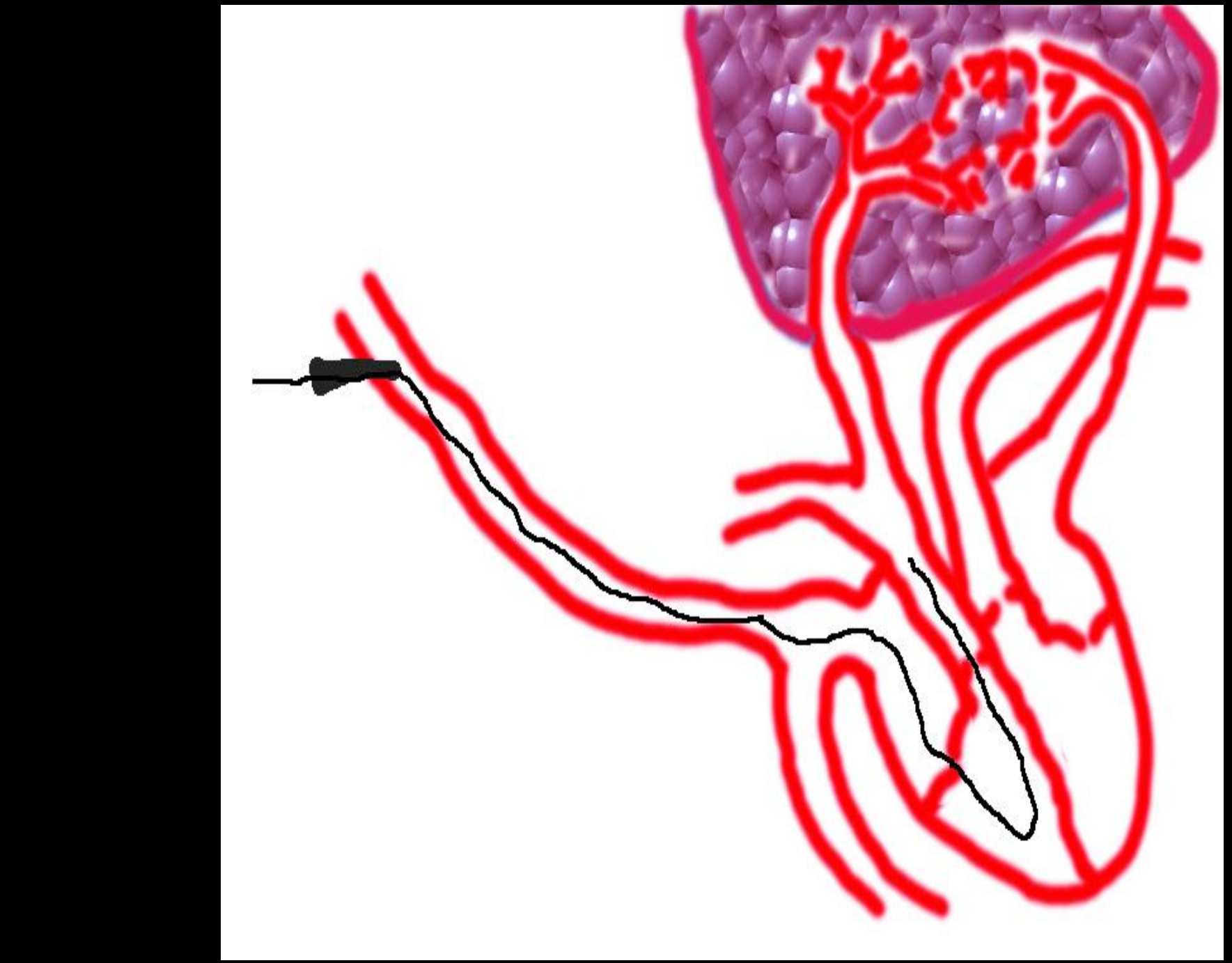



28
-1
(11)

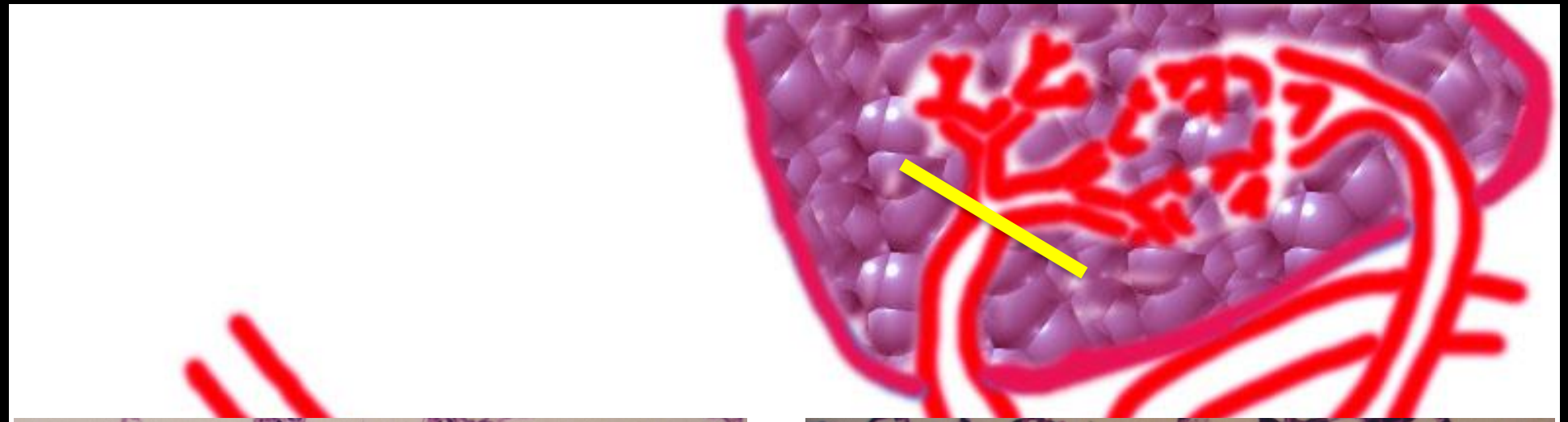


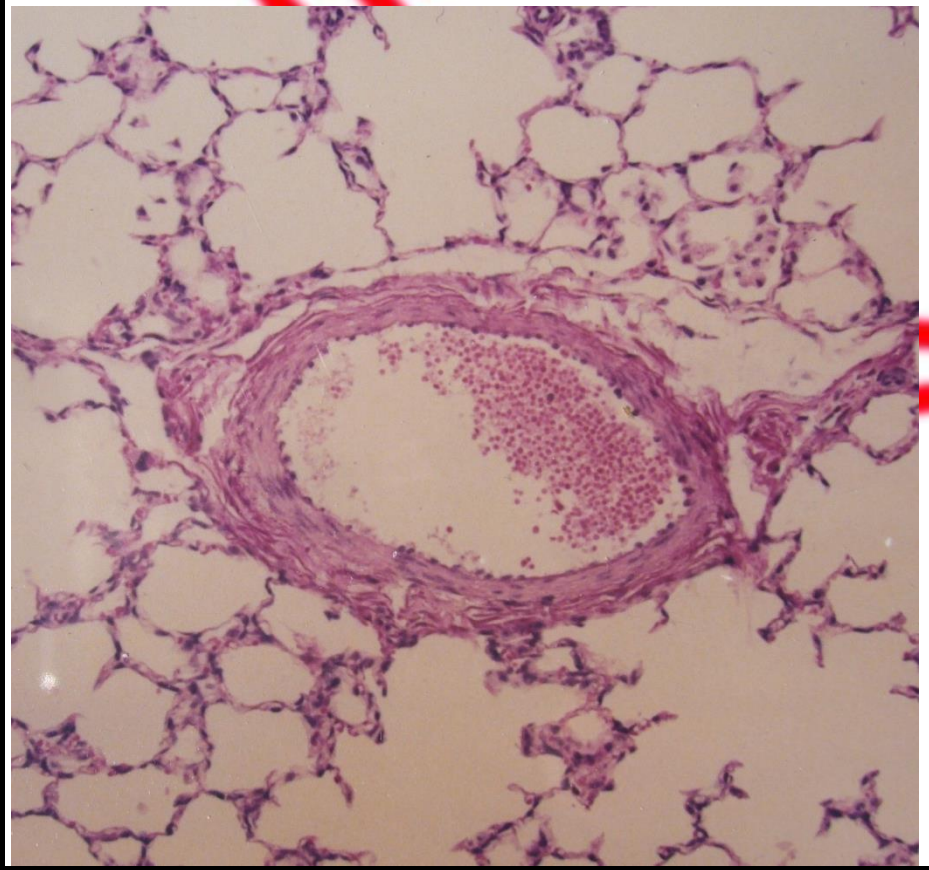

60
PAP
PAP
98
0
S
50
20
128
(37)
Bionet

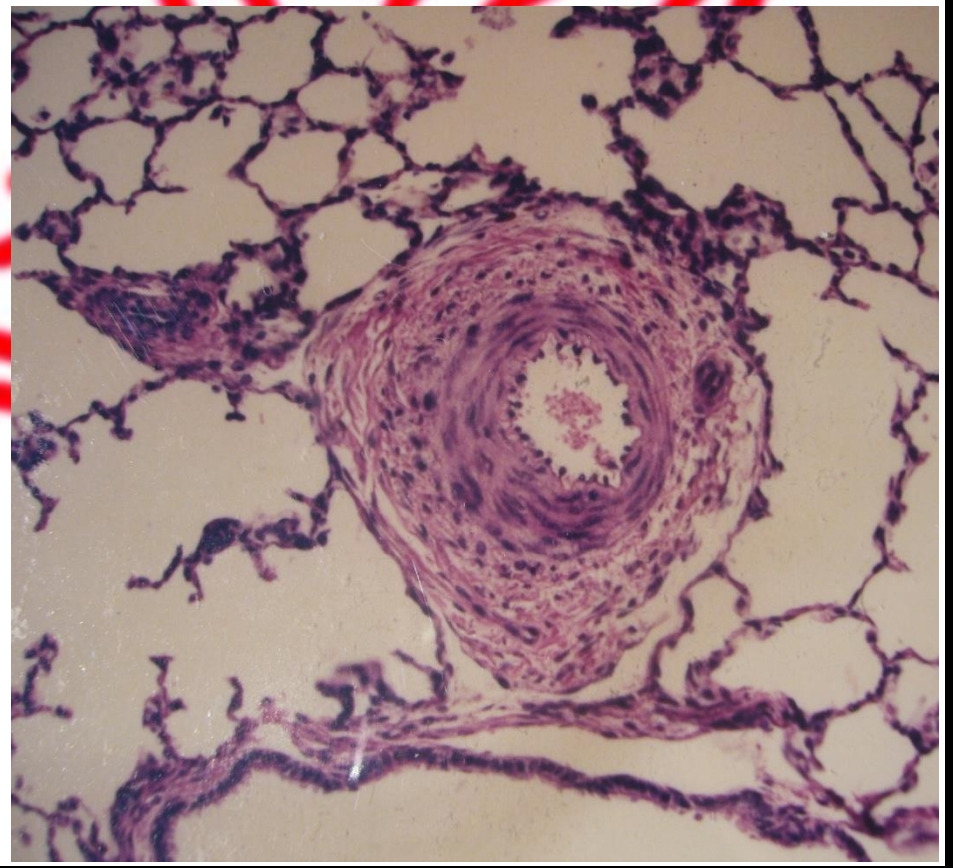

PAP
88
-4
117
(34)
Bionet




PAP
88
4
97
(44)
Bionet





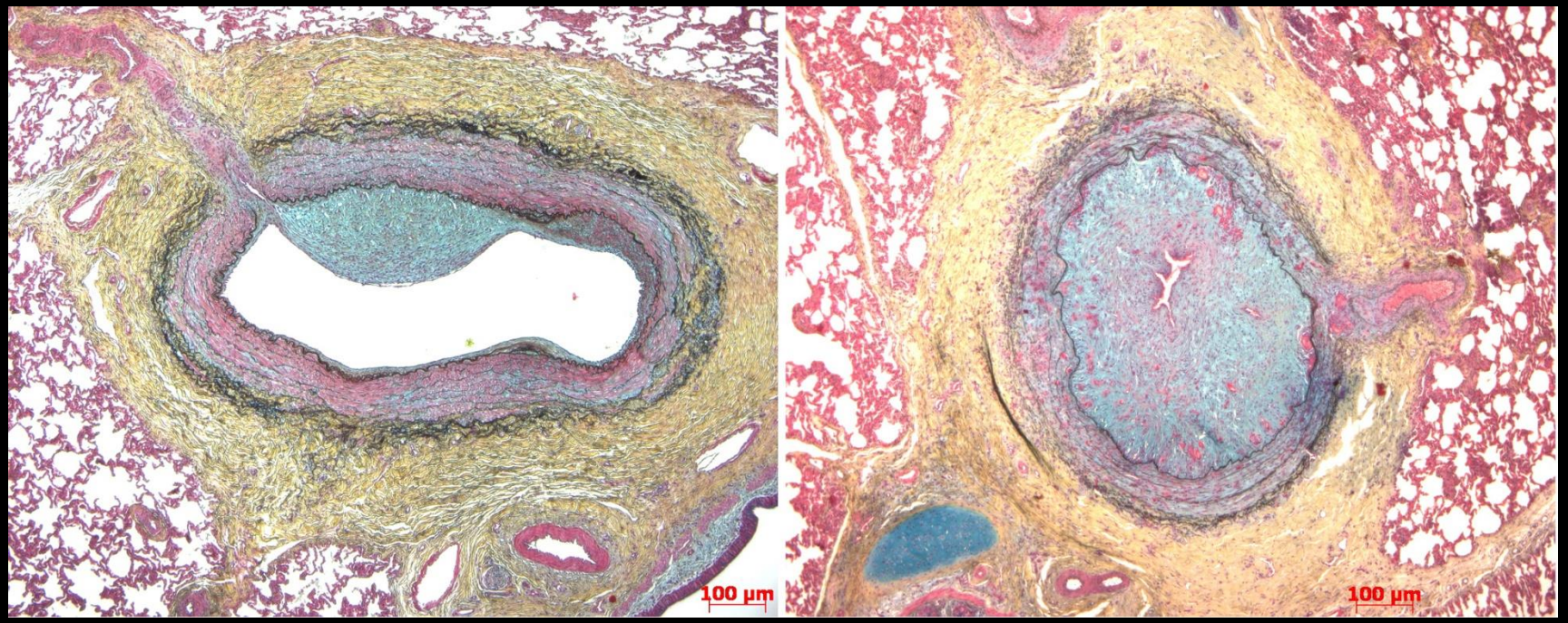



CURAD
Latex
PF
Bionet


BM5 VET
DOG
102
-1
114
(41)
Bionet

PAP
of
46 mmHg

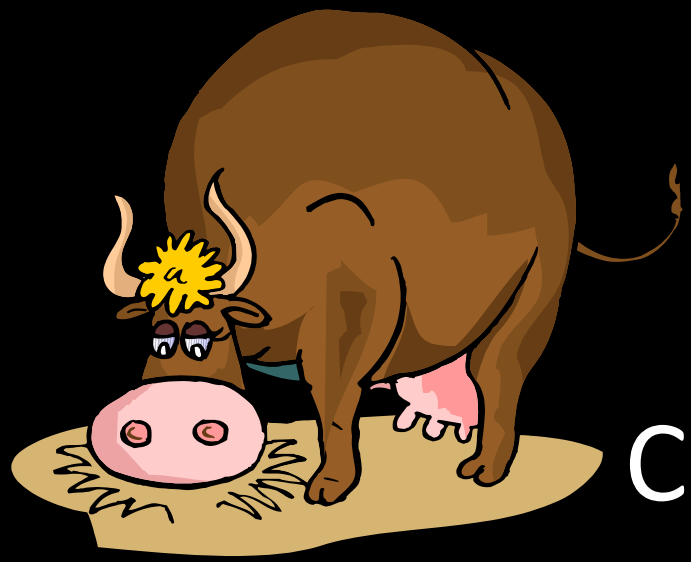
PAP
of
94 mmHg



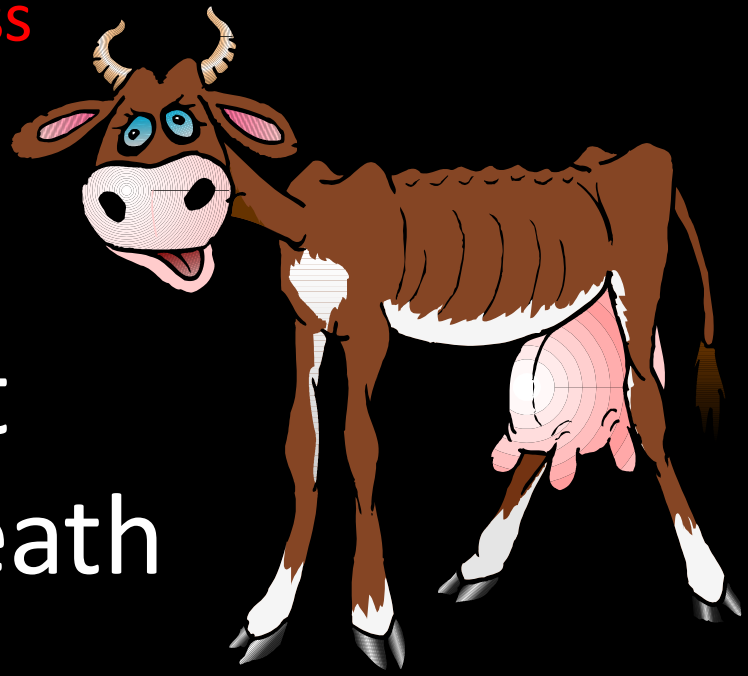
Confounding Factors
"Body Condition"

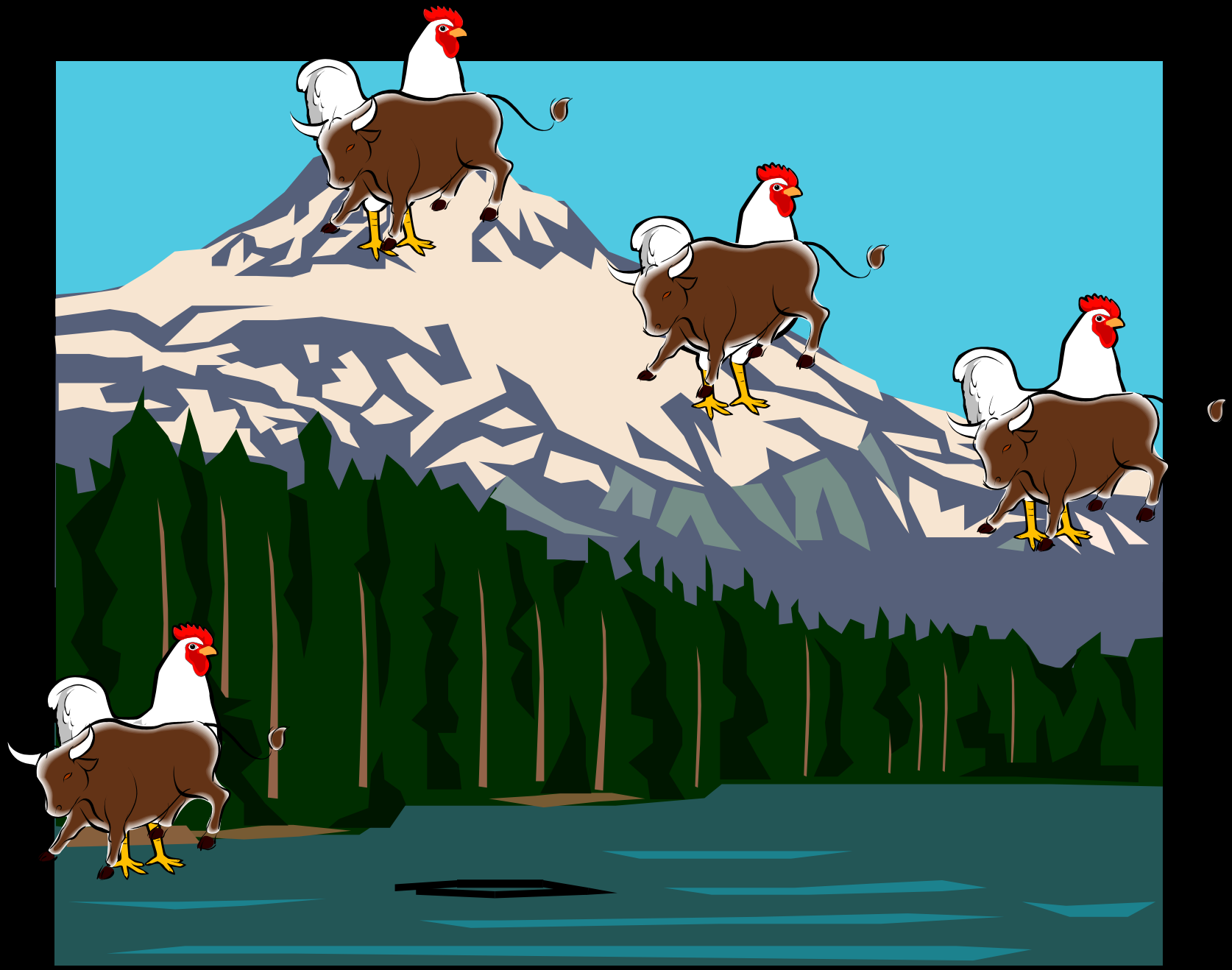
- Excessive body condition increases PAP
  - Bulls on Test
  - Feedlot Cattle, Newest area of Research!

1.4 billon dollar loss
per year
concerning

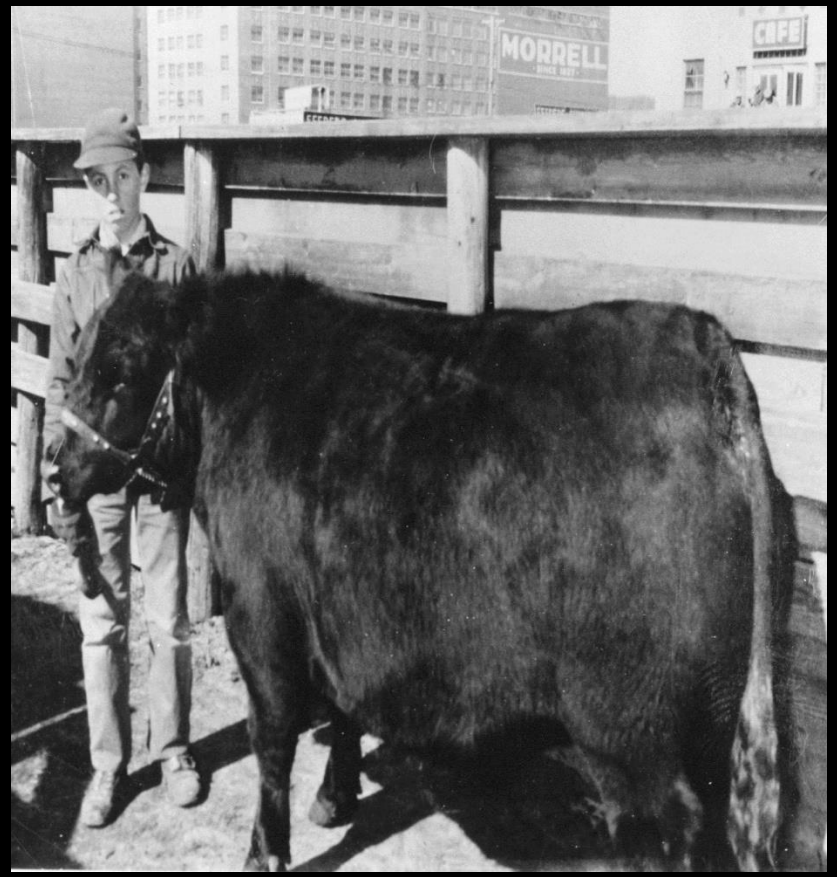


Feedlot
Cardiac Death



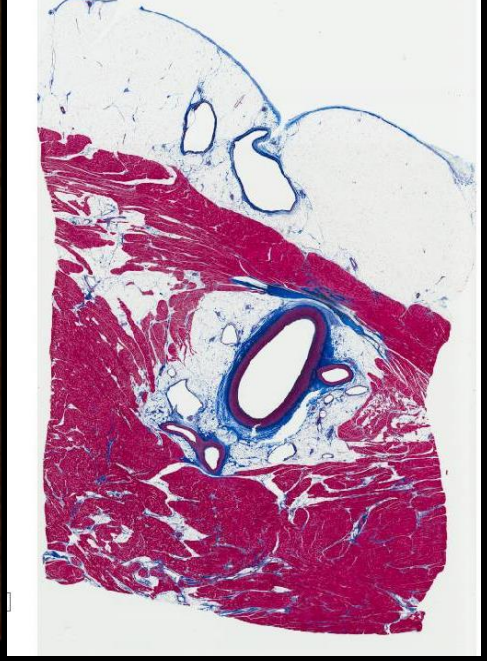


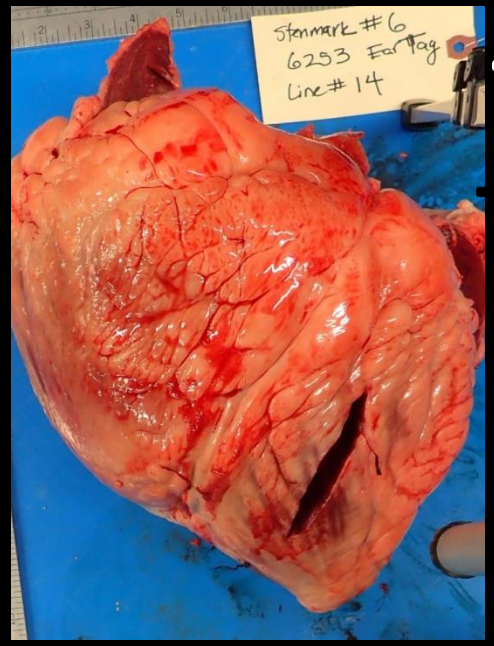
Average Live Market Weight has Increased 48% since 1944



1953 Angus Steer
950 lb. Live Weight

2015 Angus Steer
1200-1600 lb. Live Weight



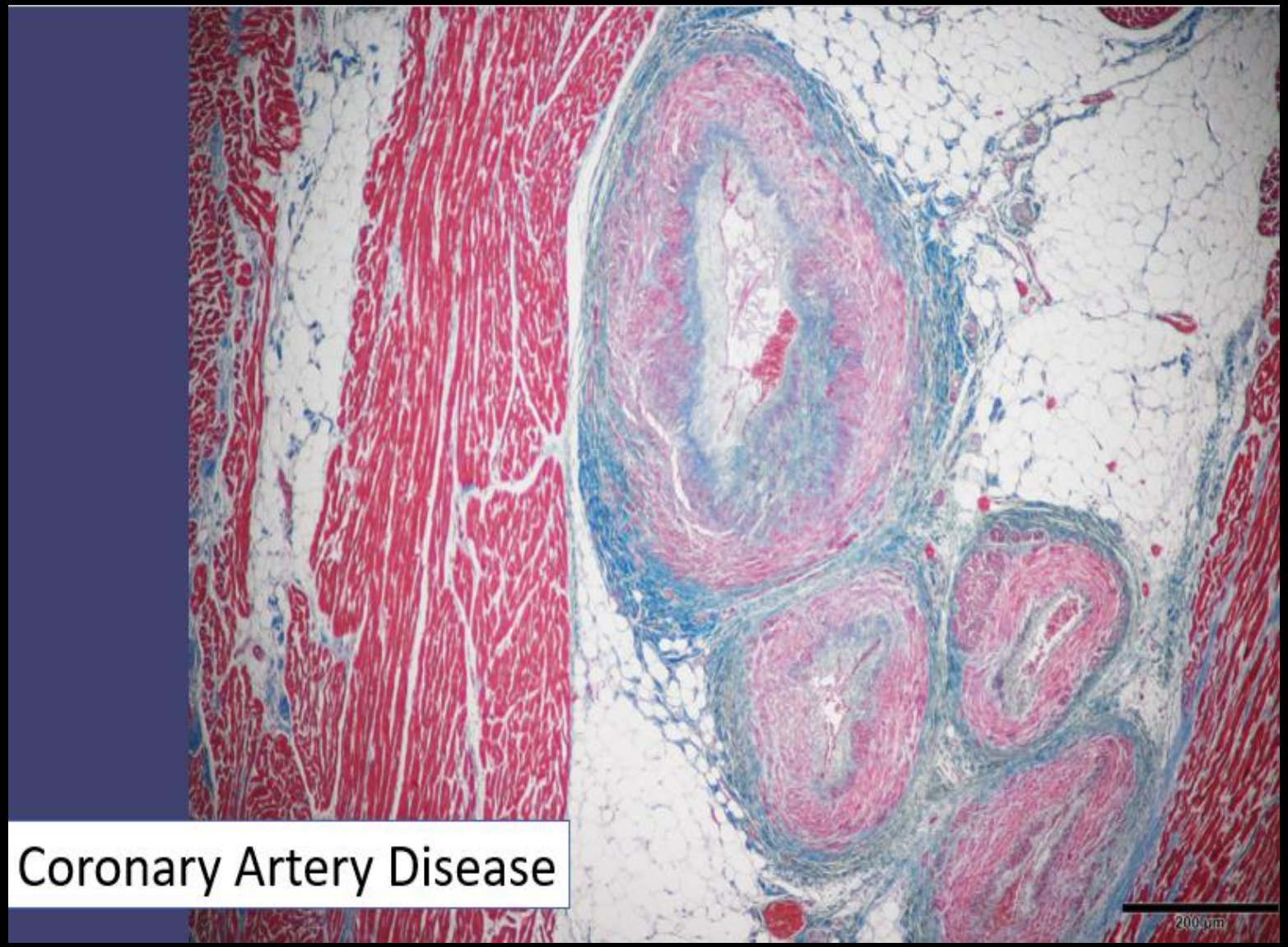


The Well-Marbled Heart

Closer Look at Feedlot Cardiac Death
Is It Bovine High Mountain Disease

Feedlot Cardiac Death

Fattening Induces Hypercholesterolemia and Dyslipidemia



Obesity

Hypoxia

PH

Cardiac Death

Greta

Altitude and Repeatability

- <5000 feet

  Estimated Repeatability

  60% Predictive

  Screening only

- 1-1.5 mmHg increase per 1000 feet elevation rise.

Elevated PAP—Accurate Measurements <41

Questionable predictive value

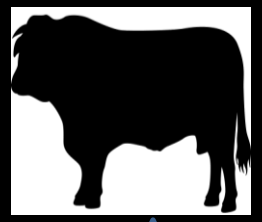
PAP Hot Topics

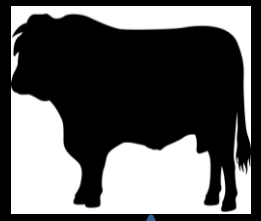
Herd Example: Red Angus Bulls
16 months of Age

25 head out
1-4 weeks
12 BHMD

PAP Test #2
75 remaining

PAP Test #1,
100 selected
36-41 mmHg





MT
3,200 ft

6 weeks

Laramie, WY
7,240 ft

Results
Elevation and Repeatability
(3200 ⟶ 7240 feet)

- **48% (36/75) had PAPs ≥46 mmHg**
  - **10/75 had PAPs 46-50 mmHg**
    - **Pulled from sale**
  - **26/75 had PAPs > 50 mmHg**
    - **Pulled from sale and moved to lower elevation**
- **52% (39/75) had PAP ≤45mmHg**
- **Average increase of +12 mmHg**

PAP Risk Factor

Low Elevation Test Chart

PAP test conducted at elevation ≤4000 ft.

(60% Repeatable, Predictive Value)

PAP Score	Use at Low Elev. (<4000 feet)	Use at Moderate Elev. (4000-5500 FEET)	Use at High Elev. (5500-7500 feet)	Use at Extreme (>7500 feet)
34-39	Low Risk	Low Risk	Moderate Risk	High Risk
40-45	Low Risk	Moderate Risk	High Risk	High Risk
46-49	Moderate Risk	High Risk	Do Not Use	Do Not Use
≥50	Moderate Risk	High Risk	Do Not Use	Do Not Use

PAP Risk Factor

Moderate Elevation Test Chart

PAP test conducted at elevation 4000-5500 ft.

(70% Repeatable, Predictive Value)

PAP Score	Use at Low Elev. (<4000 feet)	Use at Moderate Elev. (4000-5500 FEET)	Use at High Elev. (5500-7500 feet)	Use at Extreme (>7500 feet)
34-39	Low Risk	Low Risk	Low Risk	Moderate Risk
40-45	Low Risk	Low Risk	Moderate Risk	High Risk
46-49	Moderate Risk	High Risk	Do Not Use	Do Not Use
≥50	Moderate Risk	High Risk	Do Not Use	Do Not Use

PAP Risk Factor

High Elevation Test Chart

PAP test conducted at elevation 5500-7000 ft.

(75-95% Repeatable, Predictive Value)

PAP Score	Use at Low Elev. (<4000 feet)	Use at Moderate Elev. (4000-5500 FEET)	Use at High Elev. (5500-7500 feet)	Use at Extreme (>7500 feet)
34-39	Low Risk	Low Risk	Low Risk	Low Risk
40-45	Low Risk	Low Risk	Moderate Risk	Moderate Risk
46-49	Moderate Risk	Moderate Risk	Moderate Risk	High Risk
≥50	Moderate Risk	Moderate Risk	High Risk	High Risk

PAP Risk Factor

Very High Elevation Test Chart

PAP test conducted at elevation ≥7000 ft.

(95% Repeatable, Predictive Value)

PAP Score	Use at Low Elev. (<4000 feet)	Use at Moderate Elev. (4000-5500 FEET)	Use at High Elev. (5500-7500 feet)	Use at Extreme (>7500 feet)
34-39	Low Risk	Low Risk	Low Risk	Low Risk
40-45	Low Risk	Low Risk	Low Risk	Moderate Risk
46-49	Moderate Risk	Moderate Risk	Moderate Risk	High Risk
≥50	Moderate Risk	Moderate Risk	High Risk	High Risk

WHY ETHIOPIA?

- Ethiopian highlanders maintain venous hemoglobin concentrations and arterial oxygen saturation within the ranges of sea level populations, despite the decrease in the ambient oxygen tension at high altitude.
- Different from Andean and Tibetan populations

PAP testing in
Ethiopia
Elevation
14, 300 feet

Tested 325 Head
Highest PAP
Measurement
34 mmHg

Questions

Finished

Thank You !!

Questions

Finished

Thank You !!