MUSE

(Microscopy with UV Surface Excitation)

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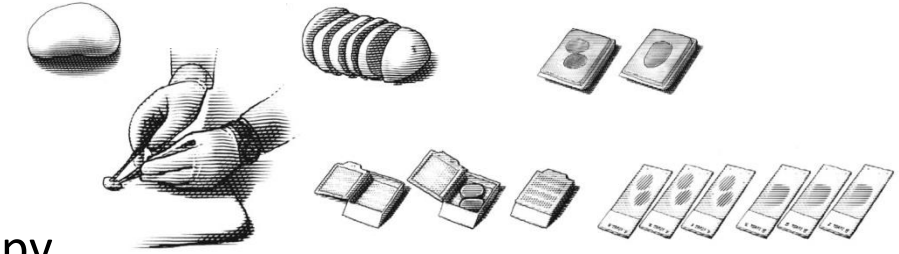
➢ Disclosure

- ❑ Dr. Richard Levenson is co-founder and CEO of MUSE Microscopy Inc.
- ❑ Remaining authors declare no conflicts of interest

➢ Pathology

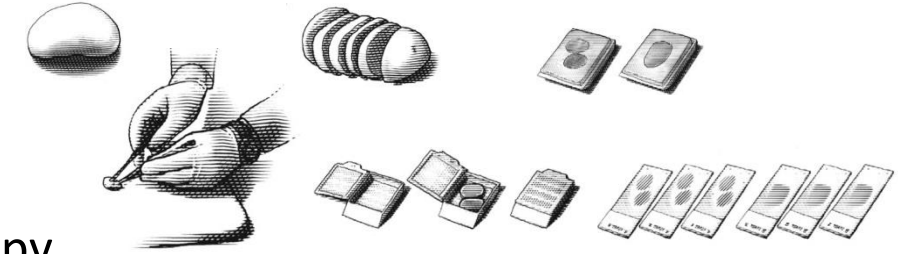

Muscular Structure of Heart.
W. WATSON & SONS
313 HIGH HOLBORN
LONDON
From the Human Subject.

➢ Pathology



- ❑ Conventional microscopy
  - ❖ Require traditional fixation, thin-sectioning and staining

➢ Pathology



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- ❑ Ex-vivo microscopy (Slide-free)
  - ❖ Rapid imaging of biopsy material

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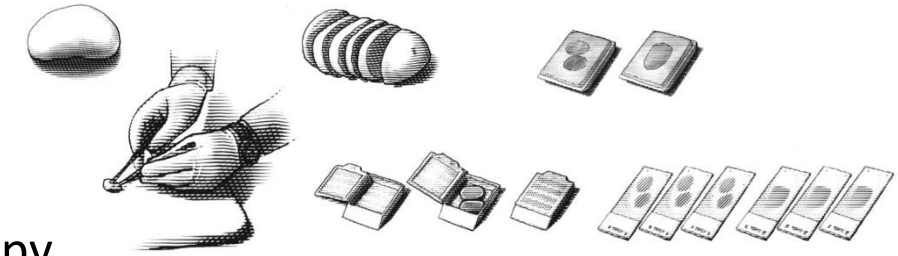

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- ❑ Ex-vivo microscopy (Slide-free)
  - ❖ Rapid imaging of biopsy material

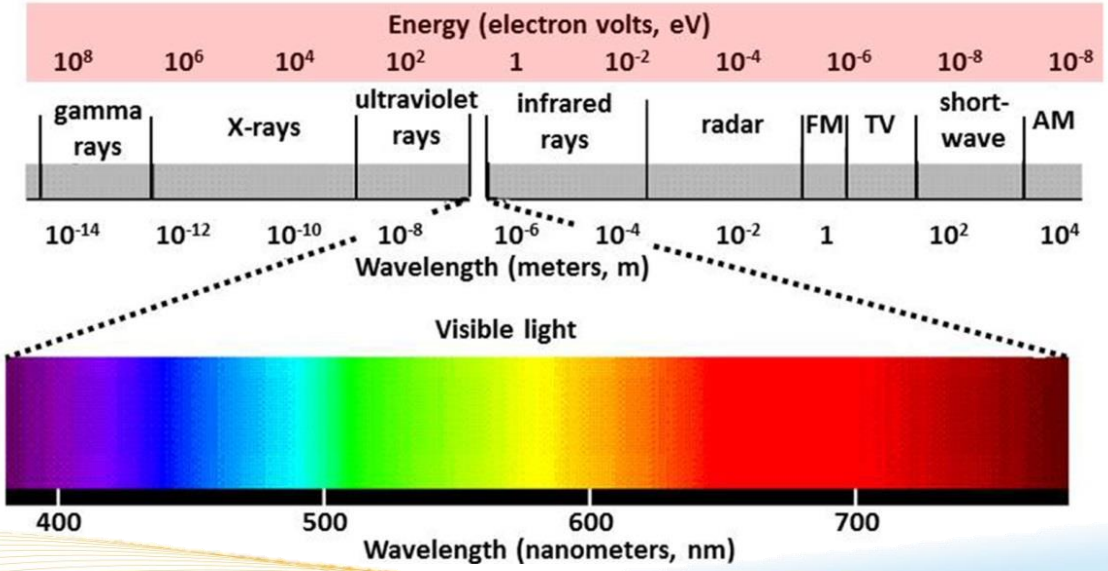
- ❑ In-Vivo microscopy (Biopsy-free)
  - ❖ Evaluation of human tissue microstructure in real time

➢ What is MUSE?

- ❑ A novel Ex-Vivo microscopy
  - ❖ Slide-free method developed at UC Davis
  - ❖ First in evaluating on human tissue
- ❑ Microscopy with UV Surface Excitation (MUSE)
  - ❖ Using UV-emitting LED with wavelength of 275 to 285 nm
  - ❖ Digital camera captures the excitation light

➢ How MUSE works?

- ❑ Ultraviolet (UV) is an electromagnetic radiation
  - ❖ Wavelength: 10 nm to 400 nm (Shorter than visible light)



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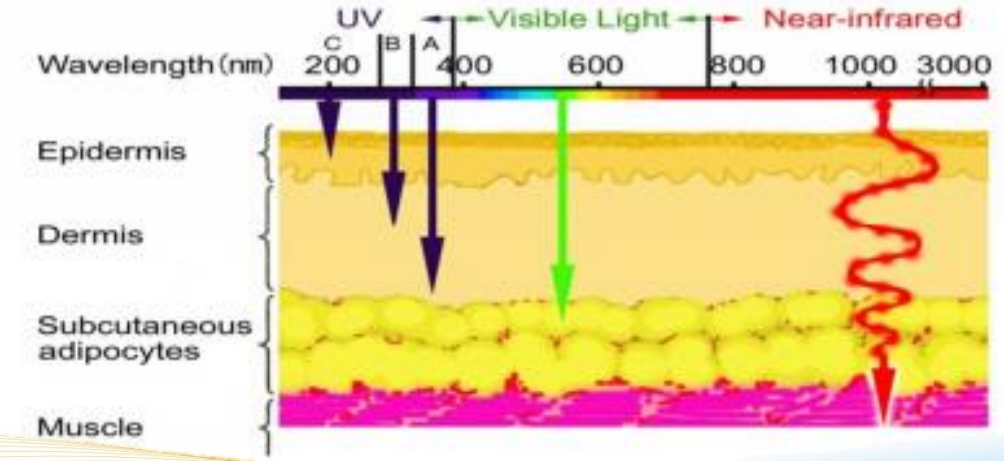

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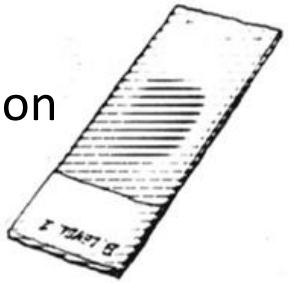
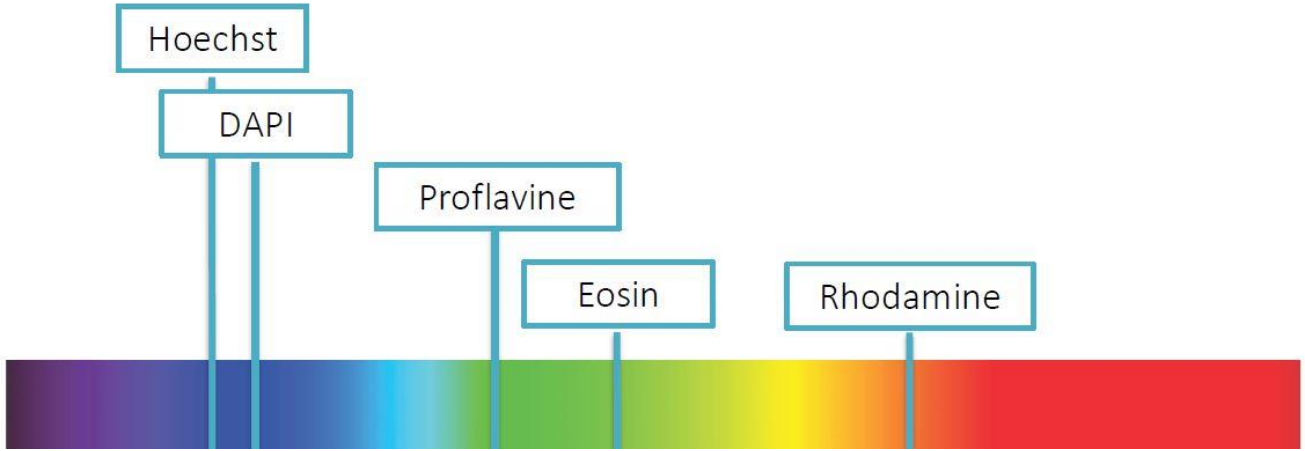
- ❑ 275 to 285 nm UV light has penetrate depth of 3 microns
  - ❖ Approximately the thickness of a conventional tissue section



➢ How MUSE works?

- ❑ UV light can excite dyes or endogenous auto-florescent materials
  - ❖ The emission light varies from blue to red



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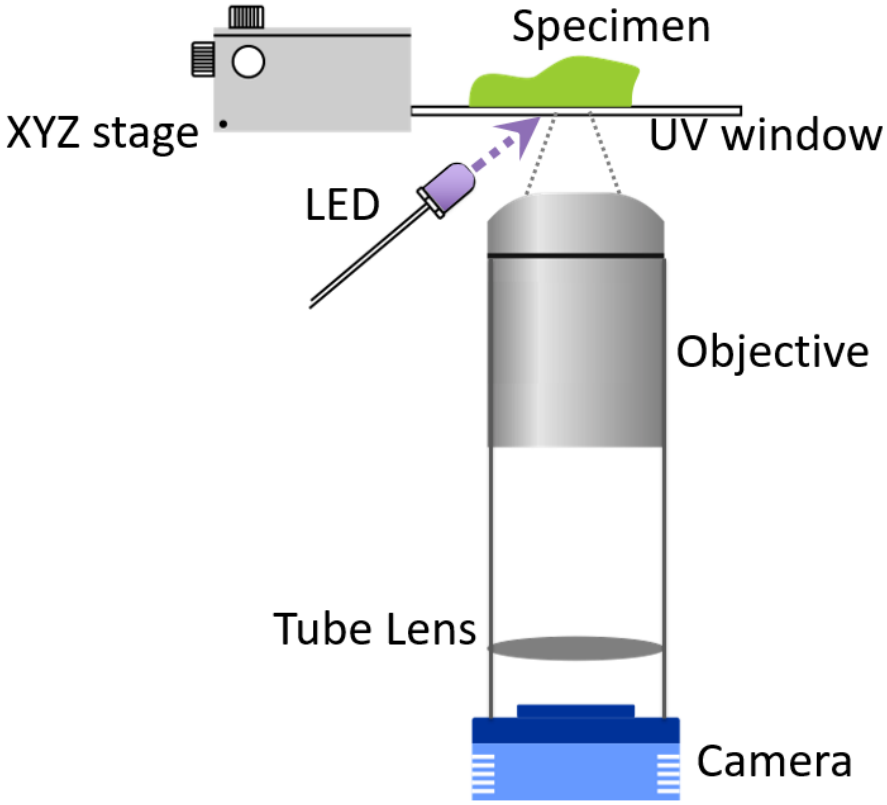
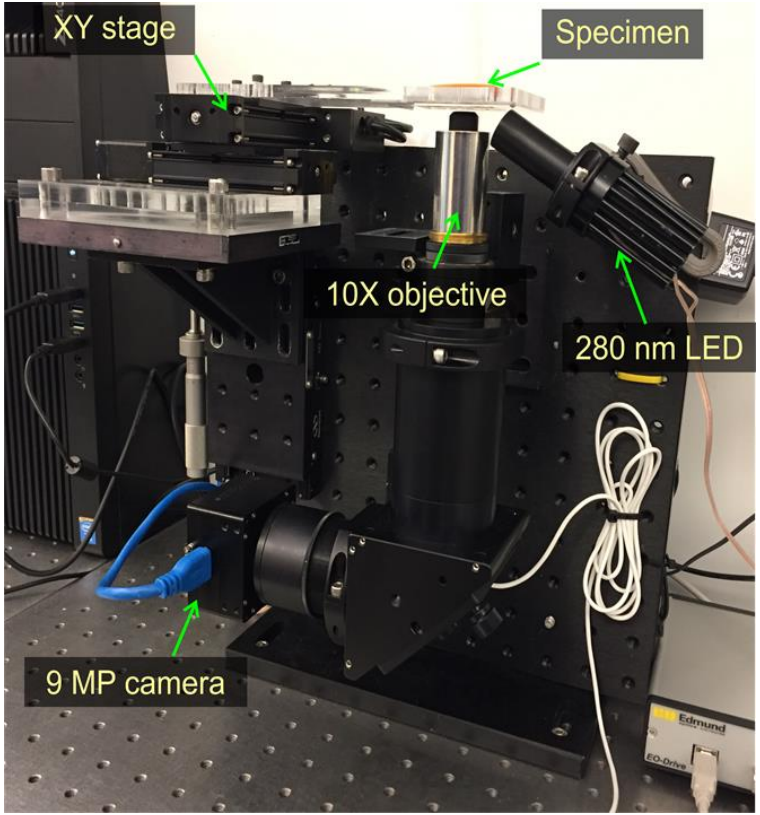
- ❑ A digital camera can capture the emitted lights
  - ❖ 3 microns thickness from the surface of the specimen
  - ❖ The images must be similar to H&E but in full color

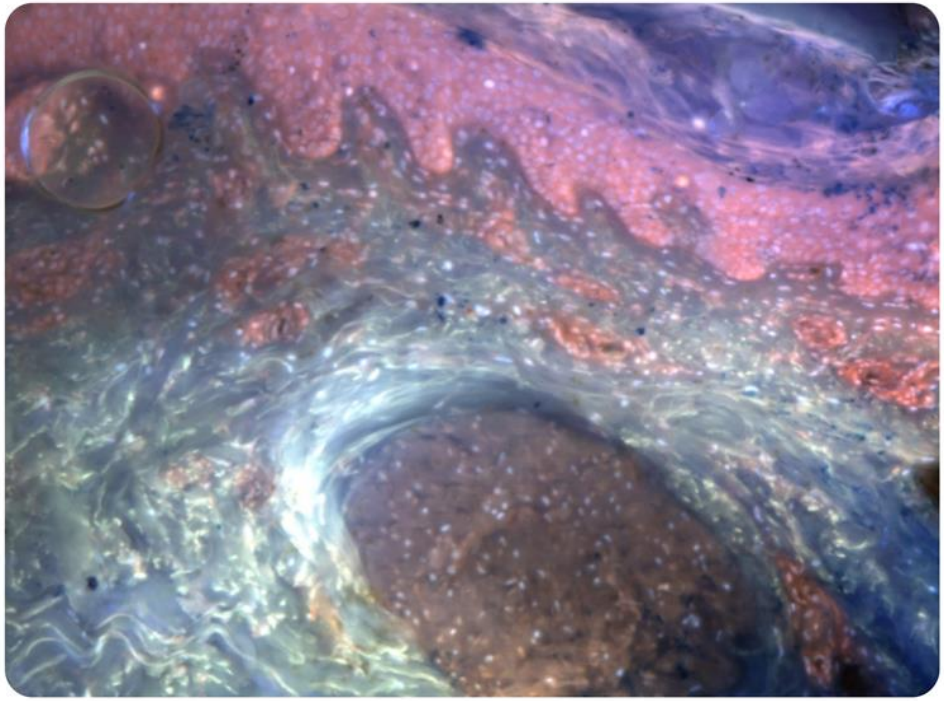
➢ MUSE setup:

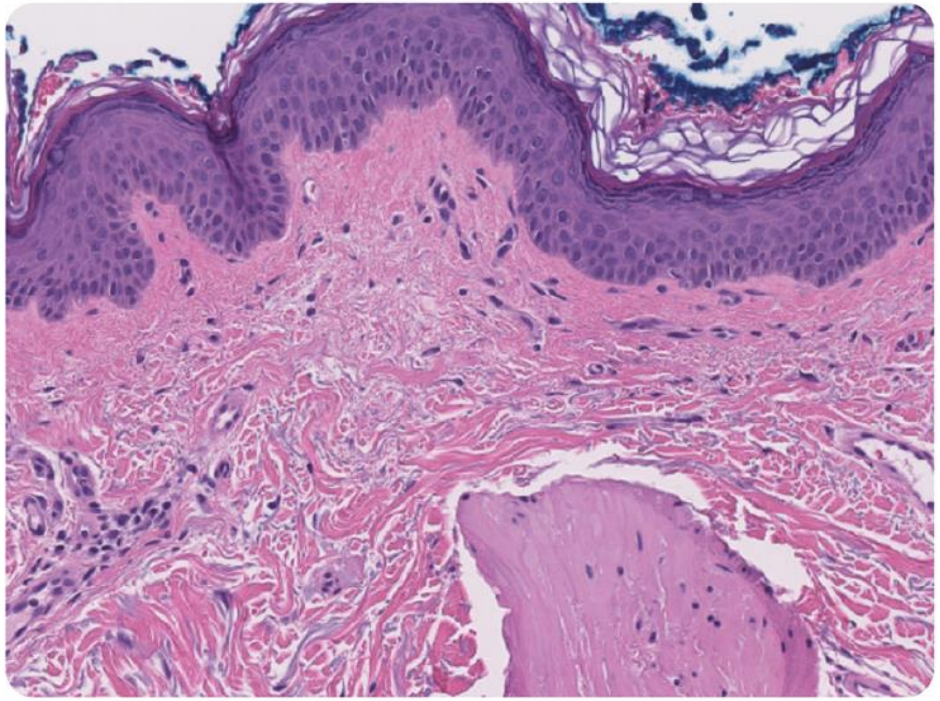

Specimen
XYZ stage
UV window
LED
Objective
Tube Lens
Camera

➢ MUSE setup:

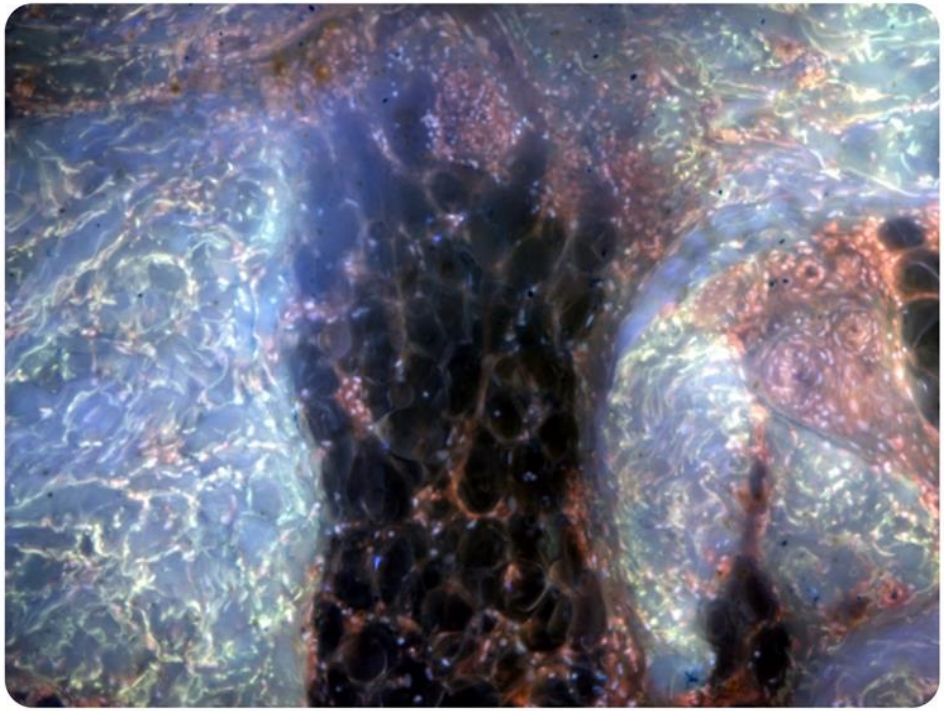
- ❑ Prepare flat tissue surface
- ❑ Staining (50 sec total)
  - ❖ Rhodamine B,
  - ❖ Hoechst 33342
  - ❖ Eosin
  - ❖ Propidium iodide
- ❑ Capture images

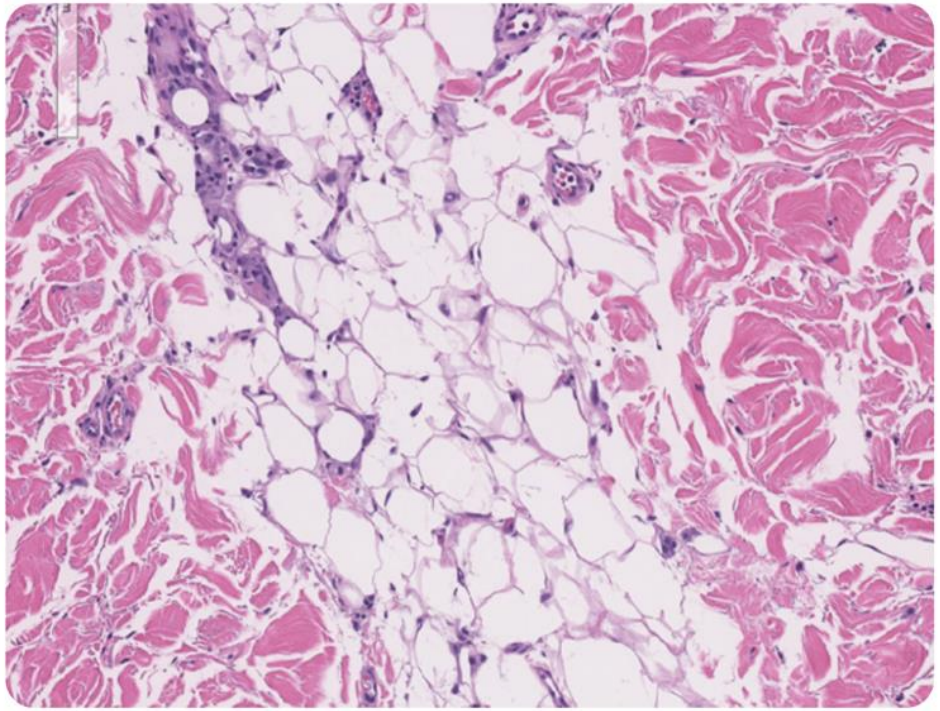






Normal Histology





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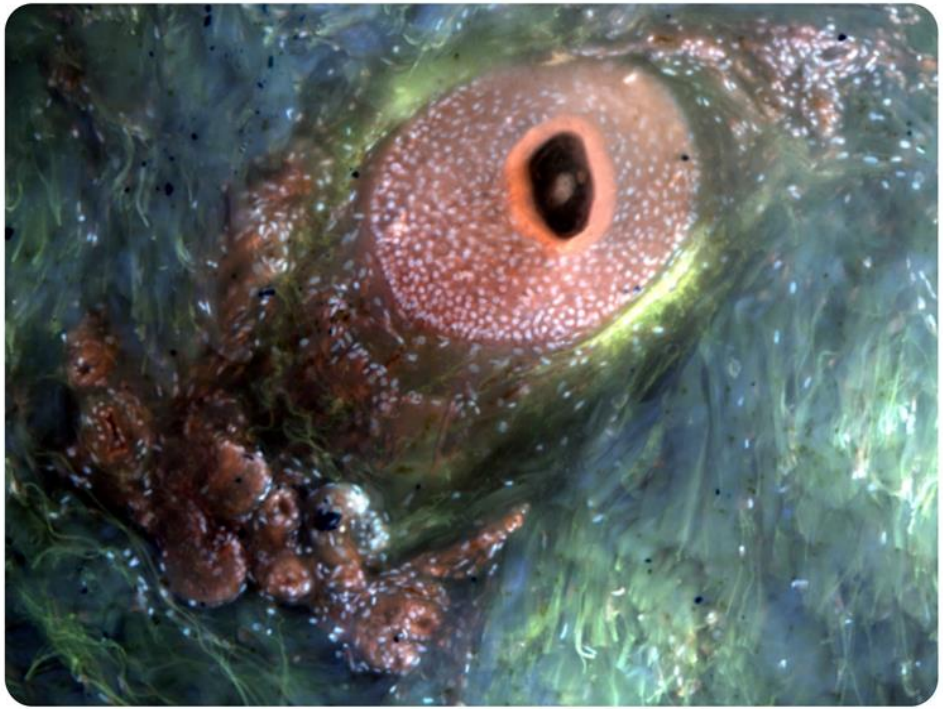
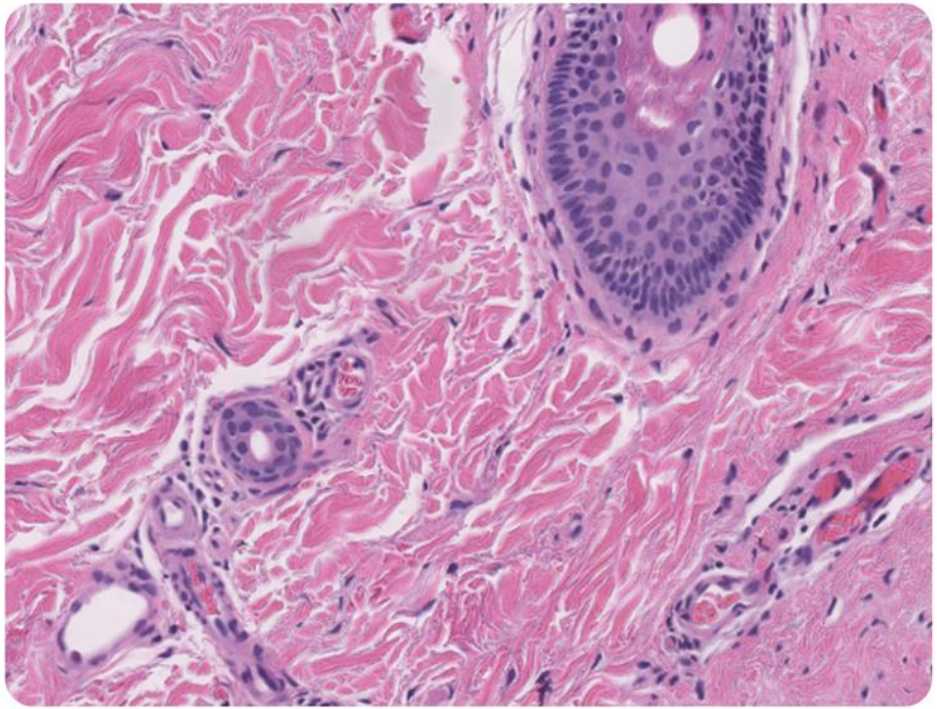
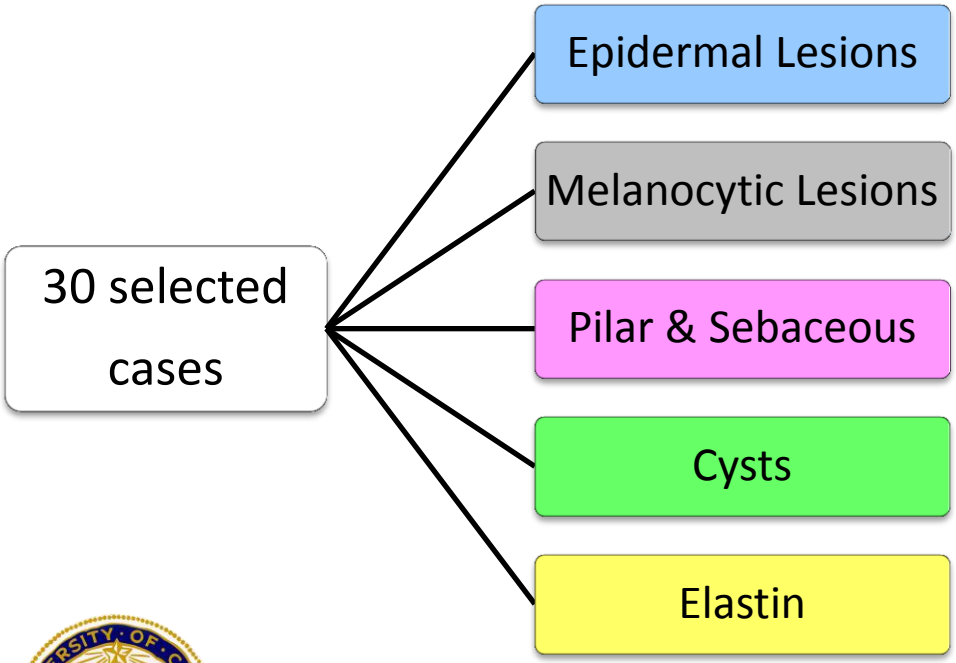




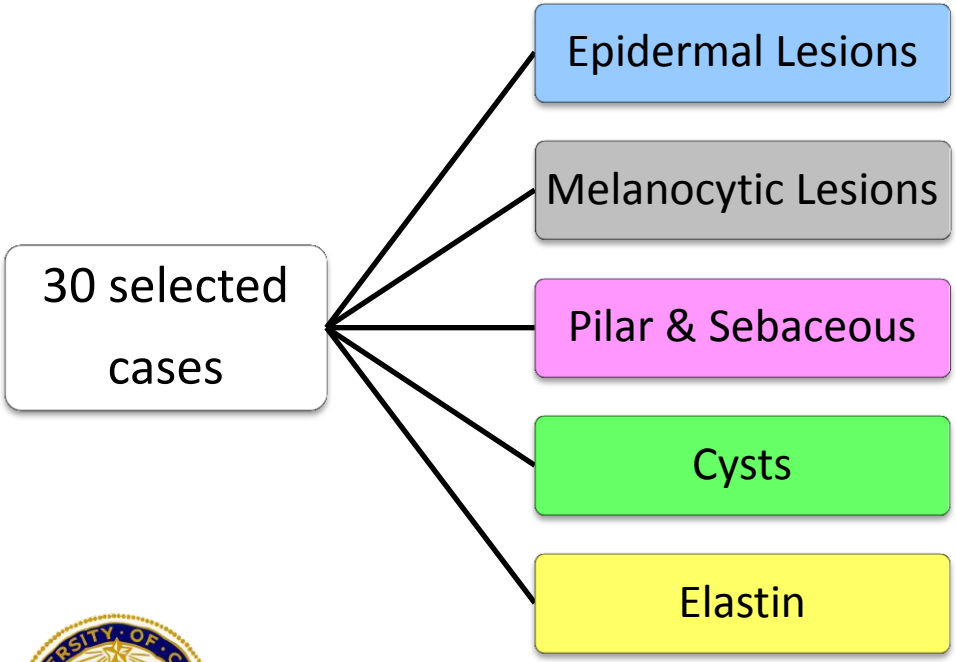
Normal Histology

➢ MUSE: Diagnostic value



1	Verruca Vulgaris
2	AK, Acantholytic and hypertrophic
3	Bowen's
4	SCC KA type
5	SCC in dermis
6	BCC superficial
7	BCC nodular
8	Pig nodular BCC
9	BCC infiltrative
10	Pig Seborrheic keratosis

➢ MUSE: Diagnostic value



11	IDN
12	Compound Nevus
13	Lentiginous Nevus
14	Blue Nevus
15	Spitz Nevus
16	MIS
17	MM

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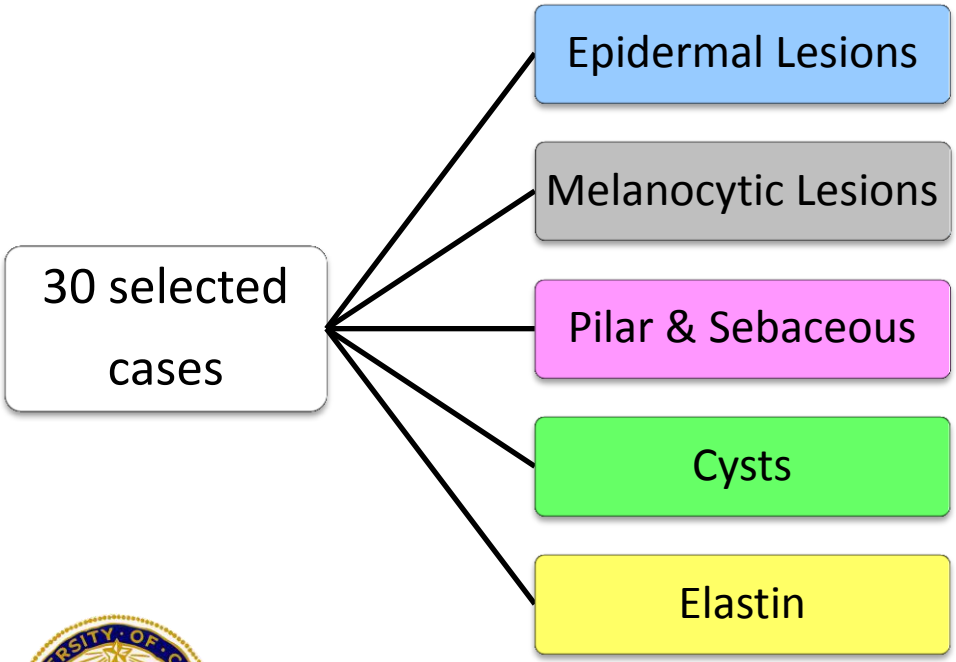
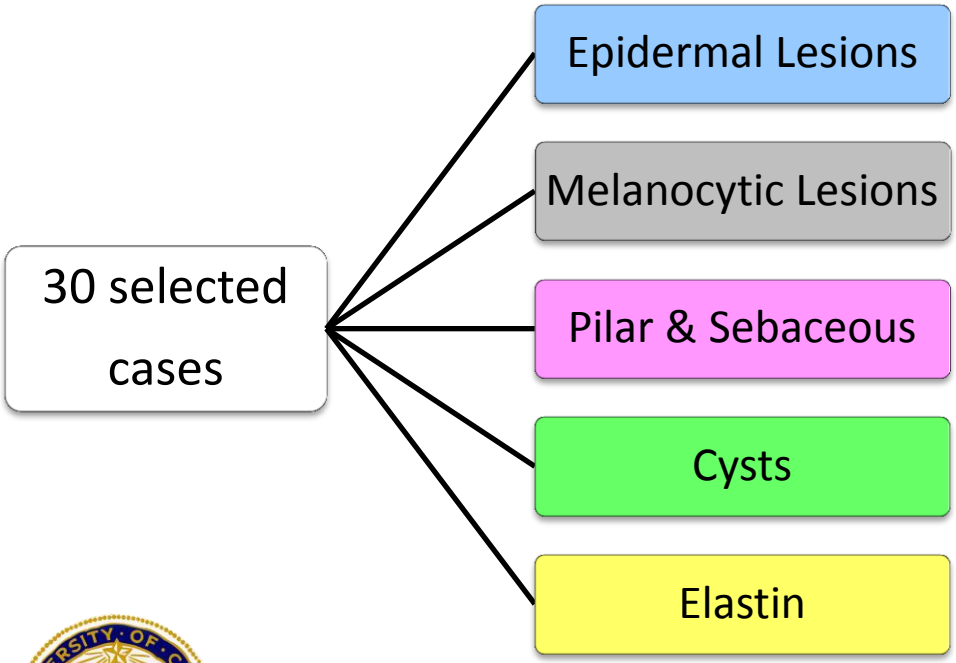


18	Sebaceous hyperplasia
19	Nevus Sebaceous
20	Pilomatricoma
21	Cylindroma
22	Poroma
23	Mixed tumor
24	Syringoma

MUSE: Diagnostic value



25	Hidrocystoma
26	Steatocystoma
27	Pilar Cyst
28	EIC

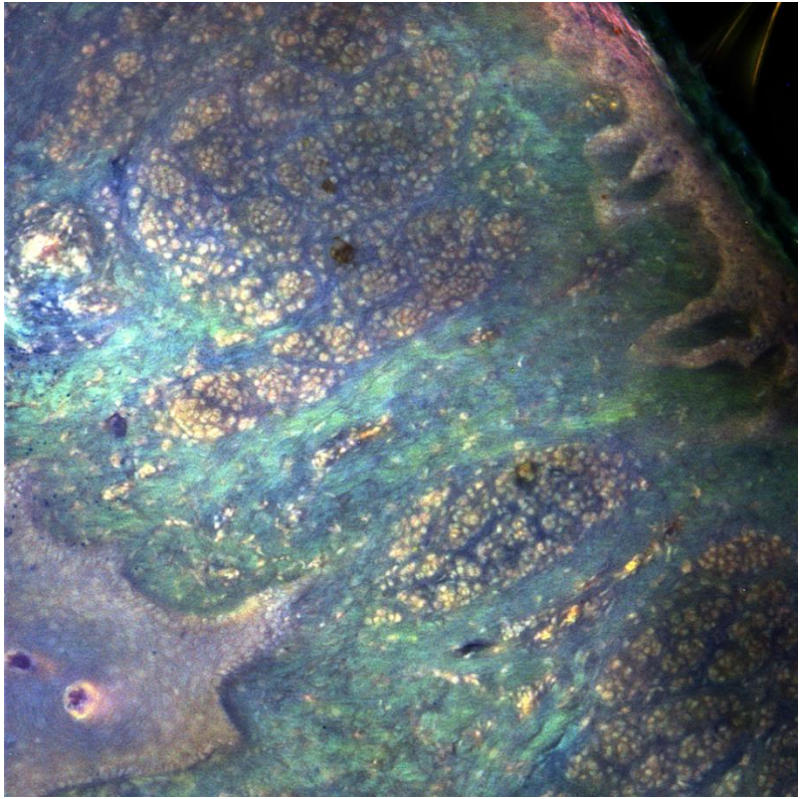
29	PXE
30	Solar elastosis

➢ MUSE: Scoring

- ❑ Diagnostic score:
  - ❖ Percentage of correct diagnosis of each MUSE image
- ❑ Comparison score:
  - ❖ Assessed by the concordance between MUSE images and correlated H&E images generated by whole slide scanner

➢ MUSE: Diagnostic score

- ❑ What is this?
- ❑ Total Dx score: 70.83%
  - ❖ Cystic lesions: 88%
  - ❖ Epidermal lesions: 80%
  - ❖ Adnexal lesions: 79%
  - ❖ Melanocytic: 46%
  - ❖ Elastin lesions: 62%



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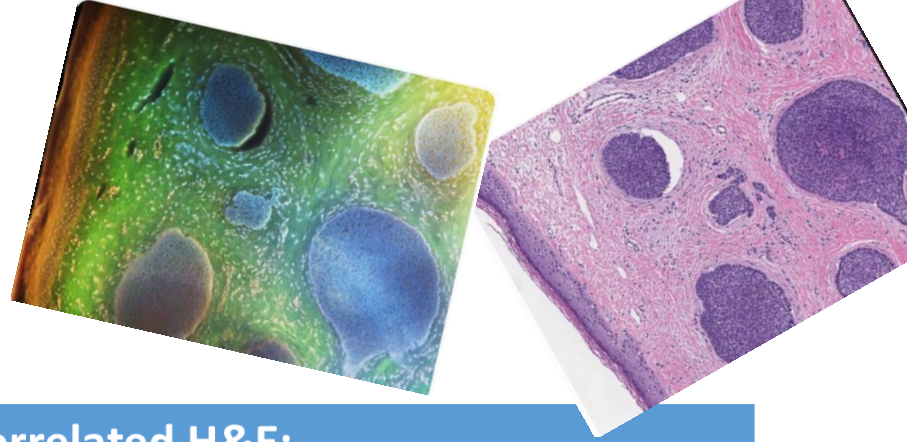
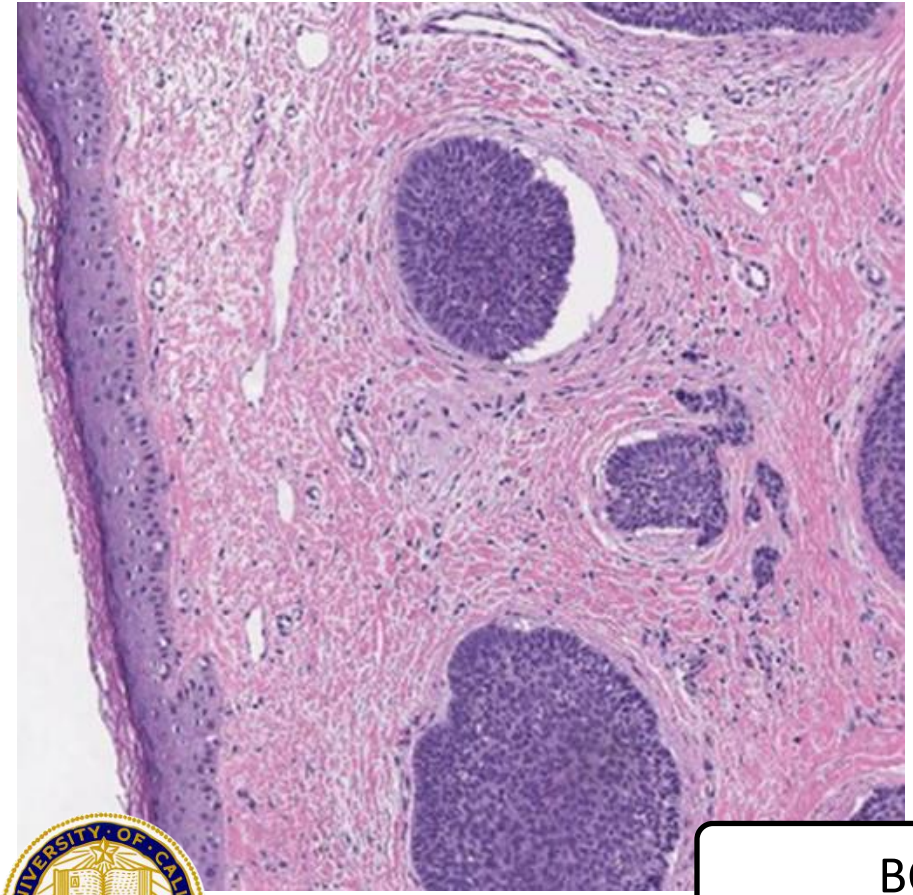
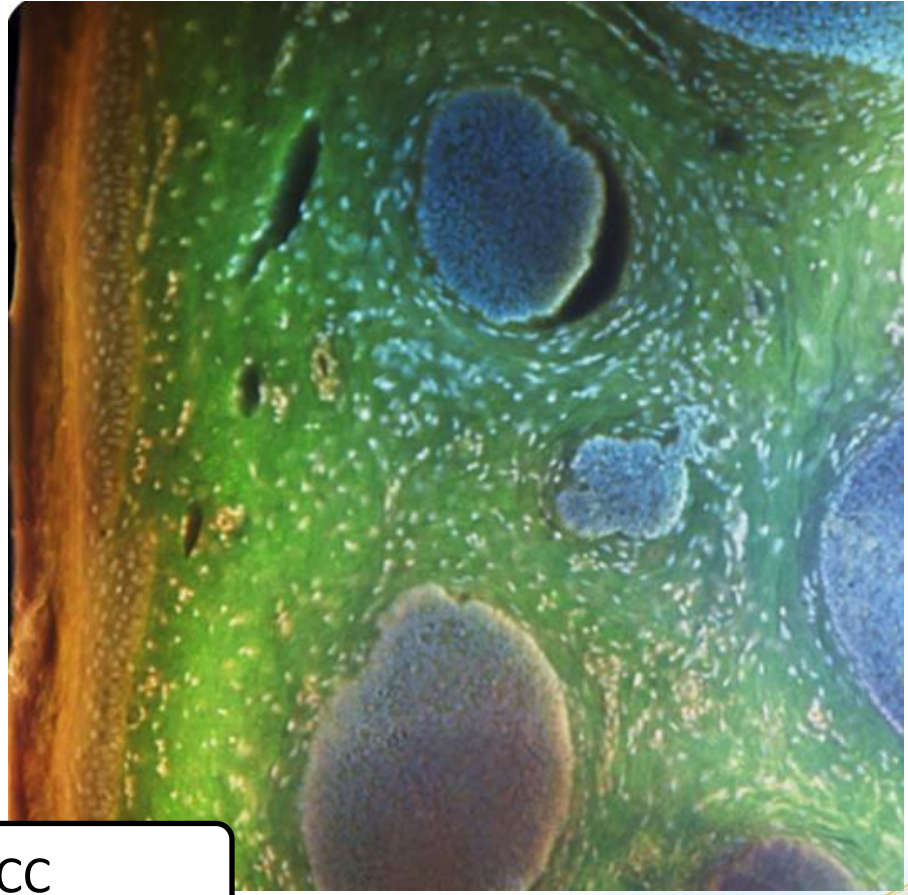


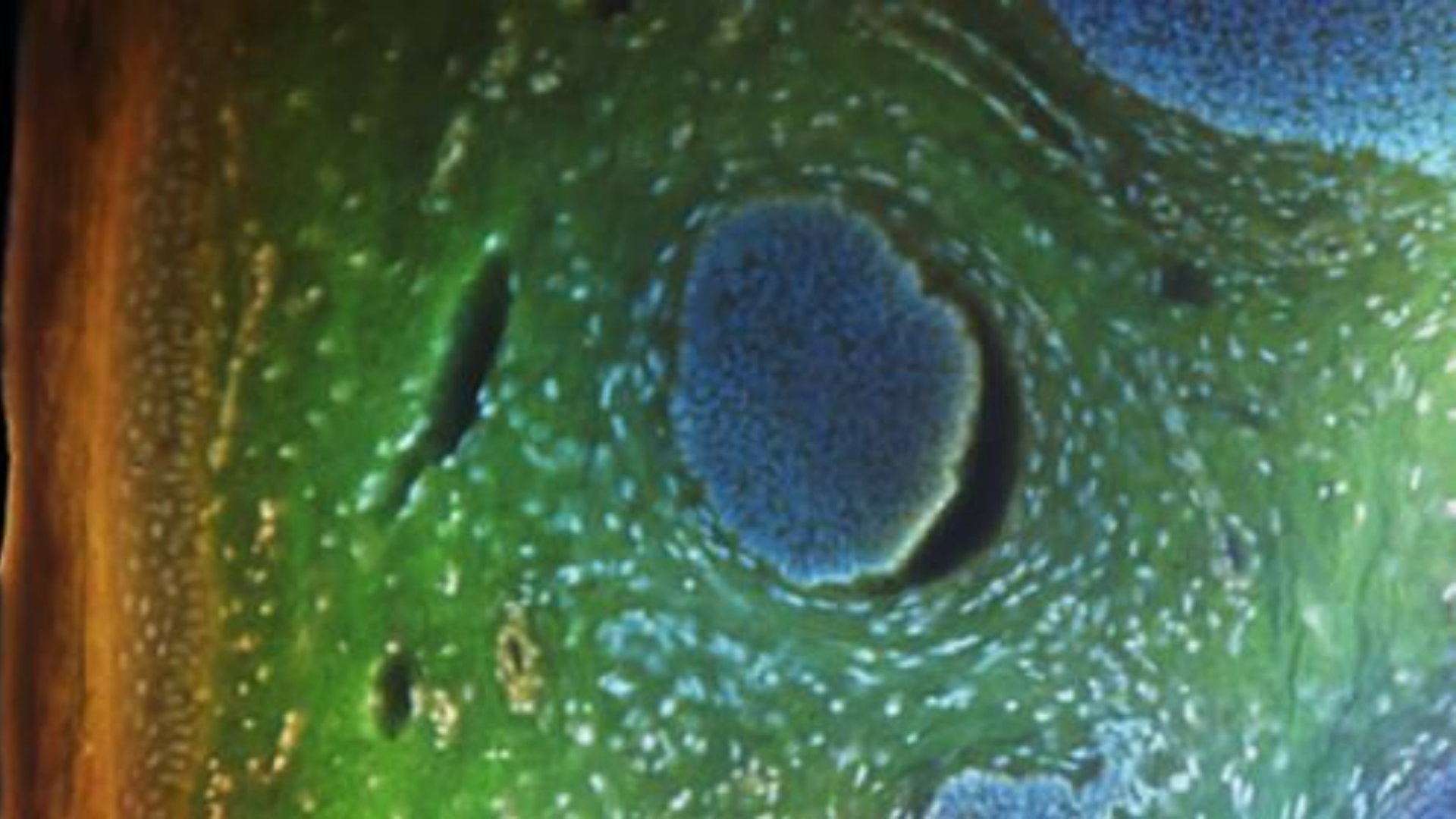
❑ Is it better than H&E?

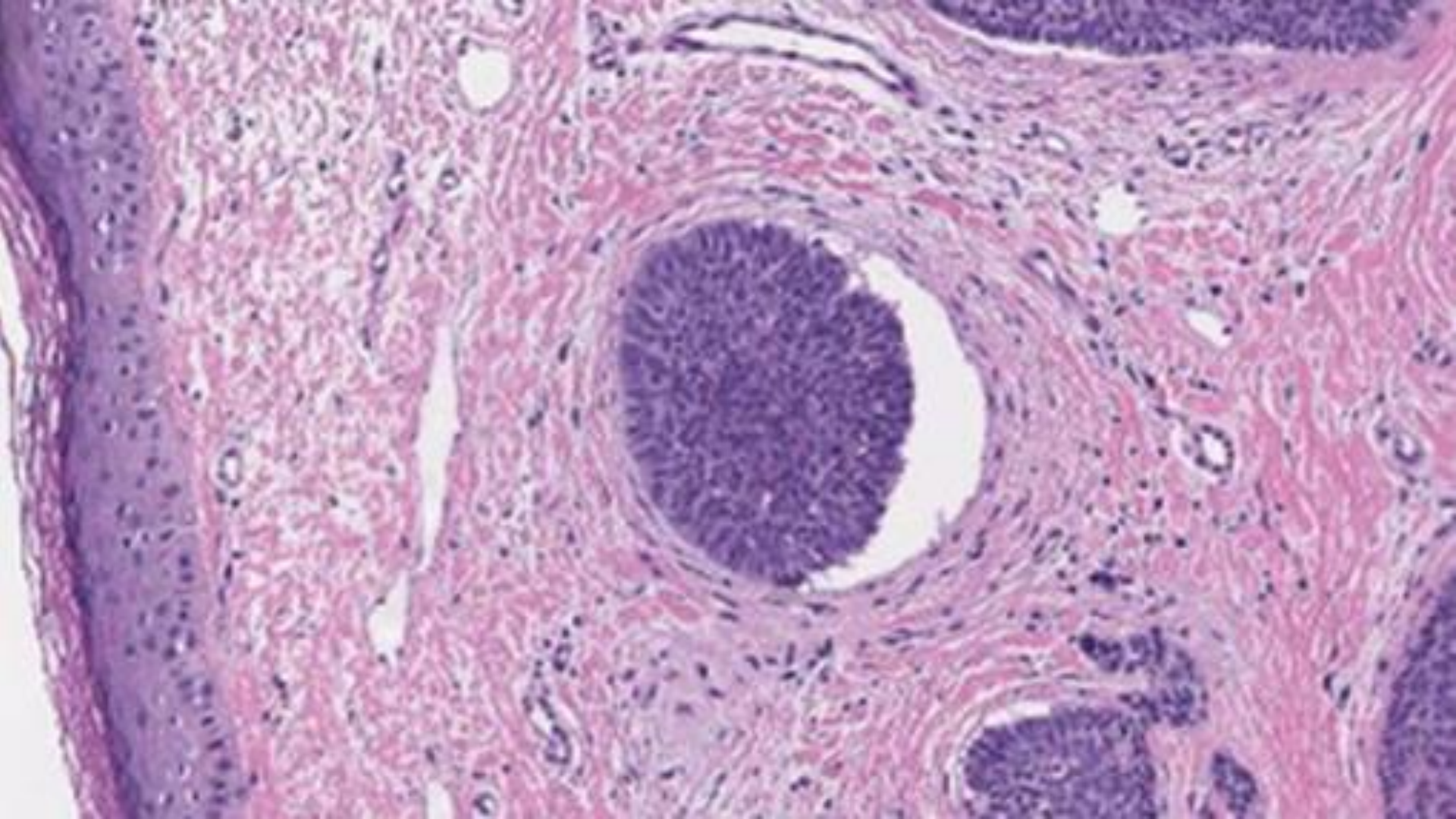
Score	By comparing the MUSE with correlated H&E:
0	MUSE works poorly compare to the H&E/ Diagnosis cannot be made just by MUSE / MUSE failed to show the required diagnostic features
1	MUSE can diagnosis without the need of H&E (can show the diagnostic details)
2	MUSE is better than H&E in diagnosis or showing the details (More details/ less artifact/…)

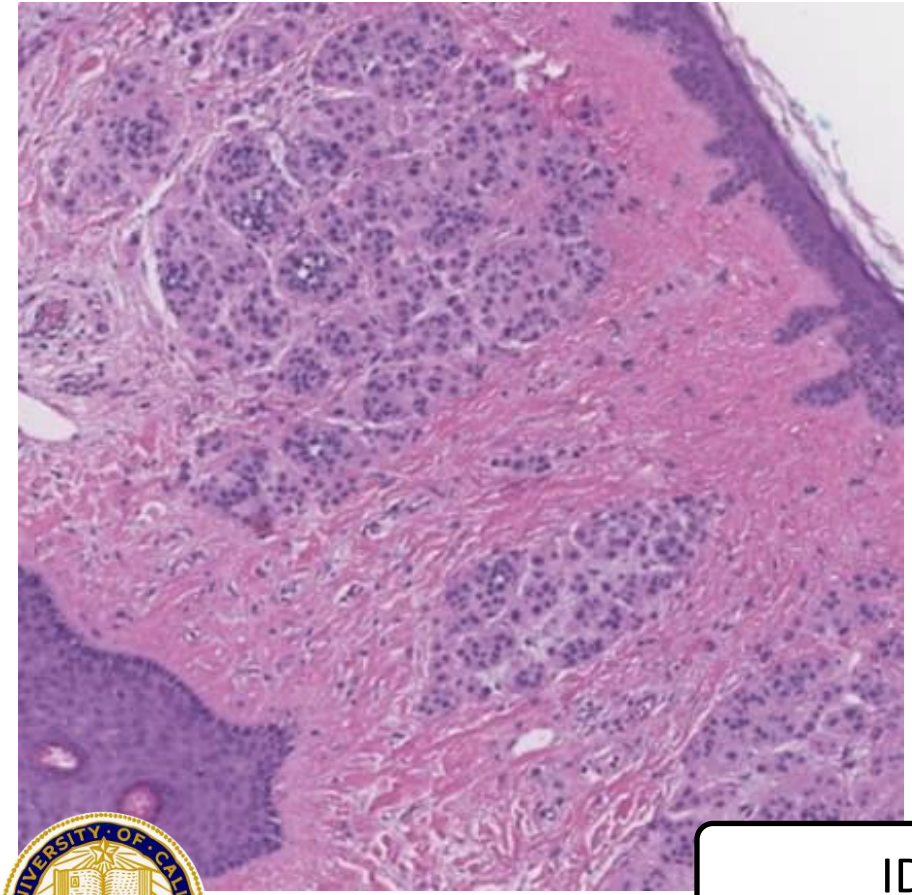


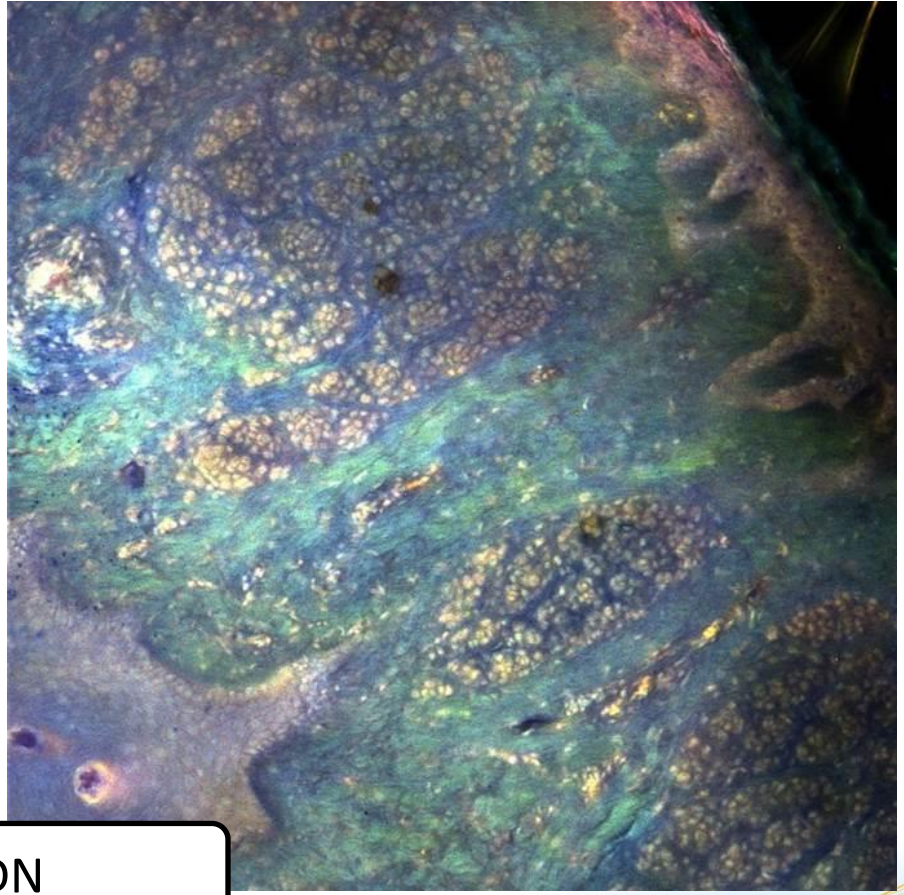


BCC









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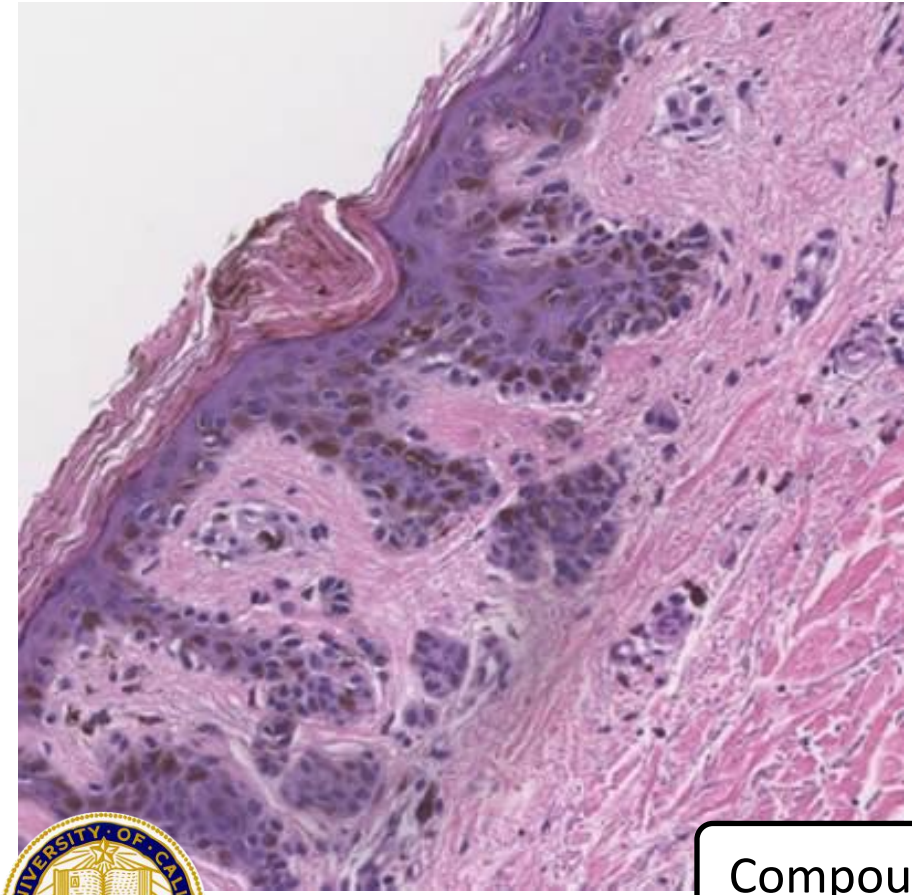
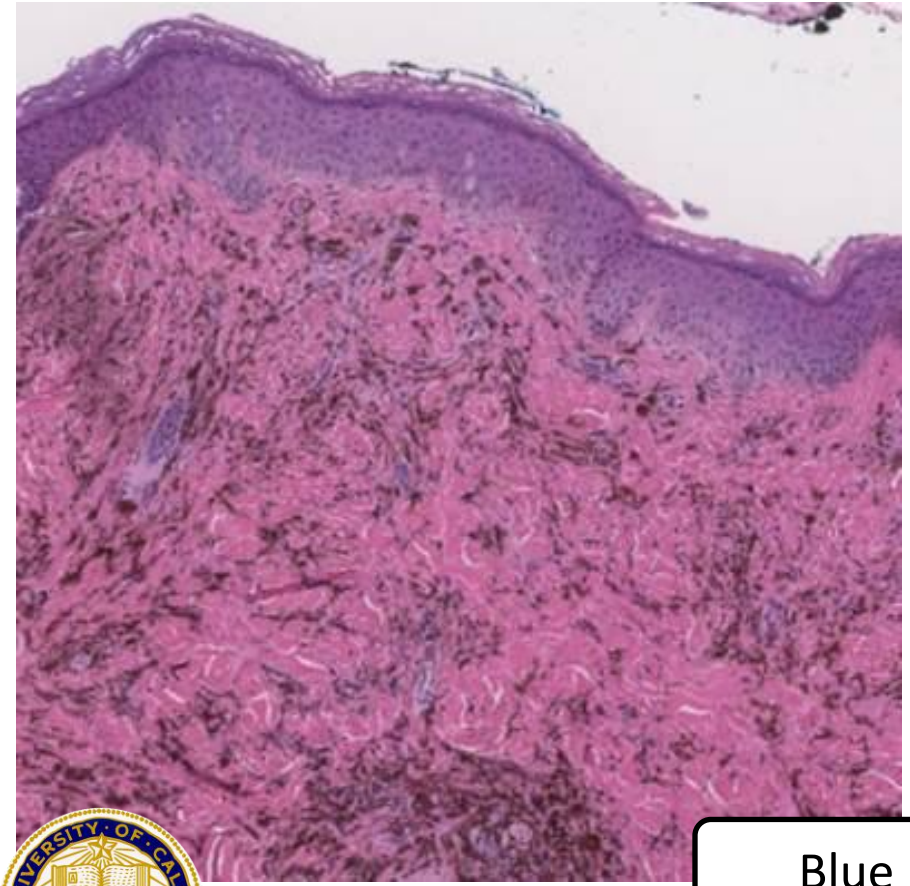
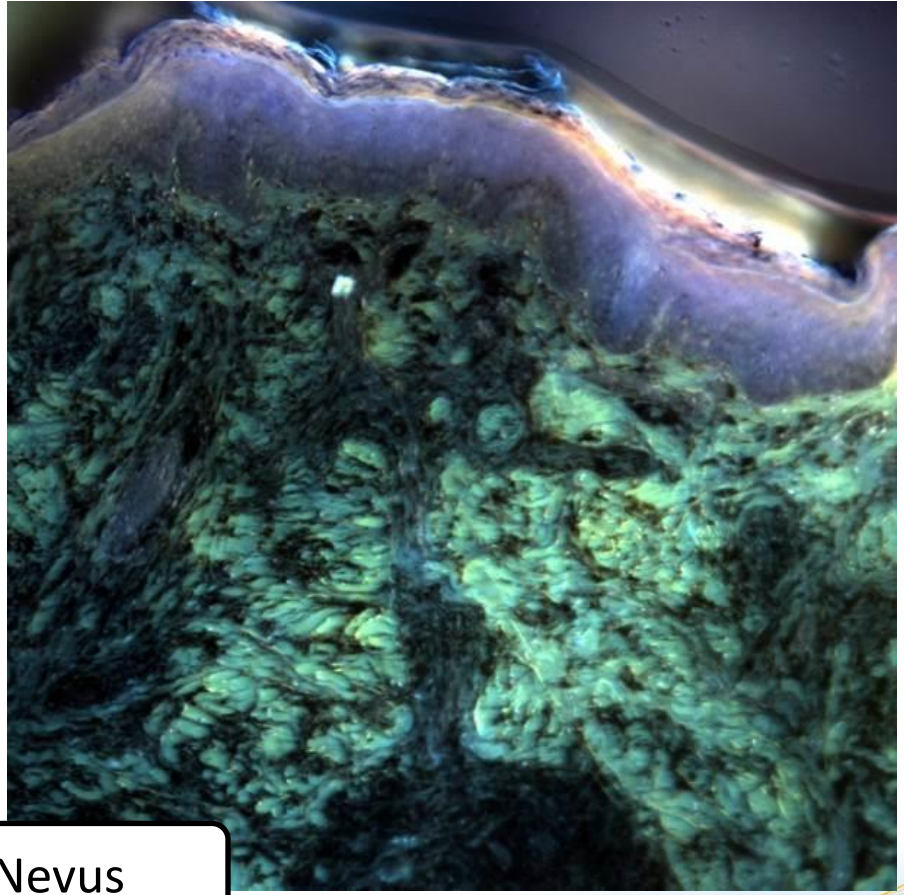
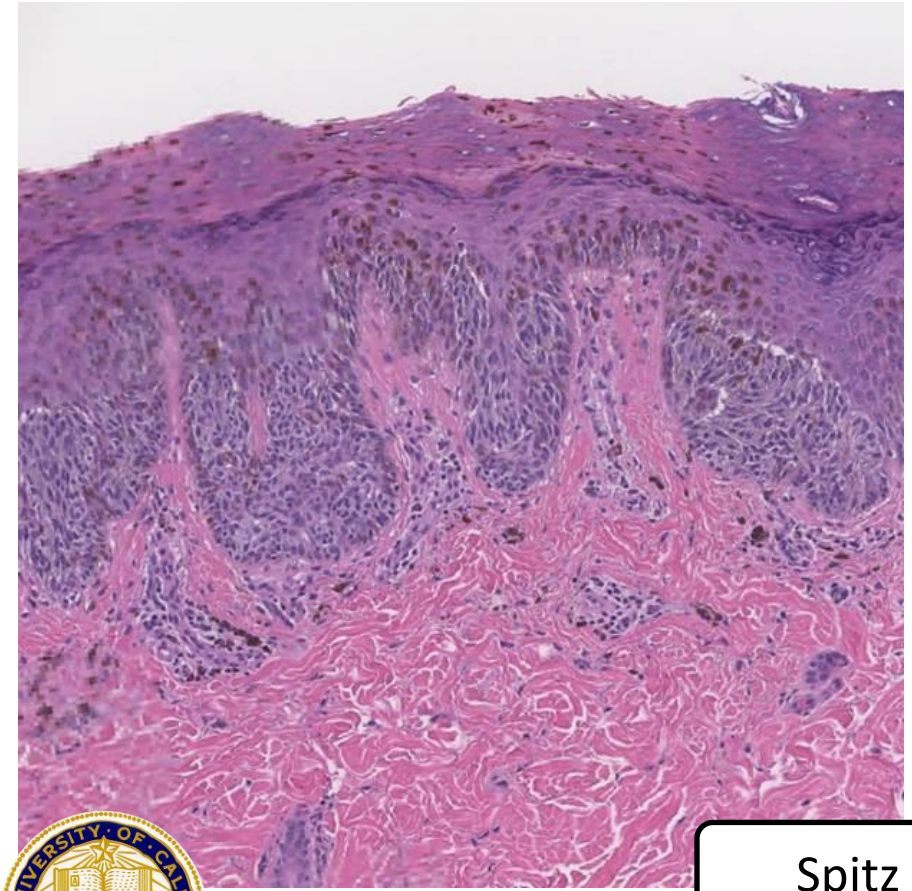


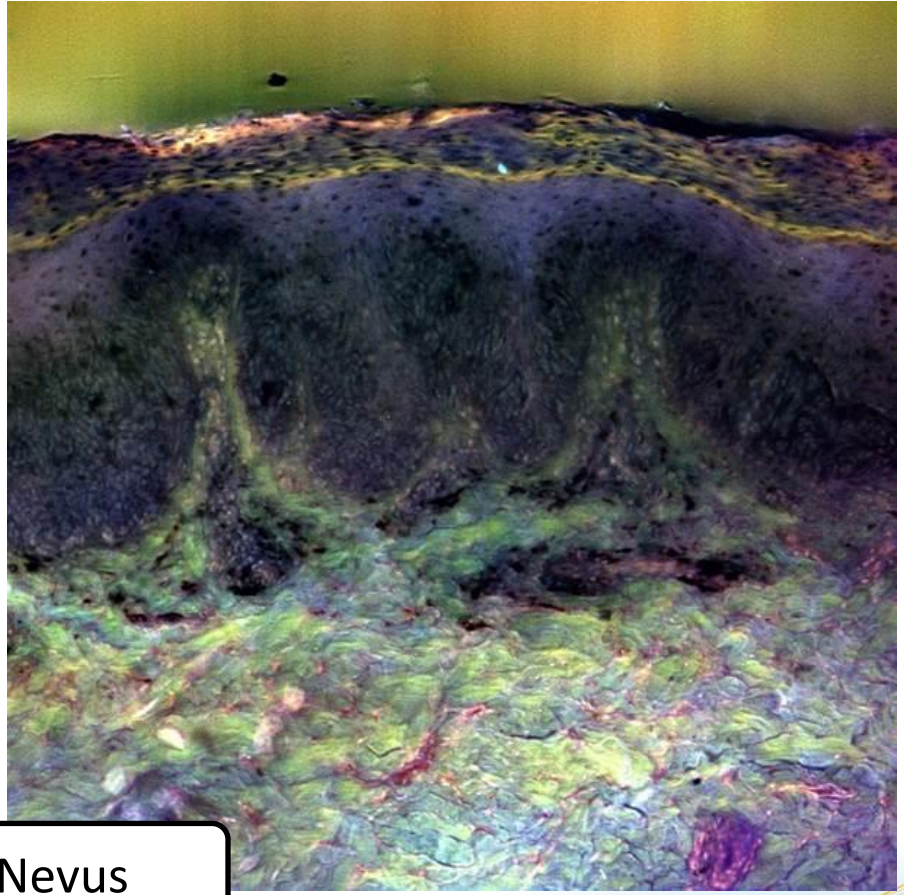
Compound Nevus



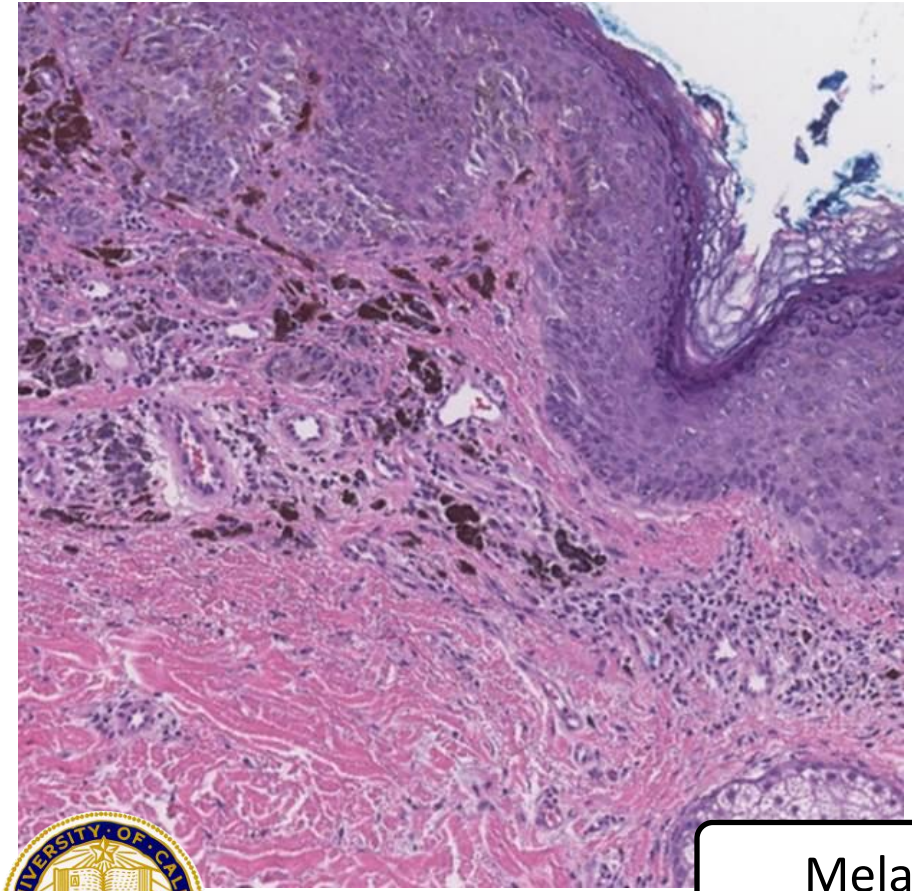


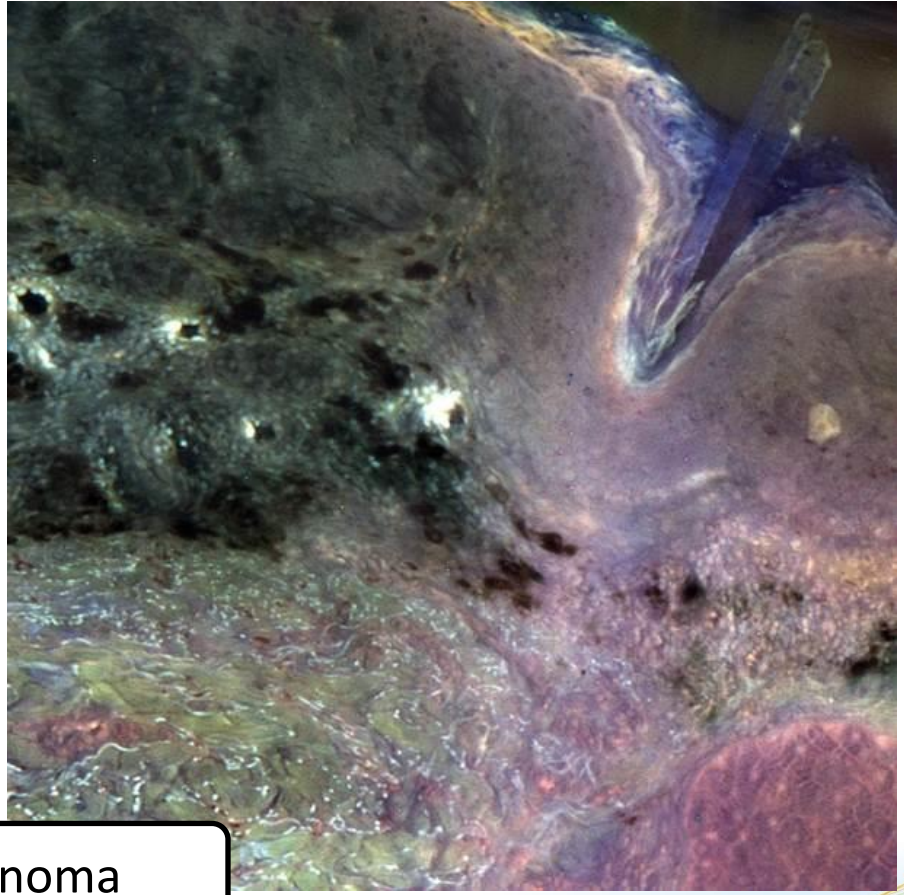
Blue Nevus



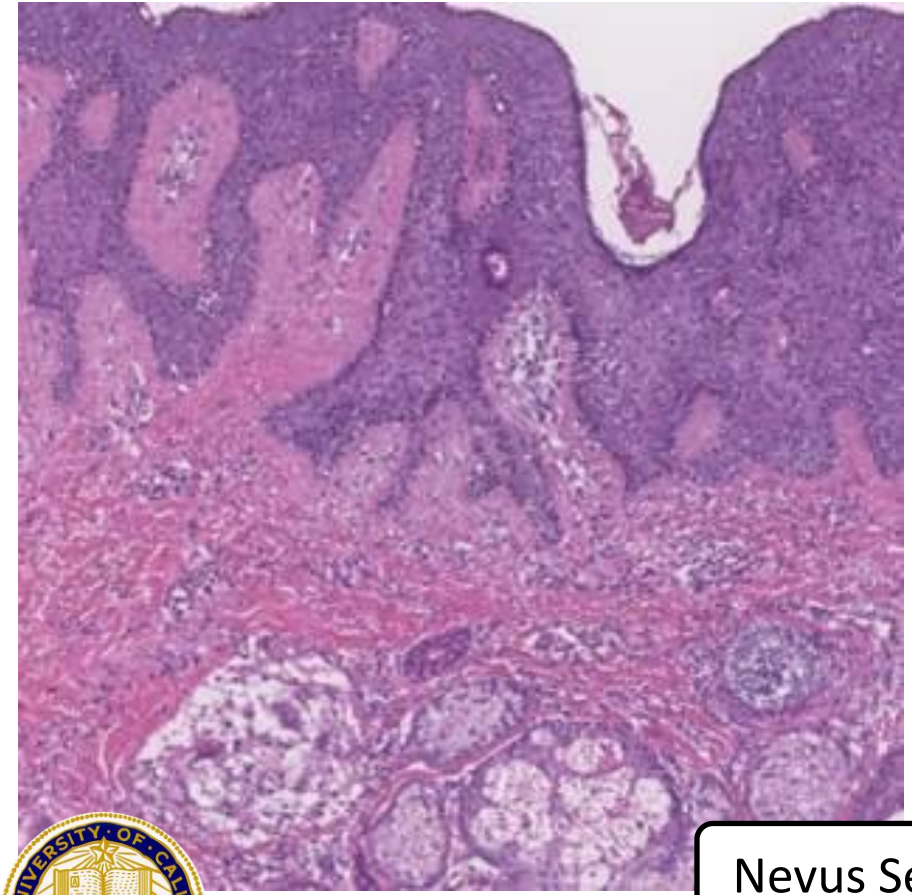


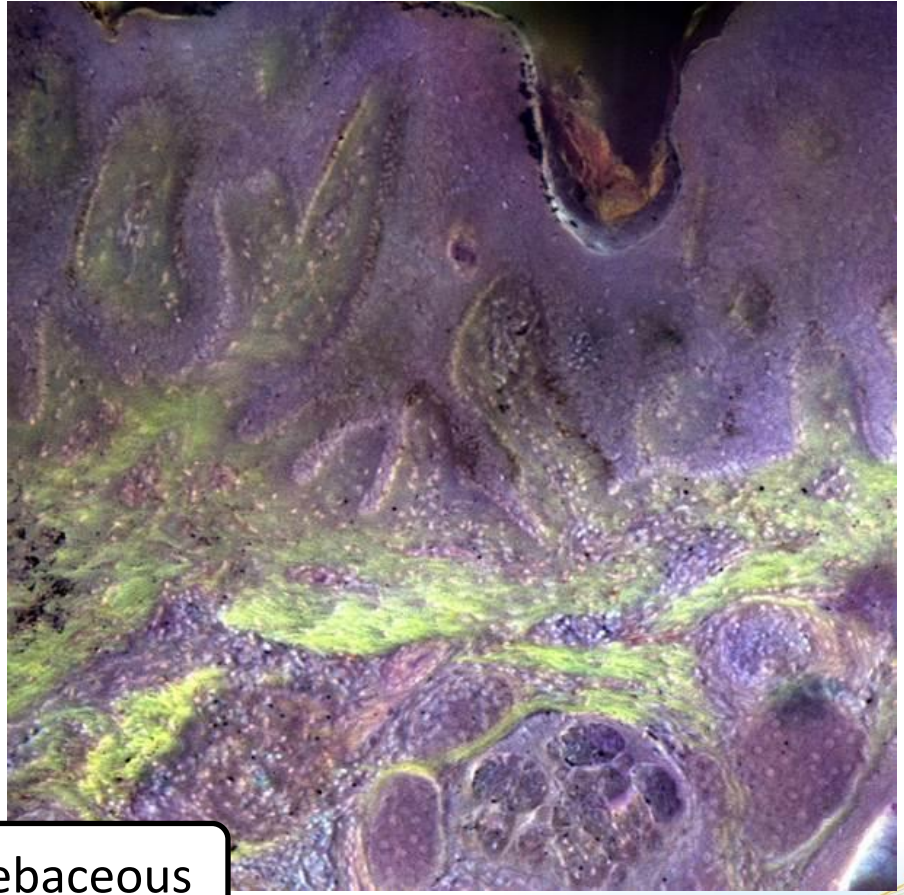
Spitz Nevus



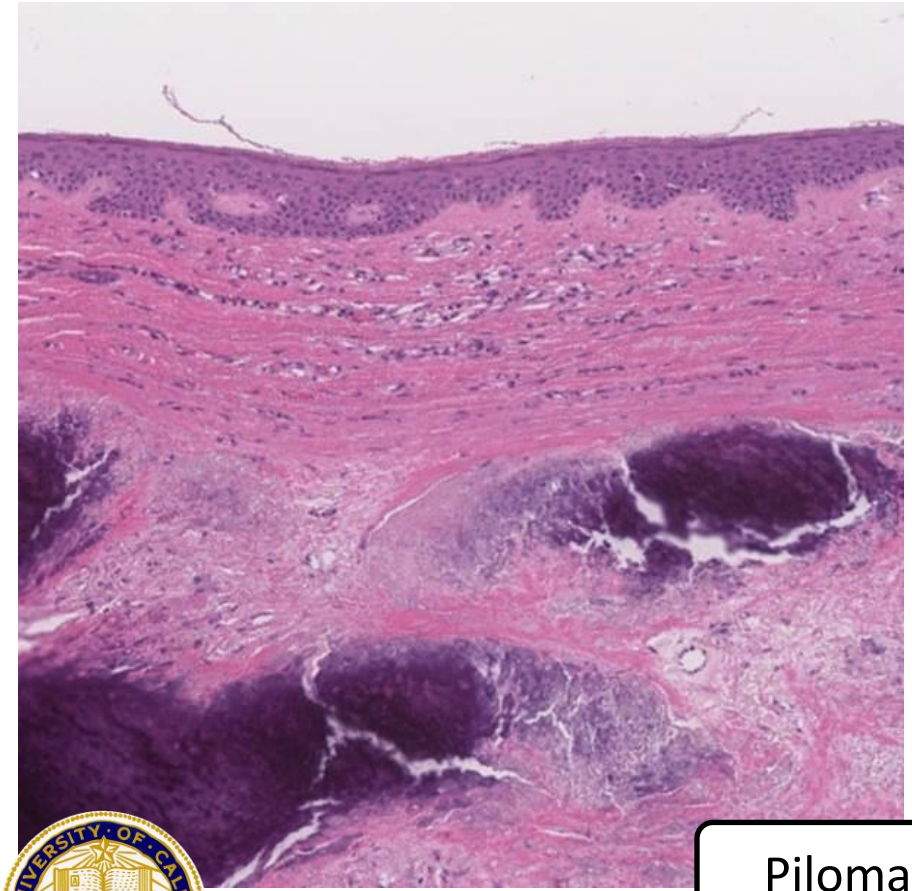


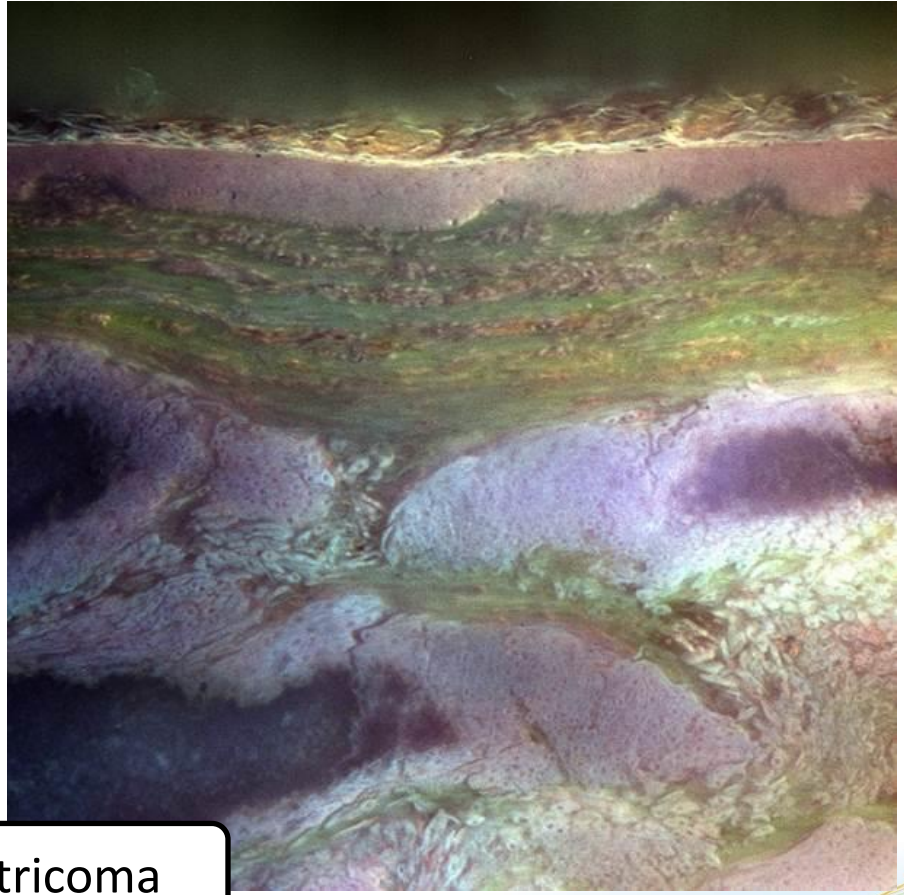
Melanoma



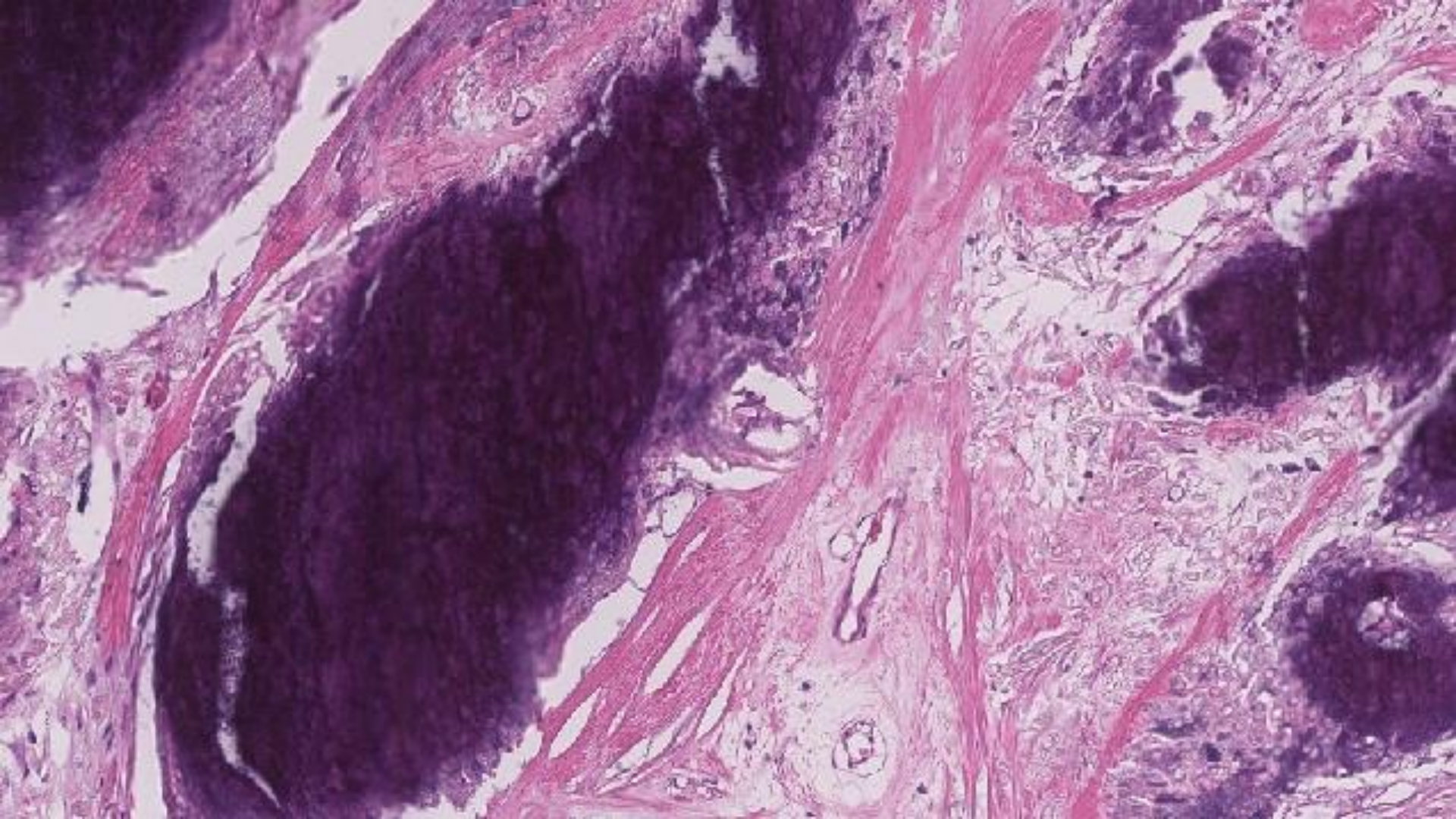


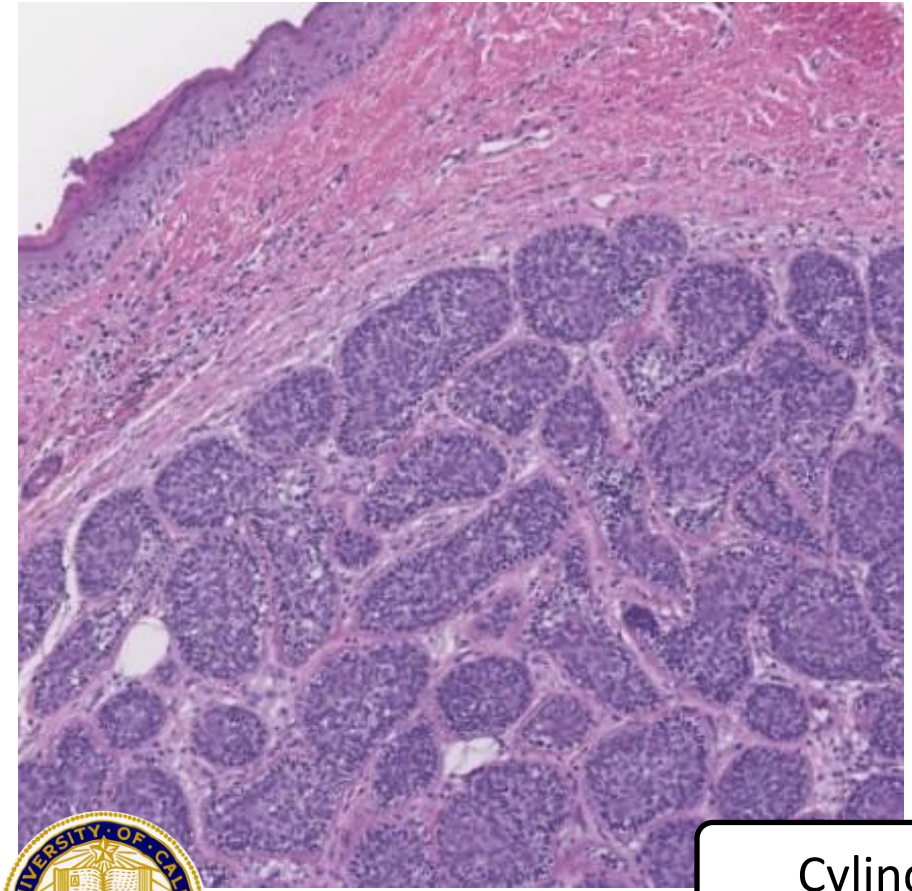
Nevus Sebaceous

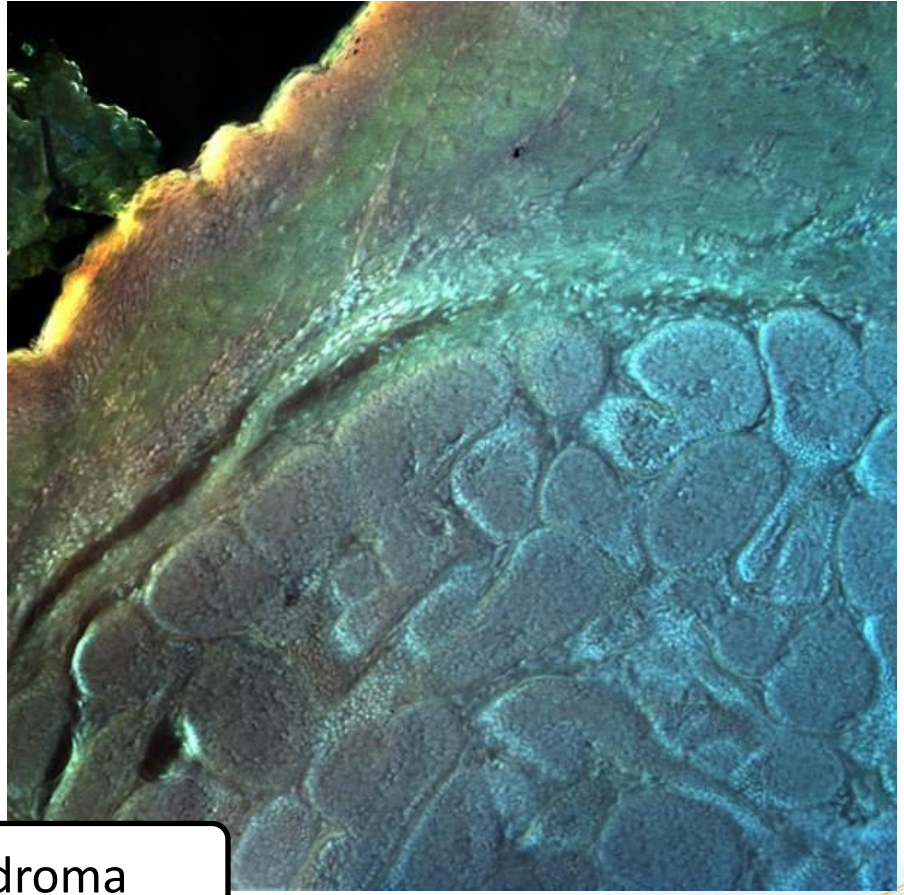




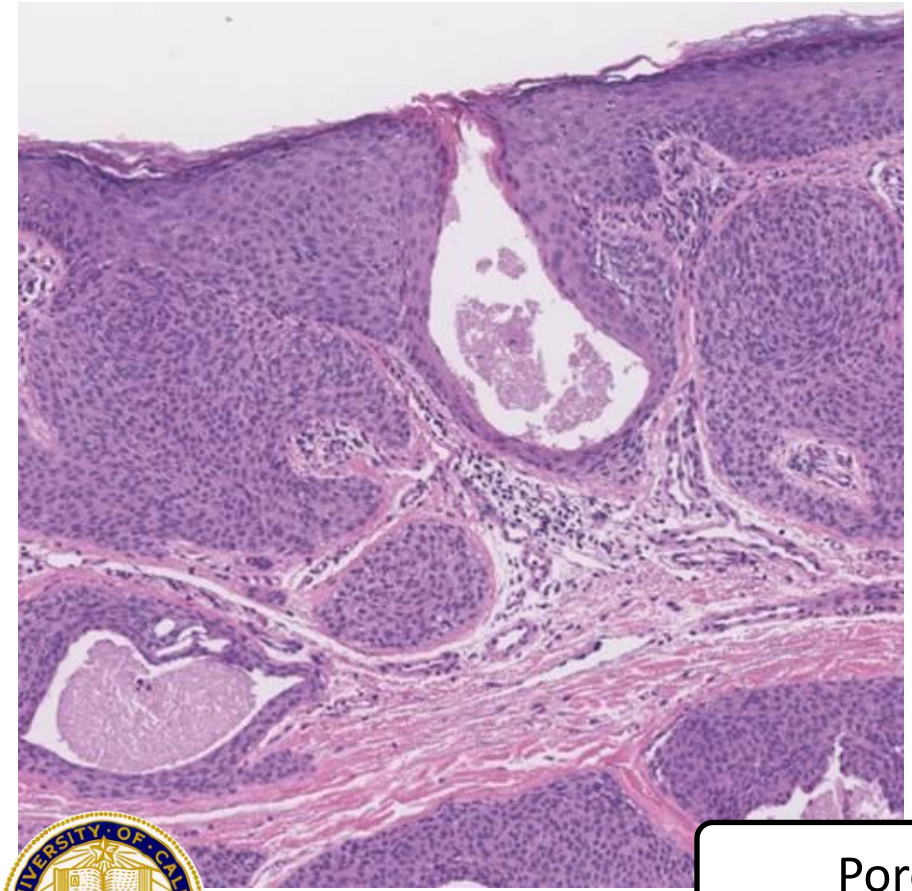
Pilomatricoma

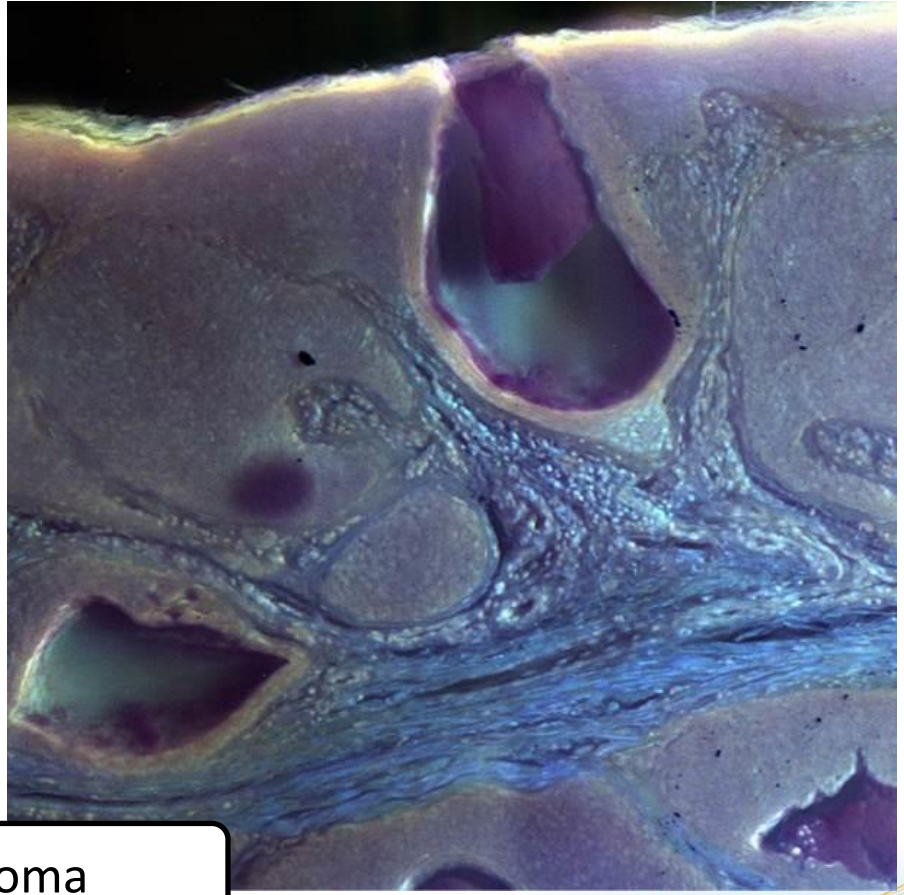




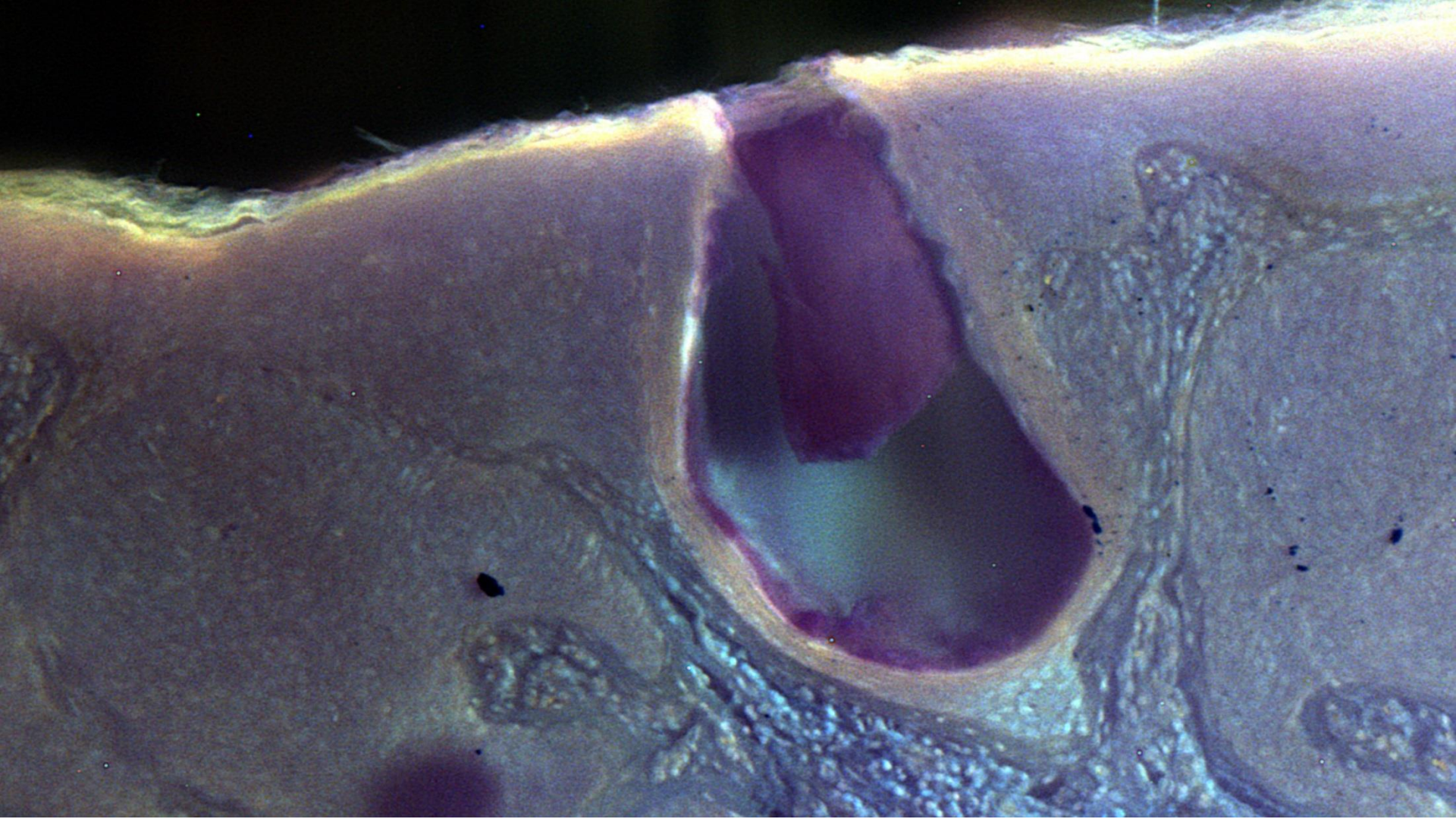


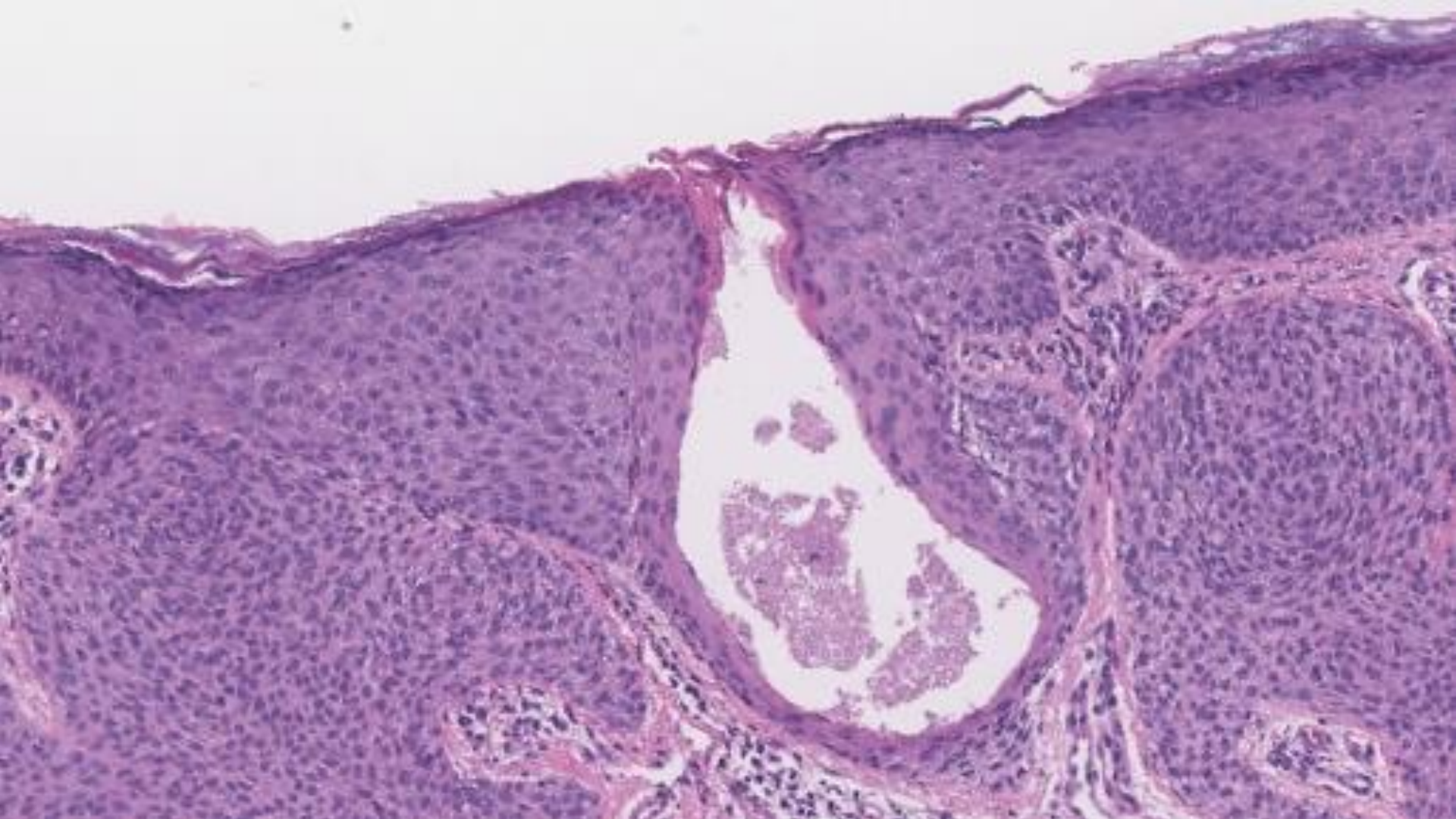
Cylindroma

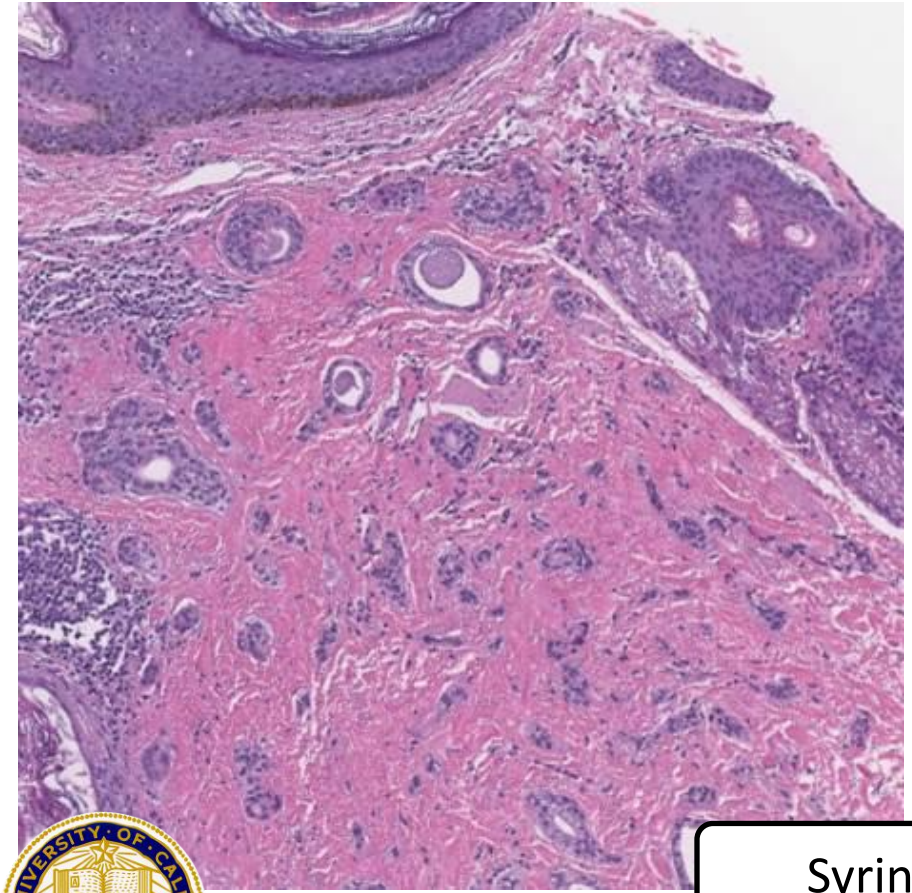


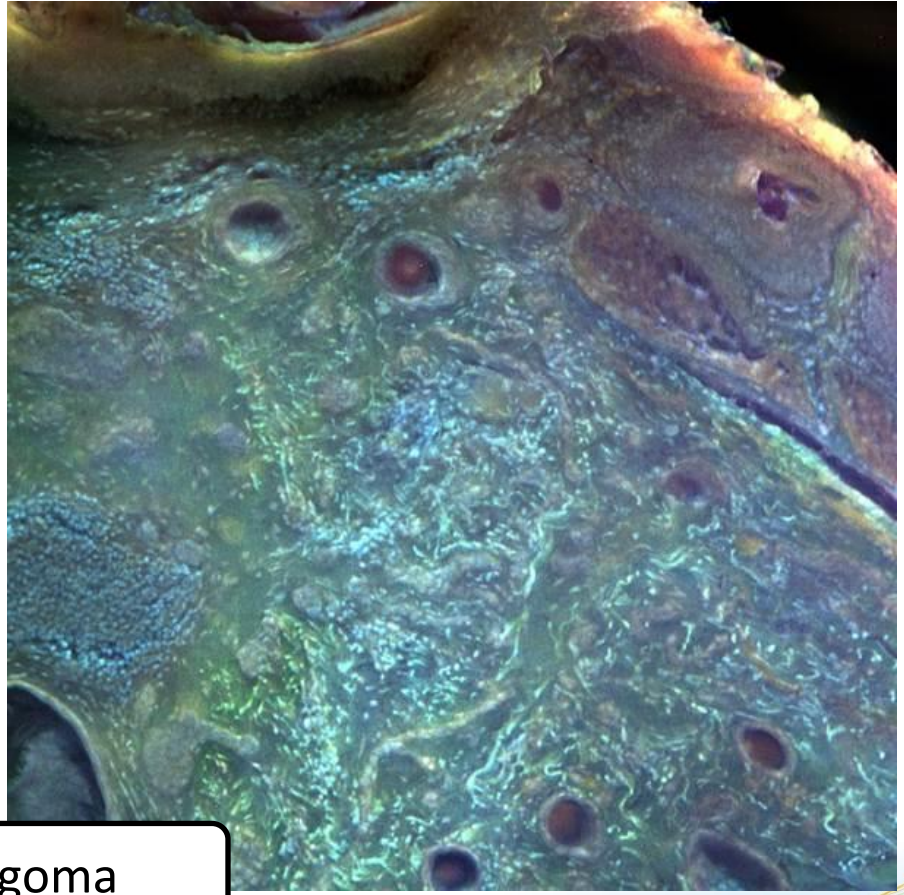


Poroma

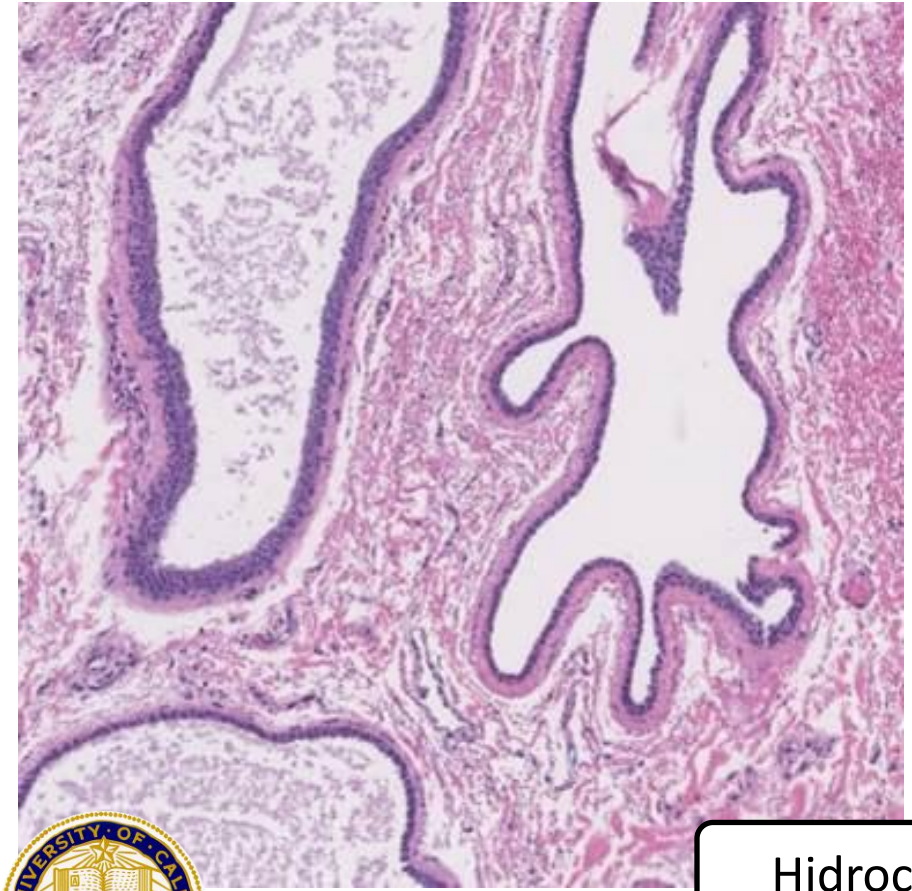


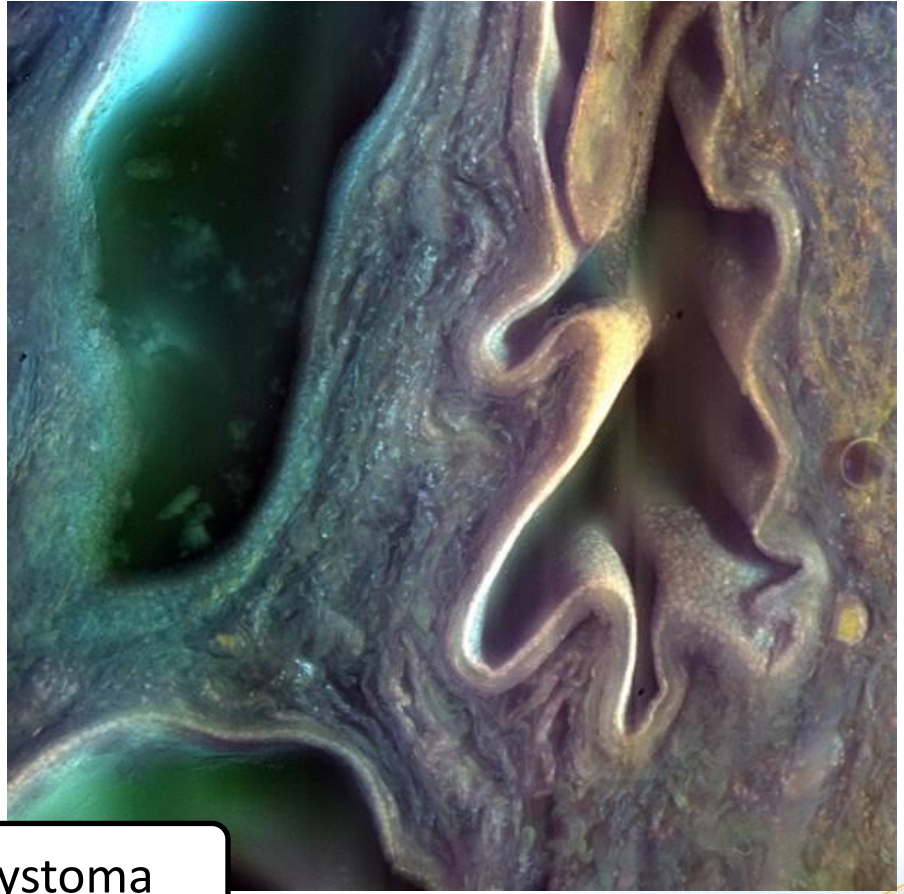




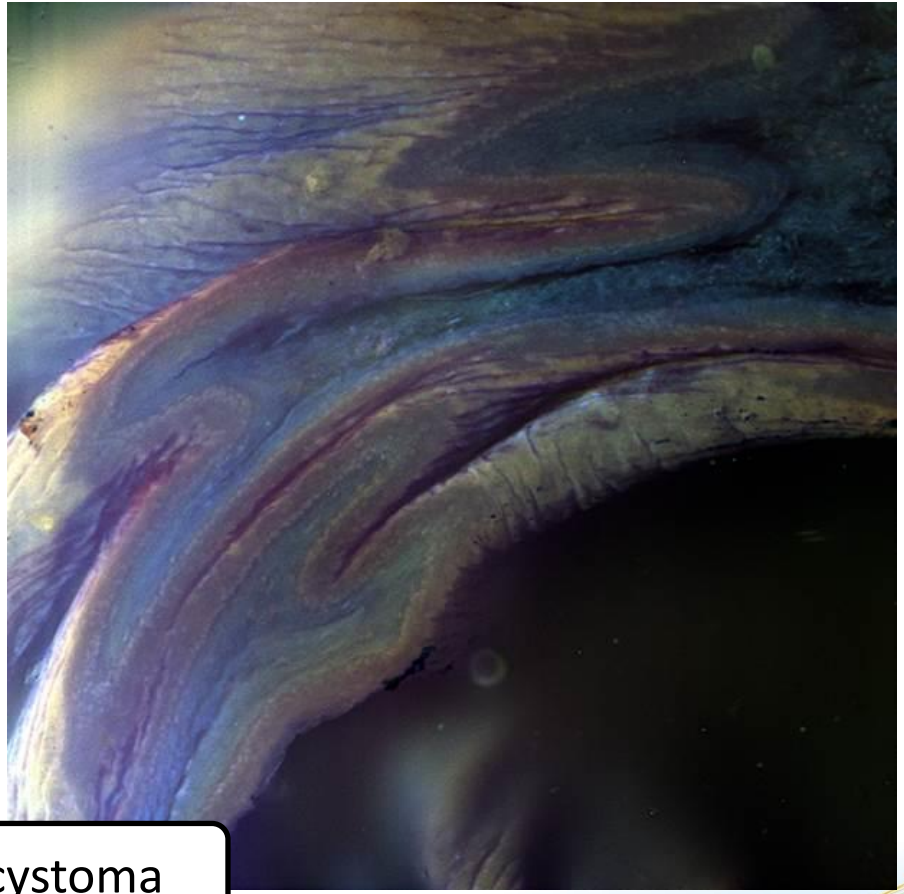


Syringoma

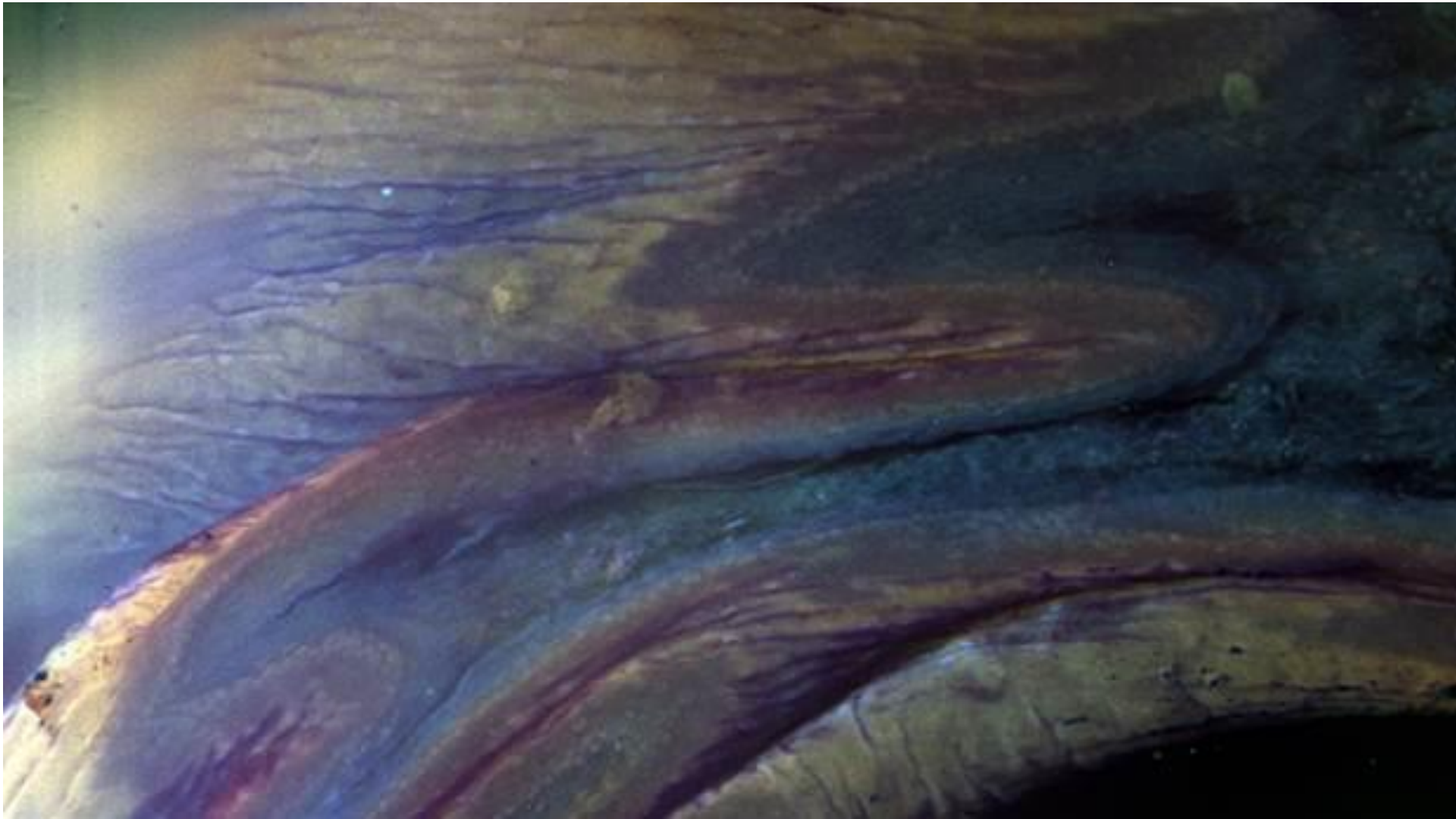


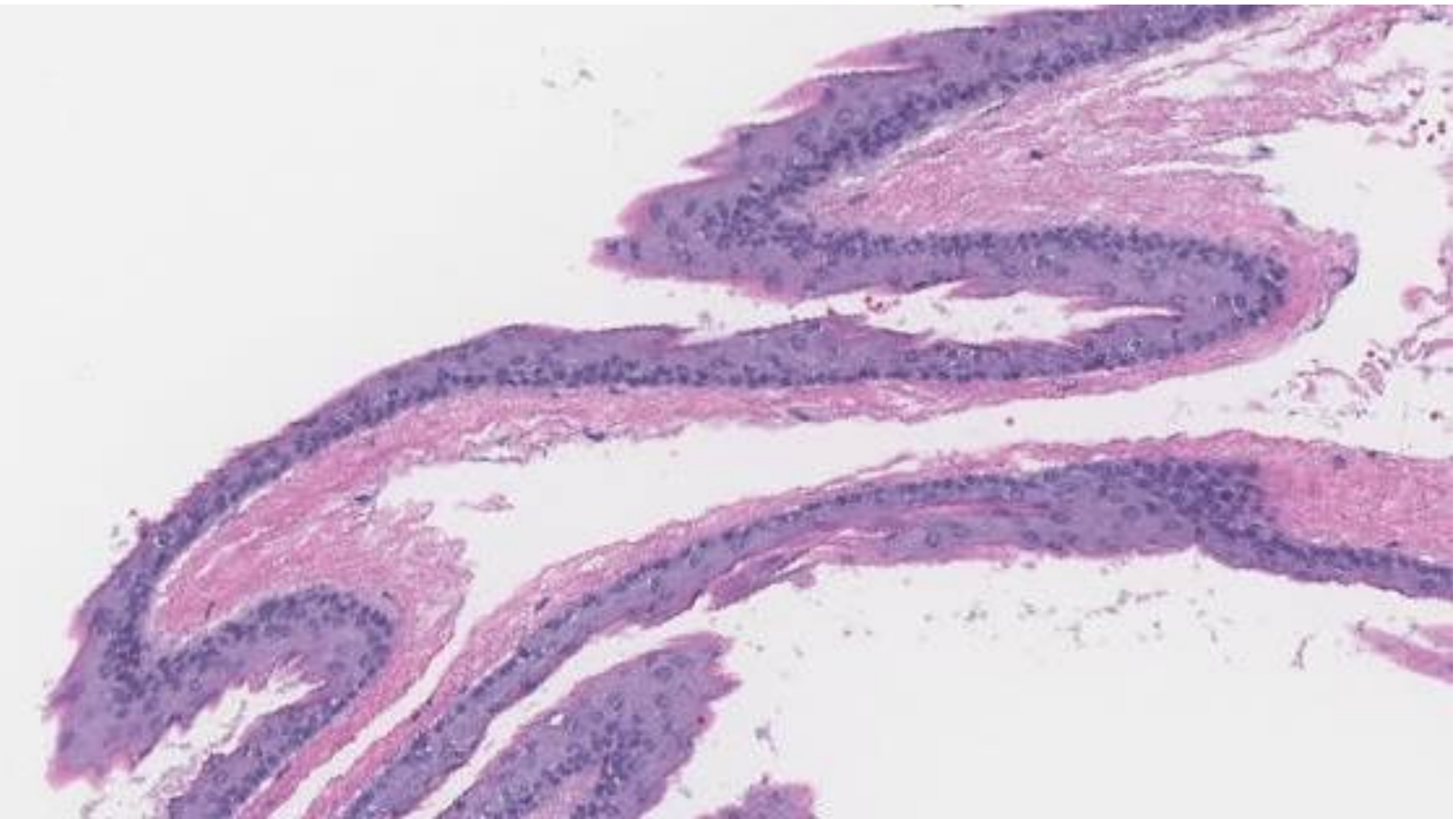


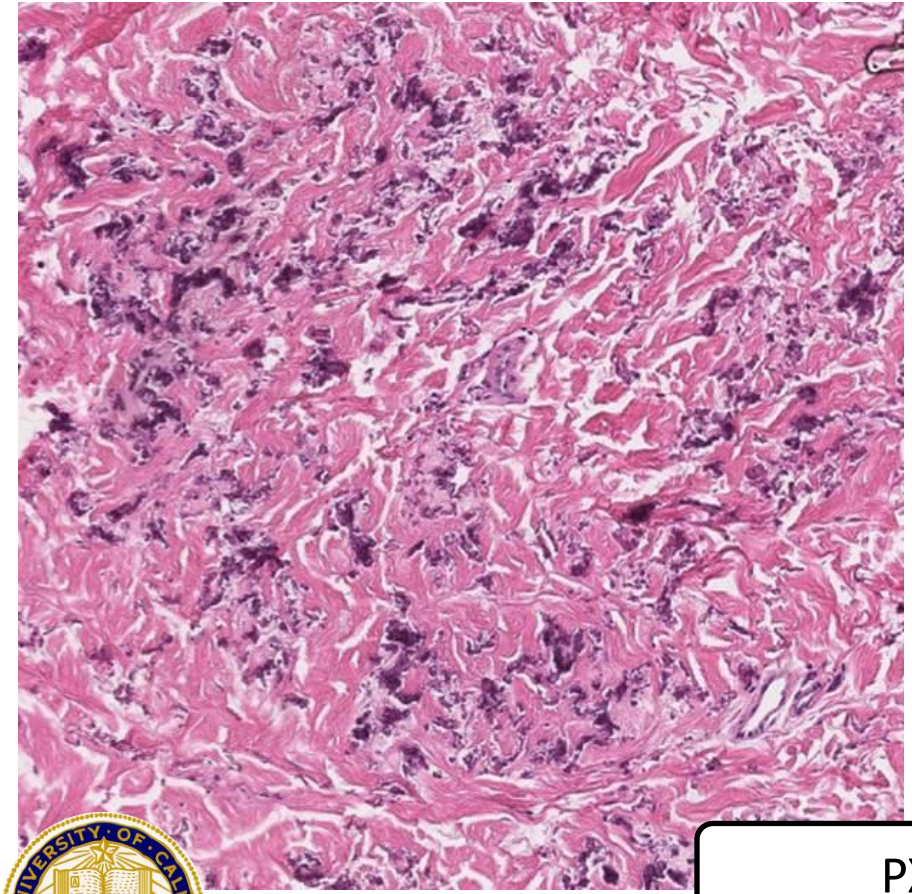
Hidrocystoma

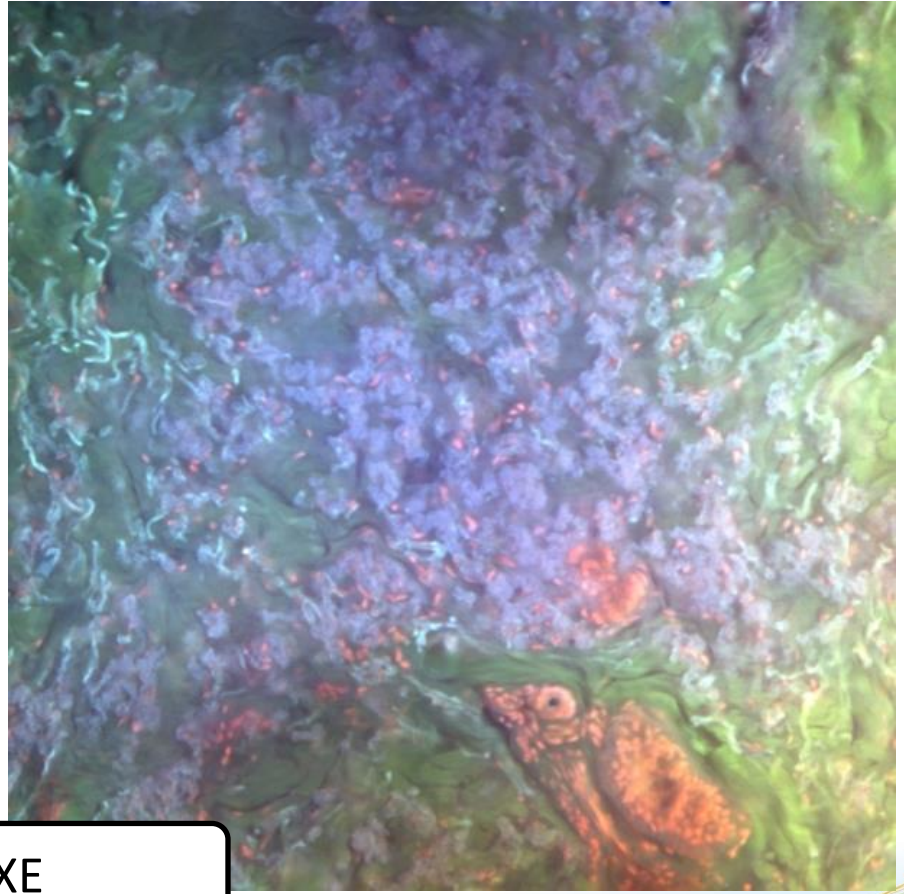


Steatocystoma





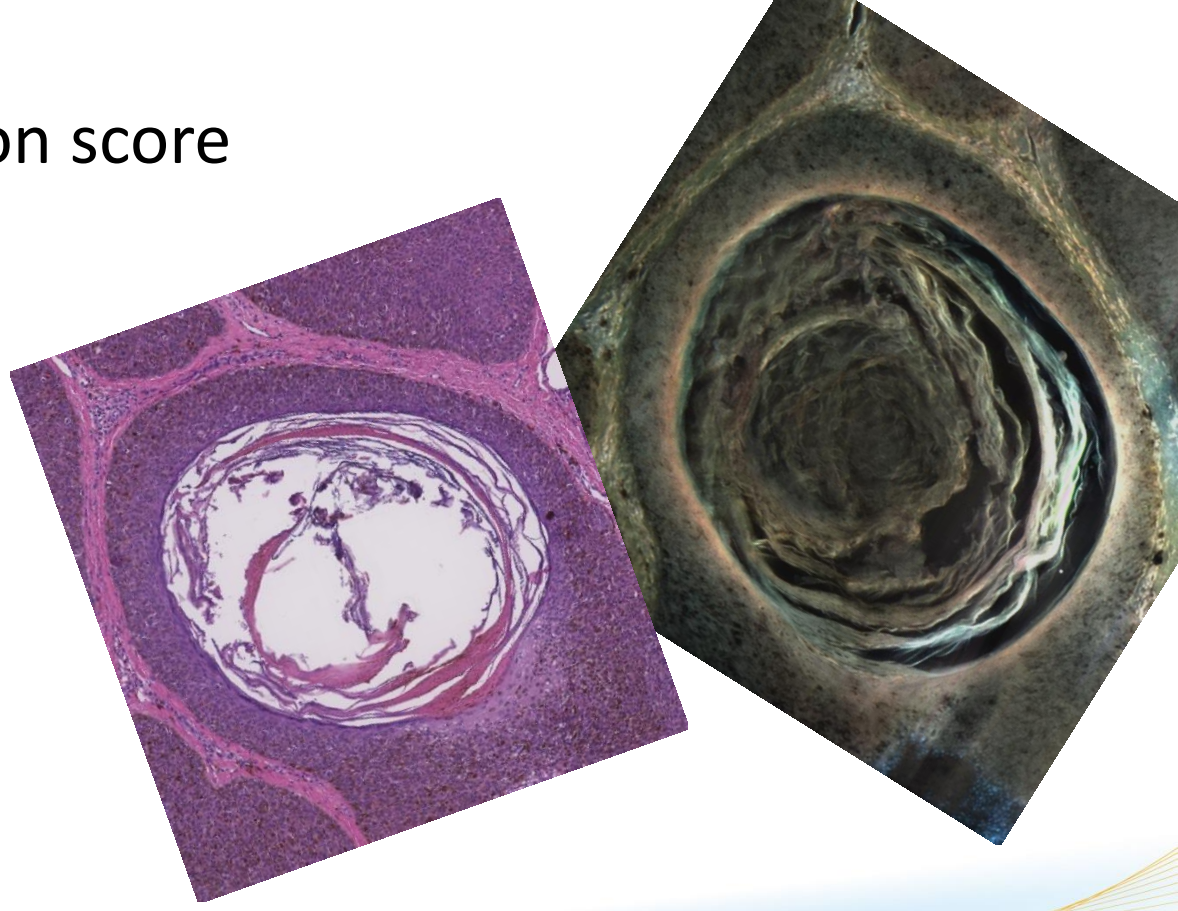




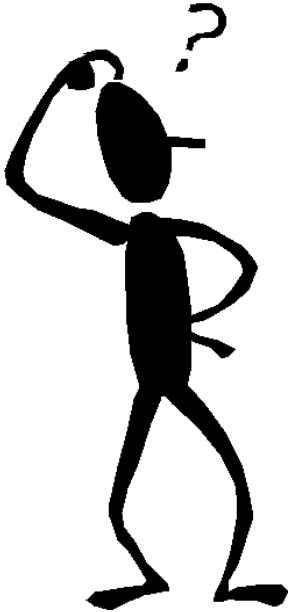
PXE

➢ MUSE: Comparison score

- ❑ Is it better than H&E?
- ❑ Total C. score: 0.8
  - ❖ Cystic lesions: 1.2
  - ❖ Adnexal lesions: 1.0
  - ❖ Elastin lesions: 1.0
  - ❖ Epidermal lesions: 0.7
  - ❖ Melanocytic: 0.6



- MUSE vs H&E:



➢ MUSE vs H&E:

- ❑ Cons:
  - ❖ Pre-image:
    - Unable to changing magnifications
    - Hard to work with very small specimens
  - ❖ Image:
    - Nuclear features (melanocytic, inflammatory)
    - Unfamiliar colors
  - ❖ Post-image:
    - Large data
    - Tissue storage

➢ MUSE vs H&E:

- ❑ Pros:
  - ❖ Robust method
    - Simple physical & chemical principles
    - Fast (2 minutes)
    - Fresh, formalin or alcohol
  - ❖ MUSE images:
    - Multi-color (more informative)
    - 3 Dimensional
    - Similar to H&E (orientation/thickness)
    - High diagnostic value (even for fresh eyes)

➢ MUSE vs H&E:

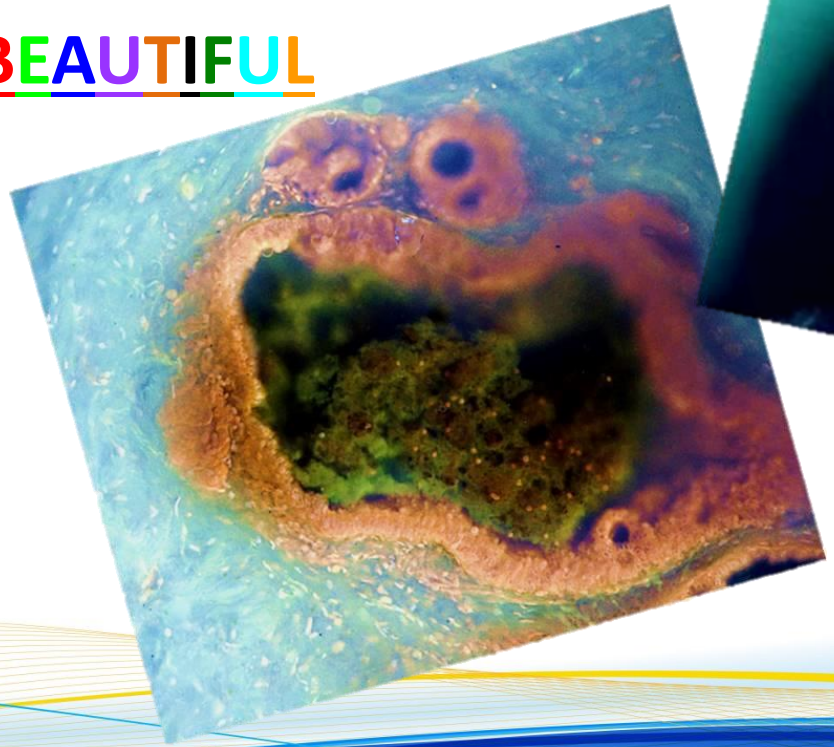
- ❑ Pros:
  - ❖ Ex-vivo microscopy:
    - Inexpensive (No histology)
    - Preserving tissue (downstream molecular testing)
    - Potential use in intraoperative consultation
    - Can potentially be used as POC
  - ❖ Digital pathology:
    - Provide service to low resource areas

➢ MUSE vs H&E:

- ❑ Pros:
  - ❖ Its **BEAUTIFUL**

➢ MUSE vs H&E:

- ❑ Pros:
  - ❖ Its **BEAUTIFUL**



- MUSE now:

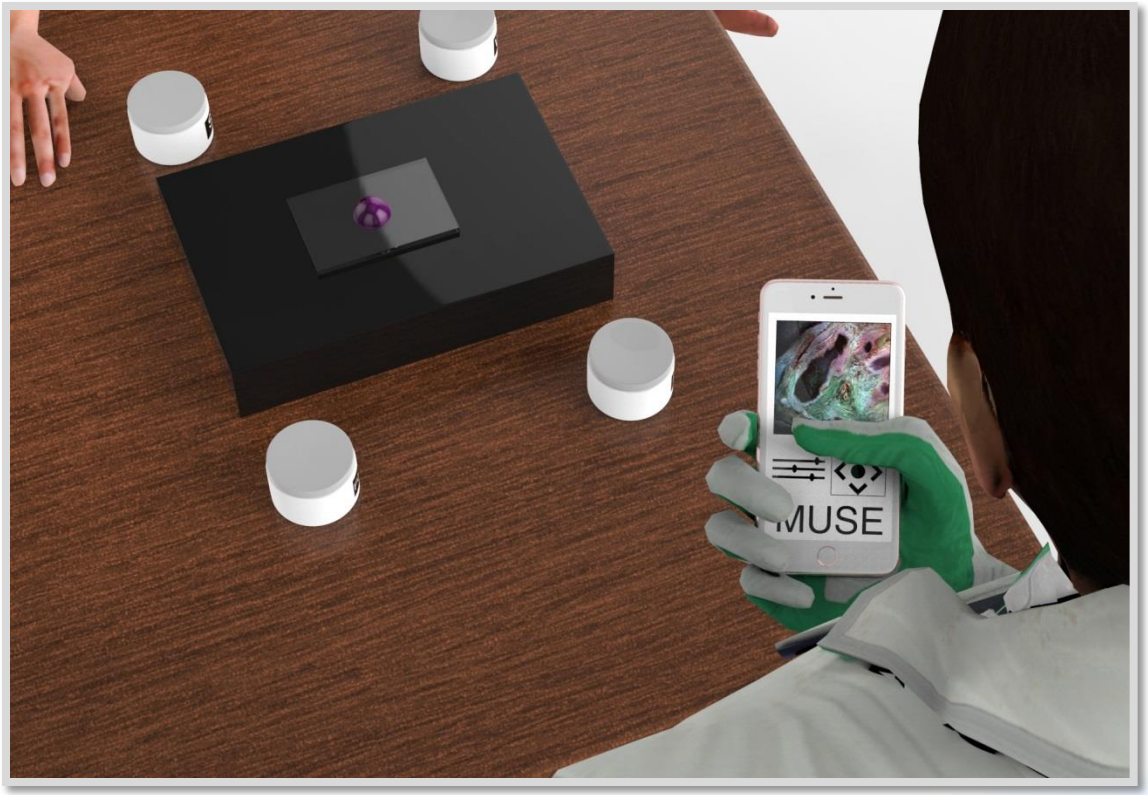
- MUSE future?

- MUSE future?

➢ MUSE future?

@BSTPath

@FungMaxwell



➢ Our team:

Maxwell A Fung MD

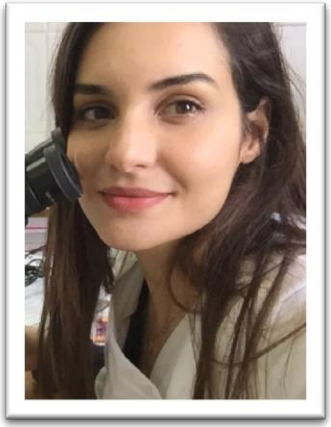
Richard Levenson MD

Samuel Balin MD PhD

Tareq Mohammad MD

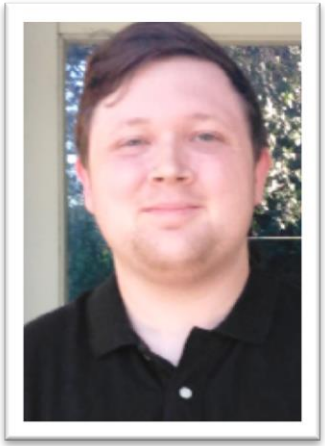
➢ Our team:

Farzad Fereidouni PhD



Yasmine Lahoubi MD

Zachary Harmany PhD



Austin Todd

- Thank you …

- Thank you …