Course Description:
This extensive course presents various photographic equipment and techniques for external ocular photography using readily available consumer digital or film-based cameras. “Cook Book” step-by-step camera settings are detailed for improved ocular photography.

Course Learning Objectives:
- Learn and understand the reimbursement requirements necessary for external ocular photography.
- Present the principal photo media types, camera types, lens types and lighting sources.
- Present and discuss various means of achieving macro photography magnification.
- Present and explain various technical terms unique to photography.
- Present and explain the various elements that control depth of field.
- Present and explain the Scheimpflug Effect - now available for DSLR ocular photography
- Provide “cook book” settings with illustrations for most DSLR cameras to achieve outstanding macro photography results.
- Brief discussion of reports and billing methods with sample sheet provided.

Outline:

- Disclaimers
  - Dr. Click prepared the content of this course independently without input from members of the ophthalmic community.
  - I have no direct financial or proprietary interest in any companies, products or services mentioned in this presentation.
  - The content and format of this course may reflect commercial bias and may claim or imply superiority of a particular commercial product or service.

- Photography Membership
  - Professional Photographers of America

- Why do External Photography?
  - Document medical conditions, treatment and/or progress
  - How (35mm, slide or digital)?
    - Close up (macro) photography 35mm, slide or digital
    - Slit lamp photography
    - Gonio-photography
    - Stereo photography

- Mutually Exclusive Procedures on the SAME DAY
  - 92285 External Ocular Photography
  - 92250 Fundus Photography
  - 92225/92226 Extended Ophthalmoscopy
  - 92135 Scanning Laser
  - May have patient return on another day to do a different procedure
  - May do more than one mutually exclusive procedure in the SAME day IF you have multiple DISSIMILAR diagnosis to support each procedure
• Medical necessity?
  o Reason for test – note reason in chart!
  o Directly stated or easily implied
  o Will it affect diagnosis or treatment?
  o Requires WRITTEN interpretation and report

• General payment policy
  o Medicare reimburses reasonable and medically necessary care
  o Diagnose and treat illness or injury
  o Improve the function of a malformed body member

• Specific payment policy
  o CPT – Current Procedural Terminology
  o ICD – International Diagnostic Codes
  o NCD – National Carrier Directives
  o LCD – Local Carrier Directives
  o “Golden Rule” – check carrier contracts!
  o Use Professional judgment

• Opinions
  o Are NOT payment policy
  o ANYTHING outside CPT, ICD, NCD and LCD = opinion

• Imaging Medical Necessity Criteria
  o NOT simply to document its existence
  o Provides a baseline for later comparison
  o Documents change in condition and/or requires a change in treatment
  o May help establish a proper diagnosis to provide treatment
  o Note reason for photos on the chart

• What Can I Photograph?
  o Conjunctival problems
    ▪ Pinguecula, Pterygium, Foreign Body, Pigmentation issues, Pannus, Burns, etc.
  o Corneal problems
    ▪ Ulcers, abrasions, neovascularization, kerratitis, dry eye, etc.
  o Eyelid problems
    ▪ Ectropion, entropion, styte, hordeolum, ptosis, neoplasms, tumors, etc.
  o Eyelash problems
    ▪ Triachiasis, maderosis, bacterial infection, neoplasms, lice, tumors, etc.
  o Cataract problems
    ▪ Photograph with retroillumination or direct illumination
  o Glaucoma problems
    ▪ Gonioscopic photography
  o Pupil problems
    ▪ Coloboma, iritis, pigmentation, neovascular, trauma, etc.

• Comprehensive list of Ocular Conditions & ICD9 Codes
  o www.aetna.com/cpb/medical/data/700_799/0734.html

• CPT 92285 External Photography Requirements
  o Image quality clinically relevant and graphically equivalent to a photograph
  o Images film based or digitally stored
  o Requires a WRITTEN interpretation and report.
  o Unilateral or bilateral fee
  o 92285 qty 1 for unilateral or bilateral
  o Modifiers E1, E2, E3 or E4 if eyelids
    ▪ E1 = upper OS
    ▪ E2 = lower OS
    ▪ E3 = upper OD
- E4 = lower OD
  - Appropriate ICD9 diagnosis

- **Sample Written Report and Interpretation Form**
  - See handout for sample

- **Sample Photography Release Form**
  - See handout for sample

- **Macro Photo Types**
  - Digital
  - Film
  - Slide
  - Polaroid

- **Camera Types**
  - **“Point & Shoot”**
    - Viewfinder and/or LCD screen
    - Non-interchangeable lenses
    - Need macro-zoom or super-macro-zoom capabilities
    - Best if camera has manual controls
    - Full manual, shutter priority, aperture priority
    - Built-in flash
    - May have accessory add-on lenses
  - **SLR and DSLR** (single lens reflex or digital single lens reflex)
    - View through the lens and/or on LCD screen (some models)
    - Changeable lenses – 5 options
    - Standard lens w/Dioptric add-on lenses
    - Standard lens w/Extension tubes or bellows
    - Standard lens reversed on camera body
    - Standard lens coupled with prime lenses for extremely high magnification
    - Dedicated macro lens
  - **Polaroid Macro 5 Camera**
    - Discontinued in 2006
    - As of 2009 no more Polaroid film made
    - Affects all retinal & slit lamp cameras w/Polaroid backs

- **Lens Types**
  - Prime – single focal length
  - Zoom – variable focal length
  - True or Dedicated Macro (usually single focal length)

- **Lens Magnification Types – Accessory lenses or devices**
  - Dioptric plus magnifiers and “macro” add-on lenses
  - Teleconverters
  - Extension tubes and bellows

- **Light Sources**
  - Ambient lighting
  - Built-in camera flash
  - Shoe mounted camera flash
  - Supplemental lighting
    - Off camera flash, ring flash or twin bracket mounted flashes
    - Studio lighting
    - Reflectors, shades, screens, fill lighting
Magnification Methods
- Diopter add-on lenses
- Extension tubes
- Bellows
- Teleconverters
- Reverse lens mounts
- Stacked lenses
- Dedicated Macro lenses

DSLR w/kit lens and macro accessories (Brand of Camera doesn’t matter!)
- Use prime lens not less than 55mm focal length
- Add a High Quality add-on “macro” lens of +10D or +12D
  - Can stack multiple dioptic lenses at risk of reducing image quality
  - Double aspheric lenses with antireflective coatings have highest quality

Zork Macroscope Lens
- +12D double aspheric lens with antireflective coatings
- Highest quality macro lens, but relatively expensive

Diopter Add-on Lenses
- Advantages
  - Inexpensive (except Zork Macroscope)
  - Compact
  - Works with lenses you may already own
- Disadvantages
  - Not quite as sharp as a true dedicated macro lens

Diopter Add-on lens recommendations
- +10 Diopter Double aspheric lenses recommended
  - Hoya, Nikon, Canon are sample names of companies who make Macro lenses
  - Order thread diameter for your lens (49, 52, 55mm most common)
  - Use step rings, if needed, to fit your lens.
  - Source: www.bhphotovideo.com
  - Search Hoya Macro – cost $89.90 + s&h
  - Add +2D to +10D for +12D close up work on 55mm prime lens
  - Or use Zork +12D Macroscope lens

Extension Tubes
- Total length / focal length = magnification
  - 100mm of extension tube on 100mm lens = 1:1 life size image
- NOTE: there is loss of light with extension tubes (and bellows)
  - Compensation = 2 stops of light for every doubling of the lens-to-sensor plane distance
- Extension tube is a hollow ring mounted between lens and camera body
- Advantages
  - Relatively inexpensive
  - Relatively compact – easy to carry
  - No added glass layers
- Disadvantages
  - Not all tubes retain metering or aperture controls
  - Must refocus if you zoom
  - Difficult to get the exact length you want

Bellows
- A variable length accordion style square tube mounted between lens and camera body
- Advantages
  - Great flexibility – variable length extension
  - Easy way to get a LOT of extension
- Disadvantages
  - Expensive
- Bulky
- Cumbersome to use
- Usually does not couple metering or aperture with camera body

**Teleconverters**
- Goes between camera body and lens
  - May or may not retain auto meter & aperture controls
  - **Advantages**
    - You may already have one
    - No loss of light
  - **Disadvantages**
    - Useful, but somewhat limited for true macro purposes

**DSLR with Reversed Lens**
- Special camera brand specific mounting ring that goes on camera body to hold lens reversed from normal position
  - **Advantages**
    - Optimizes lens for greater than life size images
    - Allows 1:1 or greater magnification with only the lens
  - **Disadvantages**
    - Only manual settings available with lens reversed
    - No auto meter coupling
    - No auto aperture coupling
    - Requires two hands to hold aperture open and focus

**DSLR with “Stacked” Lenses**
- Put the longer single focal length lens on camera body
  - “Stack” the shorter focal length lens in front, but reversed
  - Use special threaded coupling ring to attach lenses to each other
  - Set front lens to infinity focus and largest aperture (widest opening)
  - Capable of 6X life size BUT extremely narrow depth of field
  - Focal length of prime lens divided by focal length of stacked lens = magnification
  - **Advantages**
    - Easy way to get HIGH magnification
    - May work with lenses you already have
  - **Disadvantages**
    - Possible vignetting (darkened corners) of image
    - Not all combinations work well

**DSLR with Dedicated Macro Lens**
- Lenses available as auto focus and manual focus
  - Single focal length lens
  - Apertures of f22 to f32 for maximum depth of field
  - Highest quality optics
  - Definition: A regular lens with a great than normal extension capability built in capable of 1:1 life size images
  - **Advantages**
    - Excellent optical quality
    - Convenient to use
    - Can be used as a regular lens too
  - **Disadvantages**
    - Price

**DSLR Combinations**
- Many ways to get additional magnification
- Key issues are depth of field, lighting and working distance
- Don’t get carried away!
- **Photography Technical Issues**
  - Depth of field
  - F stops (aperture settings)
  - Shutter speeds
  - Focus
  - Lighting
  - ISO settings
  - Working distance
  - “Cook Book” settings that work

- **Depth of field (DOF) – the “heart” of detailed macro photography!**
  - Biggest challenge in macro photography is controlling depth of field
  - Image size, image working distance, magnification, light sources, aperture, shutter speed and lens focal length ALL conspire AGAINST larger DOF.
  - DOF may be defined as the area in the photo between the closest and farthest objects that look acceptably sharp.
    - At normal subject distances, DOF extends roughly 1/3 in front of your plane of focus and at macro distances, it becomes closer to 50/50 – WATCH YOUR FOCUS POINT!
  - Aperture size is the SINGLE MOST IMPORTANT ELEMENT for controlling DOF
    - With the exception of the Scheimpflug Effect
  - Most “point and shoot” cameras have a limited range of apertures with f5.6 – 8.0 being the typical maximum with little or no manual controls to choose the aperture.
  - SLR/DSLR cameras have complete control of aperture either on the lens or in the camera body with most lenses having at least f16 as the smallest aperture

- **Aperture & Slit Lamps**
  - Aperture size in almost all slit lamps is, effectively, “wide open”... i.e. the equivalent of f 1.4 or greater
  - Results in a VERY small DOF
  - Higher magnification decreases DOF
  - 40X Magnification DOF = 0.1mm
  - Explains “why” most photos taken through biomicroscopes are only “clear” precisely on focused object
  - No way to expand DOF through biomicroscopes due to ITS optics, not yours!

- **DOF and Aperture Relationship**
  - Aperture size determines DOF for a given subject from a fixed vantage point
    - Larger aperture = SMALLER DOF, smaller f-stop number
    - Smaller aperture = LARGER DOF, larger f-stop number

- **DOF and Working Distance (constant aperture)**
  - Given a constant aperture – if you move closer, less DOF
  - Given a constant aperture – if you move away, more DOF

- **DOF and Magnification**
  - Increased magnification = SMALLER DOF
  - Decreased magnification = LARGER DOF
  - In macro photography the DOF is approximately 50/50 in front/behind the point of focus
  - Keep camera body square to point of focus

- **Magnification, Depth of Field & Aperture Examples**
  - 1/10th life size - DOF = 1.5” @ f5.6
  - 1/10th life size - DOF = 6” @ f22
  - 1:1 life size – DOF = <1mm @ f5.6
  - 1:1 life size – DOF = 3mm @ f22
  - 6x life size – DOF = 0.25mm @ f22

- **Aperture “f-stops”**
  - F/stop = diameter of iris divided by focal length of lens, a RATIO
- "smaller" number f-stop = larger aperture diameter = smaller DOF
- "larger" number f-stop = smaller aperture diameter = larger DOF
- Typical lens markings 2.8  4  5.6  11  16  22  32
- F/stops double or half the adjacent value exposure
- Term "stopping down" = making the aperture hole physically smaller

- Our “Secret Weapon” - Effective Aperture & Magnification
  - Effective aperture = Lens aperture x (1 + Magnification)
  - At 1:1 magnification the effective aperture (for gauging exposure) is therefore, approx. 2 “f-stops” smaller than that set on your lens
    - i.e. a lens setting of f22 becomes effectively approx. f38 = greater DOF

- What about Diffraction?
  - In “regular” photography using the smallest size aperture can induce “diffraction” and degrade image sharpness.
  - In MAGNIFIED MACRO photography diffraction does not appear to be a significant problem!

- Scheimpflug Effect
  - Increases depth of field simply by tilting the camera lens along its axis in the direction of the image plane
  - ONLY technique that increases DOF independently of aperture

- Scheimpflug Uses in Optometry
  - Oculus Pentacam – since 2005
  - Oculus Pachycam (pachymeter & keratometer)
  - CSO Sirius 3D Tomographer
  - Ziemer Galilei G1 Dual Scheimpflug Analyzer Topographer
  - Now – anterior segment DSLR ocular photography

- Sample illustrations of HOW the Scheimpflug Effect works

- Focus
  - Critical due to shallow DOF
  - Tip: in ocular photography focus carefully on corneal reflection of light because DOF using aperture f22 – f38 will result in almost every anterior structure of the eye being in focus from the tip of the eyelashes to the iris!

- Lighting
  - Flash recommended
    - Eliminates or reduces “grain/noise”
  - Built-in camera flash works well for shorter lenses but may cast shadow on lower part of image with physically longer lenses
  - External lighting (ring, single or twin flashes) mount on end of lens to eliminate shadows
    - Recommend single or twin but NOT ring flash (HUGE light artifact)
  - TTL (through the lens) metering or manual settings depend on lens and camera used

- ISO Settings
  - International Standards Organization
  - “Speed” rating of image sensor
  - Similar to ASA ratings of film speed
  - Higher ISO = faster shutter speed or smaller aperture for same amount of light
  - Many cameras offer “auto” ISO settings
  - Better quality images at less than 400 ISO
  - Lower ISO settings yields better quality photos
  - Best images at ISO 100 or 200
  - ISO settings of 400 or greater induce grainy/noisy appearance to images

- Working Distance
  - Macro photography is almost always very close to the subject
- Longer focal length lenses = longer working distance
  - 55mm lens = 3-4" working distance
  - 105mm lens = 6-8" working distance
  - 200mm lens = 12-16" working distance
- Longer working distance = increased depth of field
- Shorter working distance = decreased depth of field

- Photomacrographic ABFO No. 2 Ruler
  - Official L-shaped ruler marked in mm to document police crime scenes
  - Can be used to accurately record size of anterior segment abnormalities
  - $3.95 from www.crimesciences.com
  - Or use your PD ruler

- DSLR “Cook Book” Technique with Kit Lens (not Camera Brand specific!)
  - DSLR “kit lens” – (typically 55mm lens)… set at longest focal length
    - Add +12D Macro close-up lenses to prime lens
  - Focus – set to infinity
  - Shutter – Manual @ 1/60 or 1/125 sync
  - Set program dial to Aperture control
  - Set aperture to maximum f-stop (usually f16-f32… eff. F22 to )
  - Flash – ON
    - TTL Metering – ON
  - Auto focus – OFF
  - System is ready to take photos
  - Focus carefully by manually moving closer or farther away until object of regard is in sharp focus
    - TIP: focus on a light reflex on cornea or carefully on desired specific structure

- Dedicated Macro Lens “Cook Book” Technique
  - DSLR with dedicated 90 or 105mm macro lens
  - Set desired amount of magnification on lens
    - The lens barrel is usually marked with degrees of magnification
  - Set Program Dial to Manual
  - Flash – ON
    - TTL metering – ON if “auto lens”
  - Manual metering if not automatic lens
    - May have to manually set flash levels in camera menus
  - Aperture – set f22-f32 (whatever the maximum f-stop the lens has)
  - Shutter – set within the rating for the camera flash sync.
  - System is ready to take photos
  - Focus carefully by manually moving closer or farther away until object of regard is in sharp focus
    - TIP: focus on a light reflex on cornea or carefully on desired specific structure

- Eye-Fi SD Card
  - Wireless memory cards 4GB $40, 8GB ($80) & 16GB ($99) available
  - Wireless computer connection via Wi-Fi
  - Adapters available for MMC and CF card cameras
  - Automatically transfers photos to computer wirelessly!
    - www.eye.fi - Approx $50-$99 (no, this is NOT a .com URL)

- DSLR Cameras to Consider
  - Pssst #1… your skill as a photographer is more important than the camera brand.
  - Pssst #2… More pixels isn’t as important as learning to focus well and hold the camera STILL!
    - Pentax – NOTE: the BODY is image stabilized, not the lenses!
      - K100DS (6MP) <$300 on eBay
      - K200D (10MP) <$300 on eBay
    - Canon EOS
      - T2i, T3i or T4i (18MP) ~ $650 online
    - Nikon
      - D40 (2006-2010) 6MP ~ $400
- D3200 24MP ~ $700 online
- D800 36MP ~ $3,000 online

**Macro Lenses to Consider**
- Auto Focus is NOT a priority. Manual focus give you MUCH more control.
- Lester-A-Dine Macro 105mm (aka Kiron 105 Macro)
  - OUTSTANDING LENS... almost legendary glass
- Vivitar Series 1 105mm
- Any "brand name" dedicated MACRO lens of 90-105mm
  - Nothing less than f22
- Pentax lenses of all generations
  - Almost ALL Pentax lenses work on Pentax DSLR bodies – and they are VERY affordable

**Wanna Go “All-In”?!?**
- Hasselblad
  - H40D-200MS
  - 50MP to 200MP (composite photo)
  - $36,000 – BODY ONLY
  - Lenses $5K - $10K EACH

**Sample Photos**

**Anterior Photo Challenges**
- Ocular photography is NOT too difficult.
- Ocular photography IS profitable.
- Anterior Setment Photographys medically reimbursable
- Enhances YOUR practice and improves patient education
- It is NOT hard to learn to utilize the technology
- OD’s frequently have a hard time billing what they and technology are worth
- Learn to “order tests” vs “selling tests”

**Practice Benefits**
- Better documentation
  - Which is better, your hand drawn picture or a detailed, well lighted in-focus photo?
- Great patient education tool
- Great telemedicine via Encrypted PDF files or surface mail with MD’s
  - Comanagement & Referrals
- Ties patients to YOUR practice

**Let’s Talk $$$ = Reimbursement**
- CPT 99285 – Texas Medicare - $44.44 as of August 2012
- 1 per day x 240 days = $10,666
- 3 per day x 240 days = $31,998
- 5 per day x 240 days = $53,330
- Takes approx. 1 minute to take photos
- Takes approx. 4 minutes to process/print interpretation and report
- Can be delegated to staff!

**Questions?**
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Ocular Photography Post Processing & Printers

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Course Description:
This course presents digital image processing emphasizing six essential elements that significantly improve photo quality. Additionally, all major printer types are discussed, and a sample written interpretation and report is provided. Telemedicine techniques are also presented.

Course Learning Objectives:
- Present the elements necessary for reimbursable anterior segment ocular photography.
- Learn about "histograms" to adjust exposure, either before or after taking photos
- Learn about "highlights & shadows" to enhance ocular photos
- Learn about “contrast & brightness” controls
- Learn about “cropping”
- Learn about file resizing and types of photography files
- Learn about a variety of quality photo editing software programs at various price points.
- Learn about the key software elements needed to maximize details of ocular photographs.
- Learn about the four major kinds of color printers.
- Present the relative strength and weaknesses of each printer type.
- Learn WHY the colors you see on the monitor doesn’t always match the printed photo
- Present techniques to share photographs electronically with referring doctors.
- Brief presentation of PDF software and encryption.

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- Samples of before/after ocular photo processing

- Okay, the photo has been taken. Now what?
  - Use photo “as is” – no post processing
  - Edit/modify/enhance photo using software
  - Recommended photo editing software features for best results
    - Optimize Highlights and Shadows
      - Not all editing software has this important feature
    - Optimize Histogram Levels
    - Optimize Contrast and Brightness
    - Crop if needed or as desired
    - Resize as desired to save file space and choose resolution to save
    - Save photo with descriptive name and date
      - Option, print photo on back of written interpretation and report page
• **The Histogram**
  o Graphical representation of range of brightness of photo
  o Darkest on left
  o Brightest on right
  o Scale 0 to 255
    ▪ 0 = absolute BLACK
    ▪ 255 = absolute WHITE
  o Can be manipulated in many cameras or with some photo editing programs!
  o No such thing as a “Correct Histogram”
  o Only shows the dynamic range of light exposure from 0 (dark) to 255 (white)
  o Can use +/- camera exposure settings to compensate for lighting conditions
  o Sliders within software allow you to change the balance of “dark-to-light” levels.
    ▪ Can enhance “mid-range” but change brightest and darkest portions very little.

• **Highlights and Shadows**
  o Human eye can see approx. 10,000 levels of light
  o Best camera can register about 5,000 levels of light
  o Dynamic range of light exceeds camera meter or camera sensor (same true for film).
    ▪ Results? Often “too dark” or “too light” (under/over exposed)
  o If in doubt... ALWAYS chose “too dark” = underexposure
    ▪ Why? - can recover details of darkness with software!!
    ▪ CANNOT “recover” data from areas that are “too light”... nothing there to recover.
  o Use LOWER ISO settings possible to reduce “grain” in photo recovery!
  o Sliders adjust highlights & shadows
  o Percentages can be used instead of sliders (PhotoShop CS)
    ▪ In my experience, typically ocular photos require about 37-48% lighter to bring out iris colors/details
    ▪ Depends entirely on the camera settings and light source
  o WYSIWYG - “what you see is what you get” - real time editing
  o Highlight & shadow adjustments are what make your ocular photos “pop”

• **Contrast & Brightness**
  o Similar to “Highlights & Shadows”, except....
    ▪ Changes the ENTIRE picture lighting all at once
    ▪ DO NOT USE until AFTER adjusting Histogram and the Highlights and Shadows
    ▪ Use sparingly... if at all
    ▪ Can easily “wash out” highlights and lose detail on light surfaces (ex. conjunctiva)

• **Cropping**
  o Don’t hesitate to use the “crop” tool
  o Lets you “enlarge” the essential part of the photo
    ▪ Can exceed 1:1 macro photography w/o extra magnification lenses or microscopes
  o Again, use LOW ISO settings to avoid grain
  o Lets you “cut out” unwanted portions of photos
    ▪ Such as dark shadows or your fingers holding eyelids

• **Resizing & Saving**
  o What file size do you want and why?
    ▪ If printing onto paper
      ▪ Larger files = better print detail
    ▪ If mostly looking at photo on monitor
      ▪ Only need file size matched to screen resolution
    ▪ If transmitting photos for referral, larger files take more time and space
    ▪ Consider “printing” to PDF and sending PDF file instead
      ▪ Still clear on screen, but does NOT print out with good detail on paper
• **File Types**
  o Most cameras default to JPG type files
    ▪ JPEG Joint Photographic Experts Group
  o Beware compression!!
  o TIP: Before editing, resave as TIFF type file
    ▪ TIFF = Tagged Image File Format
    ▪ Edit/Save in TIFF mode to avoid additional compression while editing
  o When finished editing, save in JPG format to save file space
  o OR, better still... use RAW settings
    ▪ But only some PROsumer level cameras have RAW capability
    ▪ ONLY some photo editing programs can edit or process RAW files (BIG FILES)

• **Post Photo Processing – Photo Editing Software**
  o Adobe PhotoShop CS or Adobe Elements
  o Many good alternatives – GIMP is free
  o ACDSee Pro5
  o Corel Paint Shop Pro X4
  o Nikon Capture NX2
  o Photo Impact 13
  o Serif Photo Plux X3
  o And... there are many others
  o Just be sure they offer “highlights and shadows” and “histogram” adjustments

• **Printers – 4 main types**
  o **Color Ink Jet**
    ▪ Liquid ink cartridges
  o **Color Laser**
    ▪ Solid ink
  o **Dye Sublimation**
    ▪ Color ribbon
    ▪ New gel/ink

• **Color Ink Jet – How it Works**
  o Essentially SPRAYS TINY ionized droplets of ink onto paper
  o Monochrome (black only)
  o Multi-color inks (typically yellow, magenta & cyan)
    ▪ Color subtractive process
  o “Portrait” printers may have up to six color cartridges

• **Color Ink Jet Types**
  o Printer only – local and network versions
  o Multifunction – printer, copier, fax, scanner
  o Wireless models available

• **Color Ink Jet Considerations**
  o Relatively inexpensive ($50-$400)
  o Relatively expensive consumables
  o Highlighters and moisture smears ink
  o Most ink jet photos fade over time
    ▪ Some “archive quality” inks and paper available

• **Color Laser – How it Works**
  o Typically a 4 cartridge dry powder toner system
    ▪ Black, yellow, magenta & cyan
    ▪ Color subtractive process
  o Laser light image alters electric charge on drum
  o Drum rolls through toner reservoirs
  o 4 pass system, most models
Fuses powder to paper using heat & pressure rollers
Very similar to photocopier technology

**Color Laser Models**
- Printer only
- Multifunction – printer, copier, fax, scanner
  - “Normal”, LCD & LED models
    - Each uses slightly different technique to charge the drum
- Rest of process same as regular laser printer

**Color Laser Considerations**
- More expensive initially than ink jet
- Expensive consumables!
- Prints won’t smear easily
- Prints resistant to UV fading
- Available wired, network and wireless versions
- Some models can auto duplex
- Slightly less gradient detail than multi-color ink jet

**Solid Ink Printer – How it Works**
- Uses wax based ink vs toner powder or ink cartridge
- Melts solid ink block
- Sprays through stainless steel print head onto paper
- Fuses ink onto paper with pressure and heat
- Cleaner, less waste & immediately dry prints
- Resistant to smears
- Arguably, slightly less print quality than laser or ink jet

**Solid Ink Advantages**
- Faster print time
- Ease of use
- Less waste
- No ozone emissions
- Paper type is not critical

**Solid Ink – Disadvantages**
- Print durability questionable – wax surface can be scratched
- Slower warm up time
- Higher power consumption
- Potentially excessive solid ink waste
- Possible print head damage from moving hot unit
- Odor – melting ink creates noticeable odor
- Print head can become clogged
- Incompatible with laser printers
  - Print cannot be put through copier or laser printer
  - May melt wax surface potentially damaging both the print and the second machine
  - **DO NOT run paper with solid ink photo through either a laser printer or a photocopier!** (to print on the reverse side)
- Poor UV resistance to fading
- Third party consumables voids warranty

**Color Dye Sublimation – How it Works**
- Uses film ribbon of 3 colors and a clear coat
  - Yellow, Magenta & Cyan
  - 4 pass system – subtractive process
  - Final pass puts clear coat on print
Primarily good for graphics – not good for lots of text
Prints immediately dry to touch
Available with different pixel count and shapes
  - 600 x 600 dpi with round pixels
  - Skewed 600 x 1200 dpi with oval pixels
  - Skewed 600 x 1200 dpi with round pixels
  - True 1200 x 1200 dpi with round pixels
More recently ribbon media changing to gel/ink
  - Ricoh & Epson printers using SubliJet ink supplies
  - **WARNING... Do NOT put factory ink jet supplies in printer FIRST**
  - Will NOT work as dye sub later if you do!

**Dye Sublimation Considerations**
- Much more expensive ($2,000+)
- Consumables fairly expensive
- Uses roll feed glossy paper
  - HIGH quality
  - Different widths
- Will not smear or smudge if wet
- Resistant to UV fading
- Very similar to photos from Kodak, Fuji, etc. commercial prints

**Selphy Color Dye Sublimation Printers**
- CP900 wireless model less than $99 online
- Kit contains ink & paper for 108 4x6” color prints.
- Cost approx. $35 online (Canon direct); approx. $29 (Amazon w/ free s&h)
  - Equals $0.33 to $0.27 per print

**Color Dye Sublimation**
- HIPAA PRIVACY WARNING!!
  - Plastic ribbon retains “negative” of print for YEARS!!
  - Dispose of by shredding or incineration

**Why don’t color prints match colors on the computer screen?**
- **Computer screens are color ADDITIVE;** red-green-blue
- **Printers are color SUBTRACTIVE;** cyan, magenta, yellow
- Software color registration programs exist to match prints to screen

**Additive Colors**
- Red-Green-Blue lights are mixed using additive color properties
- Combined in EQUAL PARTS
  - Blue + Green = Cyan
  - Red + Blue = Magenta
  - Green + Red = Yellow
  - Red + Green + Blue = White

**Subtractive Colors**
- Cyan, Magenta and Yellow
- Combined in EQUAL PARTS
  - Blue + Green [absorbs Red] to create Cyan
  - Red + Blue [absorbs Green] to create Magenta
  - Green + Red [ absorbs Blue] to create Yellow

**Printers – What to Get?**
- Depends on your need/application
- Define your use
• You are not limited to one type
  ▪ Mix and match for your applications
• Calculate your cost per print for true cost
  ▪ Initial cost, paper and consumables

• Telemedicine with Photos
  o Print to PDF or scan printed report to PDF
  o Encrypt and password protect for HIPAA compliance
  o Attach to email
  o Call consulting doctor
  o Discuss the case in “real time”

• PDF Software
  o Adobe Reader (best known) – free versions
  o PDF995 – FREE PDF converter w/advertising
  o PDF X-Change
  o PDF24 Editor & FAX (free)
  o Foxit
  o Nitro PDF
  o Primo PDF
  o And there are others...

• PDF Encryption Options
  o Allow printing
  o Allow modify contents
  o Allow copy
  o Allow modify annotations
  o Allow fill in (128 bit only)
  o Allow screen readers (128 bit only)
  o Allow assembly (128 bit only)
  o Allow degraded printing (128 bit only)

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  o I am NOT affiliated with nor compensated by any or the manufacturers of products mentioned in this presentation.
  o Hardware and/or software presented were either free trial versions or purchased.
  o None of the products presented are necessarily endorsed or recommended by the sponsors of this educational program.

• Questions or comments?
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  o Amarillo, Texas 79109
  o Email: Cledc@yahoo.com
  o Cell phone: 806-678-4261
  o Thank you!
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PHOTOGRAPHY RELEASE
Authorization to Obtain/Utilize Images

ADULT

☐ General Use  ☐ Photo-document physical condition
☐ Specific Project

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Signature: ___________________________ Date: __________
Witness: ___________________________ Date: __________

MINOR CHILD

☐ General Use  ☐ Photo-document physical condition
☐ Specific Project

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Signature: ___________________________ Date: __________
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