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Fundus Autofluorescence

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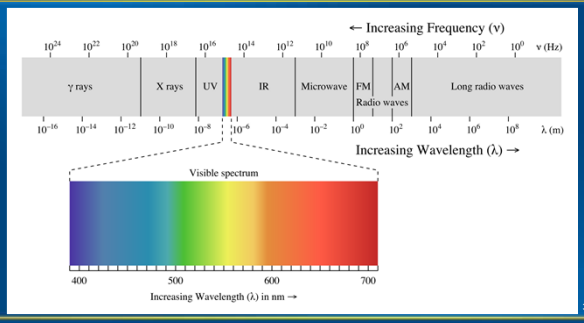
Fundus Autofluorescence

"Fundus autofluorescence imaging is used to record fluorescence that may occur naturally in ocular structures or as a byproduct of a disease process. This technique allows the topographic mapping of lipofuscin distribution in the RPE. The intensity portrayed by FAF corresponds to the accumulation of lipofuscin, which increases with aging, RPE cell dysfunction or an abnormal metabolic load on the RPE."

-Saudi Journal of Ophthalmology

Visible Spectrum



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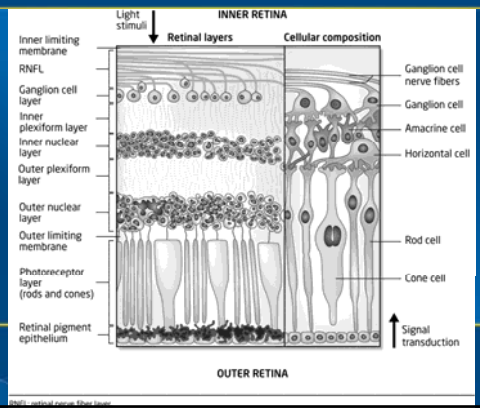
The RPE



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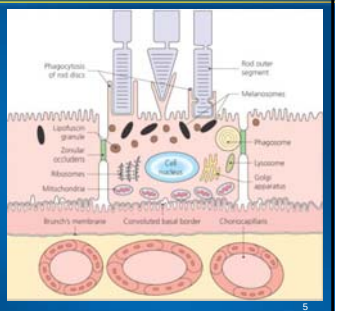
The RPE

- Retinal Pigment Epithelium – single layer of cells which separates the choroid from the neurosensory retina
- Five main roles, one of which is phagocytosis of the outer segment
  - Allows renewal process necessary to maintain photoreceptors (rods and cones) functioning normally



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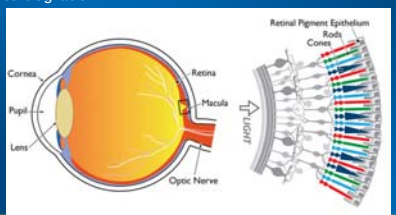
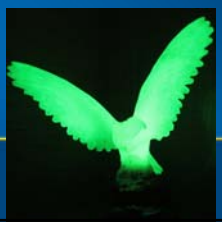
The RPE

- Aging can result in incomplete or partial breakdown of these segments which causes an accumulation of lipofuscin.
- Excessive lipofuscin is associated with visual loss.
- This accumulation is evident in ocular disease even before the visual cycle begins to degrade.



Fluorescence and Phosphorescence

- Fluorescence – emission of light by a substance that has absorbed light.
  - Immediate release of light.
  - emitted light has longer wavelength
  - electron excited to a higher energy state and relaxes to ground state
- Phosphorescence – emission of light lasts after excitation has stopped
  - electrons cannot relax into ground state therefore emission lasts after excitation



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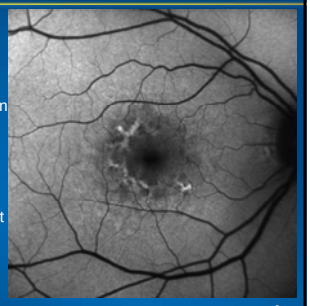
Fundus Autofluorescence

- Autofluorescence – fluorescence occurs naturally, without a dye
- Fluorescence occurs when molecules get excited by a specific light and then emit light at a longer wavelength which makes them glow
- Fundus autofluorescence works by shining a specific color/wavelength of light into the eye and capturing how it naturally fluoresces without dye
- The major source of fundus autofluorescene is this lipofuscin.



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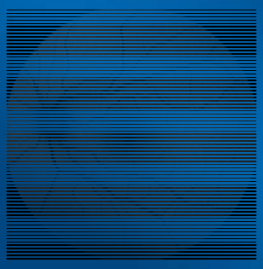
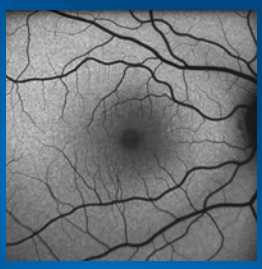
Healthy Eyes





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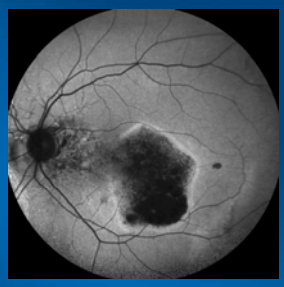
Lipofuscin and FAF

- The RPE ages or becomes more damaged which means there is more lipofuscin
- Lipofuscin properties fluoresces at about 500nm to 750nm
- Intensity of signal emitted relates to the health level of the RPE based upon what is normal.
  - Hyperfluorescence (white/really bright areas) means that the RPE cells are failing
  - Hypofluroescence (black/really dark areas) means that the RPE is dead/ atrophy



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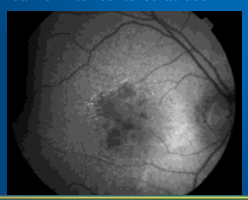
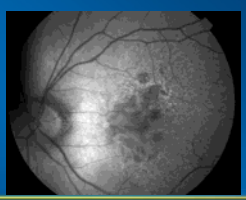
Types – Fundus Camera

- Fundus camera uses white light
- Wideband exciter filter and wideband barrier filter
- Only a single image
- Limiting factors such as ocular media opacities
- The first fundus camera technique used filters around 580nm for the exciter and a barrier filter centered at 695nm.





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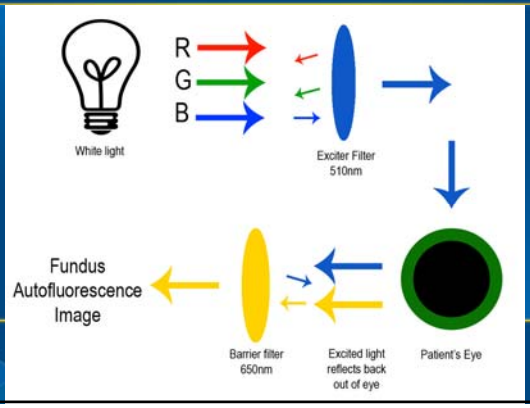
Fundus Camera Light



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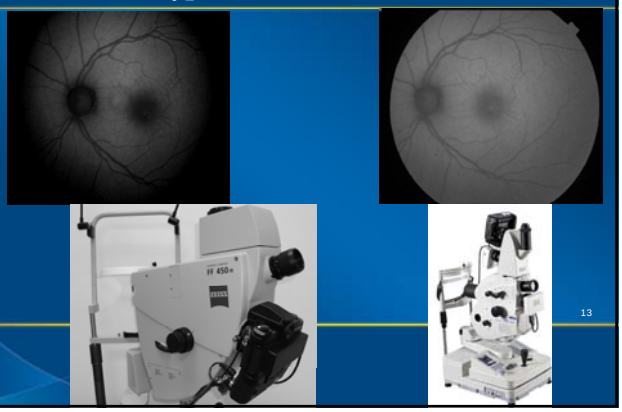
Types – Fundus Camera



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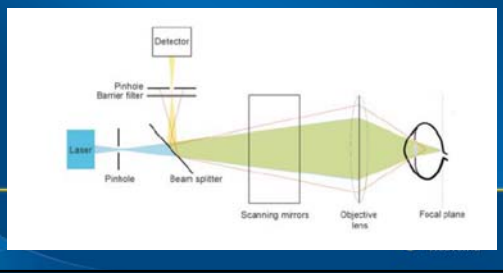
Types - cSLO

- Confocal Scanning Laser Ophthalmoscope
- Laser beam of specific wavelength on the retina to excite it
- Images "build" to reduce background noise
  - Acquire images at nearly a video rate and add the frames together
  - Provides higher-quality if there is minimal movement by patient.
- Two main types Heidelberg Retina Angiograph and the Optos



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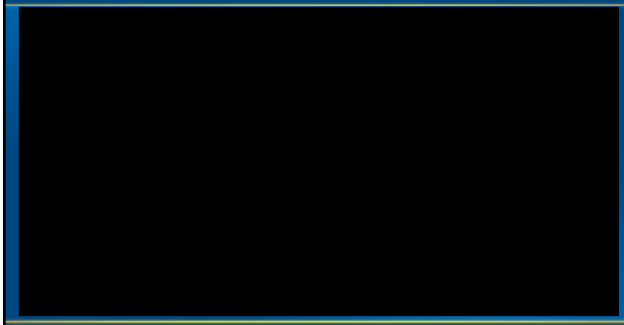
Types - cSLO



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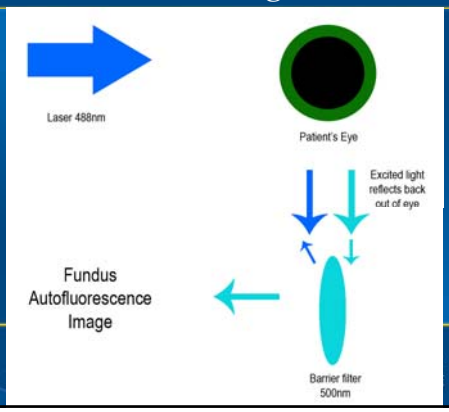
http://www.heidelbergengineering.com/us/products/spectralis-models/technology/focal-scanning-laser-ophthalmoscopy/

cSLO Light



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Heidelberg Spectralis HRA

- Heidelberg Spectralis HRA
  - Fundus Autofluorescence imaging
    - Blue laser 488nm and 500nm barrier filter
- More than just FAF Images!
  - Indocyanine green angiography / Infrared Autofluorescence
    - Diode laser at 790nm and a barrier filter at 830nm
  - Infrared reflectance imaging
    - Second diode laser at 820nm
  - Blue or "red-free" reflectance imaging
    - Blue laser 488nm and no barrier filter
  - Fluorescein Angiography
    - Same filters as FAF, only difference is that dye is introduced

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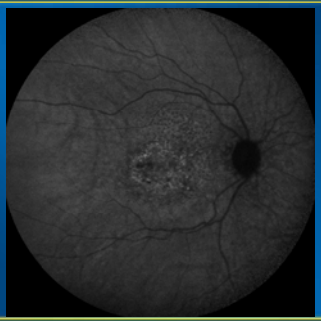
ICGA/IRFAF



Laser at 790nm
Barrier filter at 830nm

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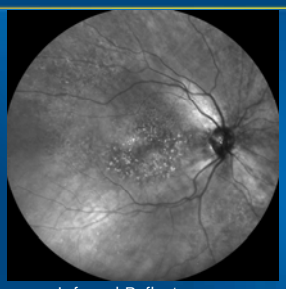
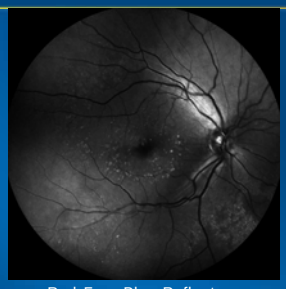
Infrared and Blue Reflectance



Infrared Reflectance
Laser at 820nm



Red-Free Blue Reflectance
Laser at 488nm

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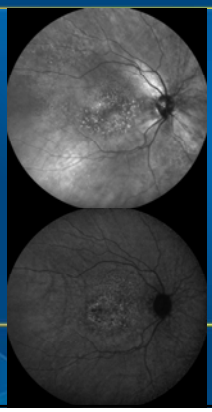
Options

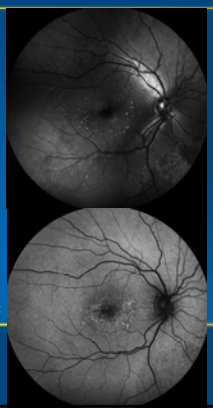


Infrared

Red-Free

ICGA/IRAF

FAF



Optos Ultra-widefield

- Optos California Ultra-Widefield
- Fundus Autofluorescence
  - Green laser at 532nm
- Other imaging modalities:
  - Indocyanine Green Angiography
    - Infra-red 802nm
  - Red-Free
    - Green laser at 532nm
  - Fluorescein Angiography
    - Blue laser at 488nm

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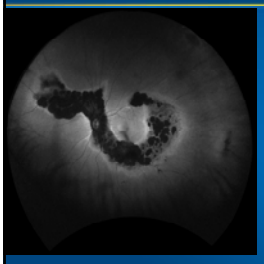
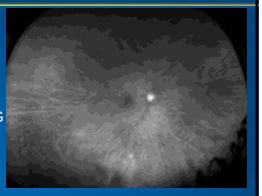
Options

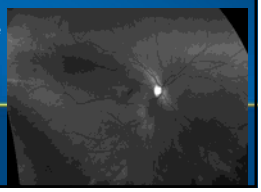


Fundus Autofluorescence

Choroidal/ICG



Red- Free



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Examples

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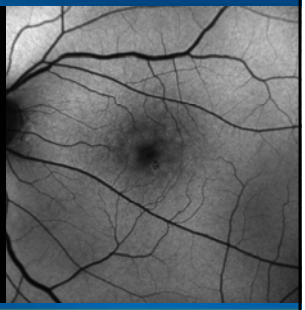
Dry AMD



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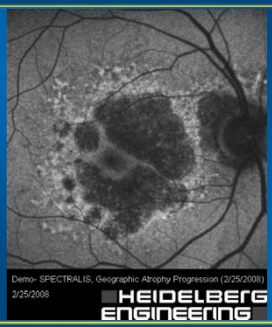
Geographic Atrophy Dry AMD



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Wet AMD

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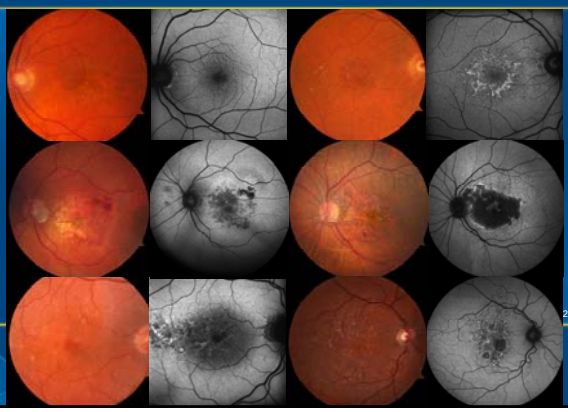
AMD



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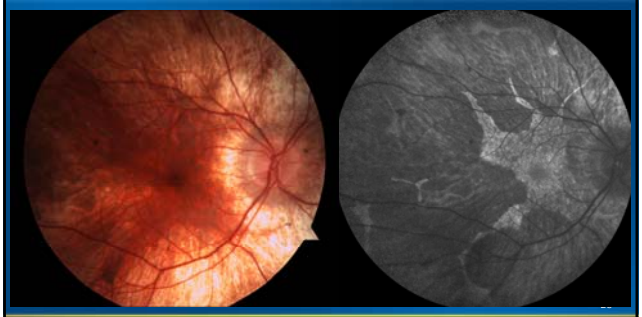
Choroideremia



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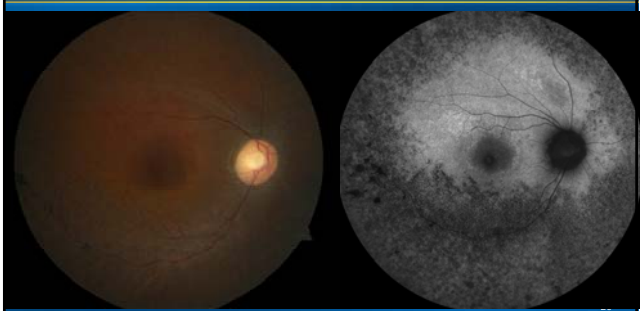
Retinitis Pigmentosa



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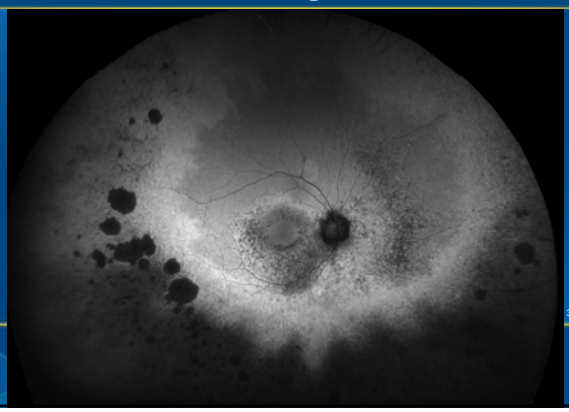
Retinitis Pigmentosa



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Chorioretinitis

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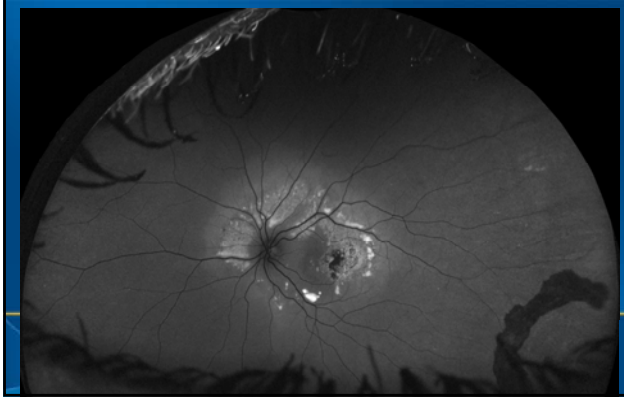
Chorioretinitis



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Non - Atrophy Examples

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Pigment

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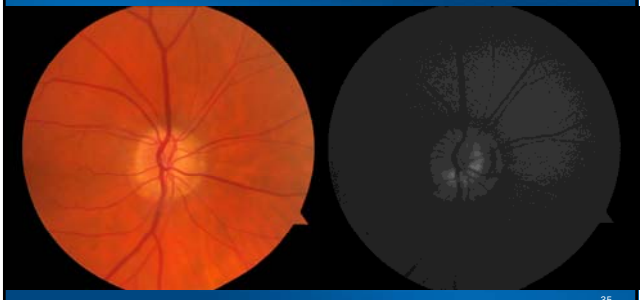
Optic Nerve Head Drusen



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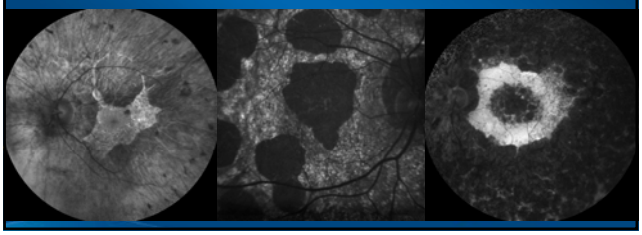
Summary

- Fundus Autofluorescence shows break down of RPE by accumulation of lipofuscin.
  - White areas means that the RPE cells are failing
  - Black areas means that there is RPE atrophy
- Fundus cameras or cSLO imaging can be used
  - cSLO Heidelberg Spectralis HRA 488nm and Optos 532nm
  - Fundus cameras 500-600nm



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Credit

- Sources:
  - http://www.aao.org/eyenet/article/nuts-bolts-of-fundus-autofluorescence-imaging
  - http://www.heidelbergengineering.com/us/
  - http://www.optos.com/en-US/Products/Retinal-imaging-products/Retinal-imaging-products/California/
  - http://www.opsweb.org/?page=Autofluorescence
  - https://nei.nih.gov/
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  - Saudi Journal of Ophthalmology
  - *Atlas of Fundus Autofluorescence Imaging* F.G. Holz, S. Schmitz-Valckenberg, R.F. Spaide, A.C. Bird
  - https://www.researchgate.net/publication/233722317_Near_Infrared_Autofluorescence_Imaging_of_Retinal_Diseases
  - http://www.comtecmed.com/cophy/2011/Uploads/assets/von%20strachwitz.pdf

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Credit

- Diagrams
  - *Clinical Atlas of Ophthalmology*, Spalton
  - http://www.closerlookatstemcells.org/stem-cells-and-medicine/macular-degeneration
  - https://en.wikipedia.org/wiki/Light
  - http://www.neurology.org/content/80/1/47/F1.large.jpg
- Images courtesy of Flaum Eye Institute Diagnostic Team and Imagers
  - Brittany Bateman
  - Brittany Richardson, COA OCT-C CRA
  - Kassandra Mundt
  - Patricia Artman, COA
  - Rachel Hollar, OCT-C CRA
  - Taylor Pannell, OCT-C CRA

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Thank you

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