An Anatomical Approach to Retinal Disease
Satisfaction / Gratification

- Complex
- Meaningful
- A clear connection between effort and reward
Dr. Semes’ s retina rules

- **RED**, it’s bleeding
- **YELLOW**, it’s leaking
- **BLACK**, it’s remodeling
- **WHITE/GREY**, it’s vitreoretinal
Can you name this condition?
What layer(s) of the retina is involved?

1. Inner
2. Outer
3. Both
4. RNFL
Are these two pigmented lesions the same thing?

How do you know?
Where are these pigmented abnormalities located?

1. Retina (RPE)
2. Choroid
3. Inner retina
“Your dishwasher is leaking into my apartment.”

- How do we know the source of the leak?
Examination Methods (Ocular Fundus)

Mainstays – ophthalmoscopy and fundus biomicroscopy

Others –
- Digital imaging (OCT, HRT, GDx)
- Ultrasound
- fluorescein angiography
- Electrodiagnostics
The most important visual!
Note locations

Normal
- Boundaries
- Vasculature
- Layers (inner vs. outer)

Abnormal
- Hemorrhage
- Leakage

Remember the Scrunge®
Fundus Biomicroscopy

- Posterior pole / peripheral retinal examination at slit-lamp
  - Optic nerve head
  - Superior and inferior arcade vessels
  - Macula
  - Superior, Temporal, Nasal, Inferior Retinal periphery
Optical Coherence Tomography

- Cross-sectional images of the retina are produced using the optical backscattering of light in a fashion analogous to B-scan ultrasonography.

- The anatomic layers within the retina can be differentiated and retinal thickness can be measured.

- Resolution may be 6-8 microns.
Normal sections

Figure 3. Macular mapping in a healthy subject (left eye). A. Radial spoke pattern of 6 scans 6 mm long, centered on the patient’s fixation point. B. Cross-sectional optical coherence tomograms obtained from the 6 radial scans. C. Macular thickness is displayed as a 2-D false-color map (left), with brighter colors (red and white) indicating areas of increased retinal thickness. Macular thickness is numerically reported as an average (mean ± SD) in each of the 9 Early Treatment Diabetic Retinopathy Study areas (right).
Histologic correlations
Ultrasound
(Diagnostic Echography)

- Indications
  - Opaque Media
  - Following trauma with suspicious fundus findings / poorly visualized fundi
  - Monitoring suspicious pigmented/elevated fundus lesions
  - Axial length measurements
    - ????
Other Diagnostic Methods

- Fluorescein Angiography
  - To confirm diagnoses and direct treatment

- Indocyanine Green Angiography
  - Superior to FA for choroidal imaging

- Electrodiagnostic testing
  - Instrumental in hereditary retinal & choroidal disorders
Anatomy

- Microscopic
  - Retinal layers
  - Choroid
  - Vasculature
  - RPE/Bruch’s membrane
  - Vitreous structure
What is the nutritional supply for the RPE?

1. Choriocapillaris
2. Retinal vasculature
3. Both of the above
4. I have no clue

25%  25%  25%  25%
What vascular system invests the inner retina?

1. Choriocapillaris
2. Retinal vasculature
3. Both of the above
4. I have no clue

25% 25% 25% 25%
Between which two layers of the retina does a retinal detachment occur?

1. Inner and outer
2. Choroid and RPE
3. RPE and sensory retina
4. I have no clue
What are the inner and outer boundary layers of the retina?

1. Hyaloid and RPE
2. Choroid and RPE
3. RPE and ILM
4. I have no clue
If you observed an exudate, where would you expect it to be?

1. Inner retina
2. Outer retina
3. At the level of the RPE
4. I have no clue

[Bar chart showing 25% for each option]
Schematic foveal anatomy - link

Normal Posterior Pole link

Cells participating in the light impulse reaching the optic nerve for relay to the brain

Where is the impulse initiated?

Where does it go next?

Where does it go after that?

What are the axons of the ganglion cells called?

To what do they connect?
Histology of the Macula (not fovea)

△ Indicates ganglion cell layer > 1 layer in thickness outside the center of the fovea
Anatomy - Terminology

- Anatomic macula (*posterior pole*)
  - GC layer > 1 cell-layer thick
  - *Generally the area within the vascular arcades* [\(\sim 5\text{mm}\)]
Posterior Pole - Clinical Features

FAZ

Macula

Macula
The Foveal Avascular Zone (FAZ)
Normal Macula

- Appears darker clinically due to
  - Denser RPE cells
  - Greater melanin content of RPE cells
  - FAZ
  - Retinal macular pigment (*zeaxanthine, lutein, xanthophyll*)

COMPARE TO FLUORESCCEIN ANGIOGRAPHY
Retinal Vasculature

- **Retinal** capillary system is “closed”
- Resides within the inner portion of the sensory retina
- Larger (*clinically visible*) vessels are in the NFL, GCL

*How does blood get from the arteries to the veins?*
Retinal Vasculature

- Capillaries are distributed within
  - NFL
  - GCL (Superficial plexus)
  - IPL
  - INL (Deep plexus)
  - OPL (partially)
Retinal Pigment Epithelium (RPE)

- Situated between sensory retina and Bruch membrane of the choroid

- *Potential space exists between RPE and photoreceptors (RD)*

- Adjacent RPE cells are attached by zonula *adherens* [isolates sensory retina from choriocapillaris] + *occludens* [denser]
Choroidal Vasculature

- Open vasculature system allowing transport of nutrients for outer retinal nourishment

WHAT ARE THE IMPLICATIONS FOR FOVEAL INTEGRITY?

WHAT ARE THE IMPLICATIONS FOR FA?
Is it inner or outer retina????

Superficial vs. deep

- *Inner retinal disorders* generally manifest blood/exudate

- *Outer retinal/choroid problems* generally appear with pigment
Is it retinal or choroidal ???

- Retinal from choroidal pigment is differentiated by red-free light examination

MORE LATER
Peripheral landmarks

- Vortex vein ampullae / vortex veins
- Long and short ciliary nerves

* look for changes in color or contour

MORE LATER
Posterior Pole Landmarks/Observations

- Optic Nerve head
- Retinal vessels
- Macula

*Then to the periphery or other areas requiring further study*
Clinical / Practical Observation

Optic nerve description

- Disc margins
  - distinct vs. indistinct (e.g., elevated)
  - insertion (normal, oblique, tilted)
  - conus
  - peripapillary atrophy

- Cup margins/contour/appearance
  - regular (ISNT)
  - notched
  - lamina cribrosa
  - C/D ratio

Images from EyeTextnet
Clinical / Practical Observation

Optic nerve description

- Disc margins
  - insertion (normal, oblique, tilted)

Images from EyeTextnet
Clinical / Practical Observation

- **NORMAL** Optic disc variations

Image courtesy Eyetext.net
Clinical / Practical Observation

What is your clinical description?

Image courtesy Eyetext.net
Clinical / Practical Observation

Optic nerve description

- Cup margins/contour/appearance
  - regular (ISNT)
  - notched
  - lamina cribrosa
  - C/D ratio

Images courtesy Eyetext.net
Clinical / Practical Observation

Optic nerve description

- Disc margins
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Clinical / Practical Observation

Vessels / abnormalities

- Patterns
  - branching
  - tortuosity (arteries, veins or both)
  - crossings / crossing changes / caliber

- Hemorrhages
  - Blot
  - Dot
  - Flame
  - Pre-retinal
Where is the large hemorrhage located?
Where are these hemorrhages located? What is the source and location of the exudate?

Courtesy eyetext.net
Where are these hemorrhages located?
Why are the veins tortuous?
Is there normal caliber to the arteries and veins?
Clinical / Practical Observation

Macula

- Foveal reflex (present or absent)
- Macular pigment (normal or disrupted)
- Druse(n); size, number, extent
- Blood (layer)
- Exudates
- Swelling / Thickening

* look for changes in color and contour
Recording Findings

Vitreous – clinical description

- Attached vs. detached (PVD)

- Clear (vs. cloudy)
Recording Findings

Macula – clinical description

- Foveal reflex present or absent

- If absent, what characteristics have replaced the normal appearance?
  - Pigment (RPE disruption)
  - Drusen
  - Blood
Recording Findings

Retinal Vessels

- Intact

- If not intact, what characterizes the clinical appearance? *(clinical description)*
  - Superficial (flame) hemorrhage
  - Dot/Blot hemorrhage
  - Include geographic location
Recording Findings

Optic Nerve Head – see earlier

MORE LATER
Peripheral retina

- Flat and attached to ora without conditions predisposing to retinal detachment

- If predisposing conditions are present, describe in words and with a DRAWING (92225/6) or PHOTOGRAPHIC IMAGE (92250)
Clinical Pearls

- Observation should begin with the BIO survey followed by fundus biomicroscopy. This routine allows detailed observation of disorders observed at survey as well as posterior-pole study efficiently.

- The lower the dioptric power of your condensing lens the greater the magnification, the smaller the field of view (given same diameter), and the greater the stereoscopic appreciation possible.
Clinical Pearls

- Use the BIO as your survey instrument; do SLB next
- Look at detail as indicated with profile examination /SLB
- Move toward what you want to include in your view
- Document your findings with a drawing or other image

Your view is indirect so the image that you see is reversed and inverted. On your chart should be findings as they are in the eye.
Clinical Case Example

This is your condensing lens view; which eye are your examining?

What is your clinical description?
Clinical Case Example

What is your clinical description?
Clinical Case Example

What is your clinical description?
Is this the same condition as the previous example?
What is your clinical description?
Is this the same condition as the previous 2 examples?
Clinical Case Example

Central V and A of rhesus monkey with hypertension, atherosclerosis and glaucoma

Note: fibrous thickening (*), venous attenuation
Clinical Case Example
Clinical Case Example

Now can you tell where is the pigmented abnormality located?
Here is what to remember

- If it is **red** it is bleeding
- If it is **yellow** it is leaking
- If it is **black** it is remodeled / remodelling
- If it is **white or grey / white**, it is vitreous or vitreoretinal