

Laser Certification Review

Certified Laser Hair Removal Provider - CLHRP

Professional Medical Education Assn.

“The Laser Training Institute™”

www.LaserTraining.org

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National Council on Laser Certifications (NCLC)

www.LaserCertification.org

The first set of slides presented here reviews the specific content of the NCLC Laser Hair Removal Certification. This content is what you should concentrate on for the examination. The review is NOT designed as a teaching instrument but rather summarizes the key points of *all* the questions contained on that exam. The Hair Removal Certification exam is jointly offered by the National Council on Laser Certifications (NCLC), and the International Aesthetic & Laser Association (IALA)

The section following the review is the specific CONTENT OUTLINE AND OBJECTIVES for Laser Hair Removal training courses that is recommended for any training program that wishes to adequately cover content that will prepare the student for the NCLC Laser Certification Exams. Certification exam applicants may additionally use it as a guide for further areas of study in Laser and Light based Hair Removal.

This study guide is offered free of charge and it may be copied and distributed freely, provided that the content is unchanged and reproduced in its entirety, including this cover page and our organizational information and website contact information.

For those that are looking for actual training programs in Laser and Light Based Hair Removal, or other Aesthetic Laser procedures such as skin rejuvenation, treatment of pigmented and vascular lesions, laser tattoo removal and more, I'd refer you to both our Computer Based Learning programs and our Aesthetic Laser Seminars and workshops. Click the following links for more information:

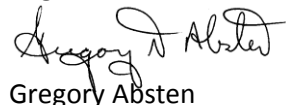
Online/Home-Study Laser Courses – Course Catalog: (computer based learning)

<http://www.lasertraining.org/Administrative/Library/PDF%20E-Brochures/LaserCourseCatalogue1012.pdf>

Seminar Schedule for Aesthetic Laser Training programs (includes hair removal):

<http://www.lasertraining.org/SeminarSchedules/default.html>

Regards,



Gregory Absten

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National Council on Laser Certifications
www.LaserCertification.org

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Written Examination

- 100 (CLHRP) Multiple Choice Questions
 - 1 Correct (Best) Answer
- 70% Required for Passing
 - can miss up to 30 Questions
- 3.0 Hours allotted for completion
- Closed Book. “Controlled” breaks allowed.

Certification Status

- Full Certification requires successful completion of the proctored examination, plus the experience and background/case requirements.
- Course participants may submit the additional materials at a later time, and have up to 5 years to complete the experience/case requirement.
- Those passing the exam but still awaiting completion of other requirements are designated a “Certification Candidate” and will receive the appropriate Certificate.

Exam Content Areas

The examination tests for a knowledge of medical laser and energy concepts, and safety.
Specific clinical laser/IPL concepts will be tested.

Exam Content Areas

The areas of testing for various NCLC Laser Certifications basically boil down to the areas of:

- (1) Laser Concepts
- (2) Tissue Effects, and
- (3) Safety

- as defined by the American Society for Laser Medicine & Surgery, and ANSI in their recommendations.

Exam Content Areas

For the CLHRP Credentials:

Safety –	40%	40 Q
Laser & Energy Concepts –	17%	17 Q
Tissue Interactions –	16%	16 Q
Aesthetic Questions	6%	6 Q
Anatomy & Physiology	21%	21 Q

Review Format

This Laser Certification review is NOT intended to be a primary teaching program. It is intended to review the key concepts covered in the NCLC Laser Certification examinations.

Those not having previous training in these areas are referred to outside courses & home study programs.

See www.LaserTraining.org

Review Format

Each slide in this review will relate to the “Content Area” classification of a specific question on the exam, but will not be specific about the question asked, although the answer to a question will be on that slide.

Each slide will note the category of the content area covered, and it is possible that more than one question is asked within that slides content area.

*Anatomy & Physiology

Skin Anatomy

- Epidermis – outer layer of skin
 - Stratum Corneum – the outermost layer of the epidermis
 - Melanin – contained within the epidermis and is a major absorber of laser light – competing with the hair follicle
 - Preventing excessive heating of the epidermis (mostly because of melanin absorption) is a critical consideration in all dermatological skin procedures including laser hair removal.
 - “Renews” itself every 3-5 weeks with migrations of new cells.

*Anatomy & Physiology

Skin Anatomy

- Dermis – deeper middle layer of skin
 - 2 Layers to the Dermis:
 - Papillary Dermis – the first layer of the dermis – looks pink when doing ablative resurfacing
 - Reticular Dermis – the deepest layer of the dermis – has a yellowish “chamois cloth” appearance when doing ablative resurfacing. Never “lase” deeper than this level.

*Anatomy & Physiology Skin Anatomy

- Dermal/Subcutaneous Fat Interface
 - below Dermis
 - separates the reticular dermis from underlying subcutaneous tissues. Ablating past this level in ablative resurfacing, or lethally heating it in laser hair removal or other procedures, causes a third degree burn and possible keloid scars since the dermis cannot regenerate.

*Anatomy & Physiology Skin Anatomy

- Subcutaneous Tissues
 - Everything below the dermis. Includes subcutaneous fat and is the source of blood vessels & nerves entering the dermis. Destroying skin to this level will create a third degree burn and possible Keloid scars.

*Anatomy & Physiology Skin Color

- The primary determinant is skin melanization
- Skin vascularity and thickness also serve to determine general skin color

*Anatomy & Physiology

Skin & Hair Biology - HAIR TYPES

- Terminal Hairs – Course hairs found on the scalp, eyebrows, armpits & bikini area.
(this is the usual target for laser hair removal).
- Velus Hairs – fine “peach-fuzz” hair covering most of the body
- Hair growth from either arises within the hair follicle.

*Anatomy & Physiology

Skin & Hair Biology Hair Growth Phases

- Anagen – Growth phase where it is most susceptible to laser treatments
- Catagen – Regression/atrophy phase where nourishment is cut off
- Telogen – Dormant phase where the follicle falls out (sheds at end of growth cycle). The hair bulb can survive laser treatments in this phase.

*Anatomy & Physiology

Skin & Hair Biology Hair Growth Phases

- Different body areas have differing time periods for growing & dormant stages. These vary from 2-6 years (growth cycle) for the scalp, to 3-4 months in the bikini or axillary (armpits) area. Most are 4-12 months.

*Anatomy & Physiology

Skin & Hair Biology Hair Growth Phases

- Not all of the hairs in any given area are in the same phase at the same time. That is why multiple laser treatments are required. If they were all in the same phase, then we would completely shed hair in that area at certain intervals.

*Anatomy & Physiology

Fitzpatrick Skin Types I-VI

- The higher the number, generally the darker the skin, but is primarily an indication of how one burns in the sun (sunlight sensitivity). The darker the skin, the harder it is to treat by laser without burning.
- This scale is the primary determinant of choice of laser type and settings for laser hair removal
- Darker skin types generally require longer wavelengths (and pulse widths) to prevent skin burning (i.e. diode or Nd:Yag lasers), and type IV skin is where this transition starts.

*Anatomy & Physiology

Fitzpatrick Skin Types I-VI

- I – Fair Transparent Skin that always burns in the sun – never tans.
- II – Fair Skin that always burns, but sometimes tans with difficulty
- III – Fair to light olive Skin that sometimes burns mildly, and tans slowly

*Anatomy & Physiology

Fitzpatrick Skin Types I-VI

- IV – Olive to light brown Skin that rarely burns and tans easily
- V – Dark brown Skin that very rarely burns and always tans
- VI – Black Skin that never burns and always tans (hardest to treat because of melanin)

*Anatomy & Physiology

Skin Anatomy

Sebaceous Glands:

Glands in the skin responsible for production of oils for lubrication of the skin and help retain fluids. They are also the site of the P. Acne bacteria responsible for Acne.

*Anatomy & Physiology

Hair Shaft & Follicle Anatomy

The hair shaft has 3 Regions:

- Inner Medulla
- Middle Cortex (contains Melanin)
- Outer Cuticle

There are two sheaths to the Hair Follicle:

- Inner root sheath
- Outer root sheath

Hair shaft is comprised of dead Keratin Strands.

*Laser & Energy Concepts

LASER ACRONYM

L IGH T
A MPLIFICATION, by the
S TIMULATED
E MISSION of
R ADIATION

*Laser & Energy Concepts

Wavelength Identification

(several (not all) wavelength questions asked)

CO ₂ – 10600nm	Er:Yag – 2940nm	Ho:Yag – 2100nm
Nd:Yag (harmonic) 1380nm	Nd:Yag – 1064nm	Krypton – 647, 568, 531
Diodes – 810 nm is typical, <i>but available ~ 530-1500nm</i>	Ruby – 694nm	Copper Bromide 577,510
Alexandrite – 755nm	Gold Vapor – 632nm	Pulsed Dye, 578-600nm (Vascular)
Helium Neon (HeNe) 632	CW Dye (PDT) 630	Pulsed Dye, 504nm (Lithotripsy)
KTP (& KDP) – 532nm	ArFl Excimer 193nm	
Argon – 488, 515nm	XeCl Excimer 308nm	

Also know visible color bands:

Blue ~ 488nm, Green ~ 504-532nm, Yellow ~ 568-585nm,
 Orange ~ 585-595nm, Red ~ 632-694nm

*Laser & Energy Concepts

HISTORY

- Albert Einstein – theory of stimulated emission based on photovoltaic cells
- Schawlow / Townes – theoretical paper on “Optical Masers” (a laser)
- Ted Maimon – First Laser – Ruby, 1960
- Dr Leon Goldman – father of lasers in medicine & co-founder of the ASLMS

*Laser & Energy Concepts

- Power Density (PD) effects on Tissue
- Power Density Parameters
 - Spot Size (Rapid Change in PD)
 - Power (Slower Change in PD)
- Techniques of changing Power Density with different delivery devices (i.e. focusing or collimated handpieces, bare fibers, waveguides)
- In aesthetics too High a PD can create burns & blistering. (also applies to excessive fluence)
- In aesthetics too Low a PD is generally safe, but ineffective for the treatment. (low fluence too)

*Laser & Energy Concepts

Physics:
Radiant Exposure

This is a measurement of the “dose” of light in energy per surface area, or Joules/cm². This is the correct term, but in medicine / aesthetic laser use it is more commonly referred to as “Energy Density” of the laser spot.

*Laser & Energy Concepts

Physics:
Light Wavelengths

- Approx 400 (Blue) to 700+ (Red) nm Visible
- Infrared ~800+ nm
- Ultraviolet – below ~351nm

*Laser & Energy Concepts

Equipment Considerations:
Laser Settings for patient treatment

- Lasers for most aesthetic procedures are set to a targeted energy density expressed in Joules/cm²
- This includes pulsed dye lasers for vascular; hair removal lasers such as alexandrite, diode or Nd:Yag; and others.

*Laser & Energy Concepts

Pulsed Laser Emission

- A compression of laser energy which emits power (watts) at a higher rate than is otherwise attainable in CW (Continuous Wave) mode
- This is different than a simple “timer” on a CW beam, which is sometimes called a “Gated Pulse”
- Is more thermally “precise” on tissues than CW mode

*Laser & Energy Concepts

FLUX

- Concept of delivering more energy in shorter time periods, in a pulse, to reduce thermal spread.
- 1W at .2s (.2J) is lower flux than 2W at .1s (.2J still).
- Look at the concept, and balance the power and time settings to see which is a higher fluence.

*Laser & Energy Concepts

Typical Power/Energy Display & Measurement:

In addition to the Energy “Joules” orientation, most aesthetic lasers are set to J/cm^2 which is the Radiant exposure and include aesthetic and hair removal lasers such as”

- Alexandrite
- Diode
- Nd:Yag, and others

*Laser & Energy Concepts

Optics Principles - Beam shapes

- Sinusoidal “TEM₀₀” best for sharp incisions and ablations
- “Flat Top” type modes preferred for aesthetic procedures including laser hair removal

*Tissue Interactions Chromophore

- Refers to the object that absorbs that particular wavelength of light. In dermatological laser procedures the two primary competing chromophores are melanin in skin and oxyhemoglobin in blood vessels

*Tissue Interactions

Laser Hair Removal

- Target is the hair follicle – the bulb and “bulge” of the hair follicle, and the matrix of nerves and vessels surrounding the hair bulb. Melanin around the follicle is the target chromophore.
- Laser Hair Removal works by selectively heating these targets to lethal temperatures
- Steps must be taken to prevent overheating of the skin at the same time

*Tissue Interactions

Laser Hair Removal

- Treatment regime of 5-7 treatments may be required. (sometimes more)
- FDA defines “permanent” hair removal as a long term stable reduction in the number of hairs regrowing after a treatment regime.

*Tissue Interactions

Hair Color

- “Pheomelanin” in Red and Blond hair does not respond well to wavelengths above 740nm.
- Red and blond hair may respond better to IPL wavelengths below 740nm, or Ruby lasers at 694nm.
- Regardless of device, Red and Blond hairs are among the most difficult to treat (aside from Gray or White which are worse).

*Laser & Energy Concepts

Equipment Considerations - Skin Cooling

Multiple methods may be used for skin cooling to prevent burns & include:

- Cooling Gels (maybe least effective, but common and adequate)
- Cryogen sprays
- Contact Cooling - Chilled Crystal windows such as sapphire plates used for contact cooling of the skin (chilled circulating fluids keep the plate cool), or cold metal rollers.
- Cold Air Chillers to blow refrigerated air on skin

*Laser Safety

Safety Practices - Skin Cooling

Overcooling of the skin could make treatments like laser hair removal less effective, but appropriate skin cooling is always provided in order to:

- Reduce the risk of blistering and burns (or scars)
- Reduce swelling & inflammation
- Reduce patient discomfort

*Laser Safety

Safety Practices - Skin Cooling

“Forgetting” to use or to activate the skin cooling system, or failure of the system during a case, can result in burns or blistering of the patient.

Always monitor the skin cooling system.

*Laser Safety

Safety Practices

- Excessive Heating of Skin
 - Developing strategies to prevent or control excessive skin heating is critical to all dermatological laser procedures.
 - Blistering can potentially lead to infections.
 - Scarring, including Keloids, or hypo or hyperpigmentation can also result.

*Tissue Interactions

Laser Hair Removal

- Ideal patient has light skin, dark hair, and is not overly sun sensitive.
- Difficult or impossible to treat would be gray or white hair – especially on dark skin. This is a relative contra-indication.
- Other methods for treating light hair include Photodynamic Therapy or Radio Frequency Electrical methods (aside from electrolysis)

*Aesthetic Procedures

Laser Hair Removal, Tissue Effects

Ensuring first that no blistering or burning is created on skin, good indications of the clinical end point for laser hair removal can include ejection of the hair shaft from inside the follicle, or redness & swelling around the hair follicle (perifollicular edema).

*Laser Safety

Safety Practices:
Skin prep for Laser Hair Removal

- If area is tweezed or waxed, or had electrolysis, then you've removed the primary target for the laser to generate heat at the follicle, and the laser treatments will be ineffective. If performing electrolysis first, the same applies, but there is no reason for laser treatments after electrolysis.

*Laser Safety

Safety Practices - Laser Hair Removal

Stronger relative contra-indications may include:

- Photosensitizing medications – (i.e. accutane)
VERY Strong contraindication
- Active Infections such as herpes, cold sores, etc.
(one of the stronger contraindications)
- Dark Tan in a Caucasian (send them away until the tan fades, or sometimes can use bleaching creams to speed the process)
- History of Keloid scarring in family

*Tissue Interactions

Thermal Relaxation Time (TRT)

- Amount of time required for a target to dissipate heat
(time to return to $\frac{1}{2}$ of peak temperature)
- Smaller objects have shorter TRT's – will get hotter, faster than larger objects, and then lose their heat more quickly

*Tissue Interactions Adverse Reactions

- Recent Sun Exposure is the most common reason for unexplained adverse reactions (rashes, redness, blisters) in the middle of a treatment series.
- Photosensitivity due to drugs/food/etc. would be the second most common reason.

*Tissue Interactions Thermal Relaxation Time (TRT)

- To “kill” an object with heat (i.e. hair follicle), the clinically effective dose of light must be delivered in a time shorter than its TRT – otherwise it will shed the heat and survive.

*Tissue Interactions Thermal Relaxation Time (TRT)

- To spare adjacent structures that also might absorb the light (epidermis), the time period should be longer than its TRT – so that it can dissipate the heat and survive.

*Tissue Interactions Typical Thermal Relaxation Times

- Hair Follicle – 40-100 milliseconds
larger follicles have longer times
- Epidermis – 3-10 milliseconds

Therefore a theoretically ideal laser pulse (at clinically effective doses) for hair removal would be from 10-40 milliseconds

*Tissue Interaction

Laser Pulsing

- Repetition Rates (frequency) of the laser pulse (usually in pulses per second) relate mostly to convenience for the user, and comfort for the patient. Slower repetition rates take longer, but allow for better heat dissipation so that it usually is less painful for the patient and better tolerated.

*Laser Safety

Applicability of ANSI Z136.3 Standards

Applies to ALL Health Care Settings Including

- Hospitals & Surgery Centers
- Small medical clinics & offices
- Mobile laser vans & services
- Medical Spas & Cosmetic Centers
- Anywhere a laser is used on a person

*Laser Safety

Medical Laser Safety Officer

- Appointed by the facility administration
- Administers the facility's Laser Safety Program
- May or may not run actual equipment
- No particular background nor education required
- Utilizes many different resources in order to manage the Laser Safety Program
- Required by ANSI in all health care facilities that utilize lasers. (Including medical spas & offices)

*Laser Safety

Medical vs. Industrial/Scientific LSO's

- Both are required by ANSI to be appointed by their respective facilities
- Industrial/Scientific based upon ANSI 136.1
- Medical based upon ANSI 136.3
- Need for measurements and calculations to determine NHZ and Laser Classification for Medical LSO's is minimized because of manufacturer preclassification and information.

*Laser Safety Administrative Controls

LSO responsibilities:

It is for overall management of the safety program to include education of staff, protective measures implemented (safety glasses), program monitoring, etc.

It is NOT to establish or enforce clinical treatment parameters or protocols – they implement those established by their medical director.

*Laser Safety

Laser Treatment Controlled Area (LTCA)

- The entire laser room, or a designated area in a very large room
- Signs required on all entryways
- Safety glasses provided, but are not required to be worn until within the NHZ
- Occupied only by authorized personnel trained in Laser Safety

*Laser Safety

Pregnancy in workers or patients

- Laser “Radiation” is electromagnetic but not ionizing like X-Rays, and is of no actual risk to women in any stage of pregnancy – whether the patient or a technician running the equipment.
- In spite of this “no risk”, most services will NOT treat women with lasers for elective laser procedures because a certain percentage will abort anyway, and the practice does not want to be exposed to the potential liability.

*Laser Safety

Eye – Skin Hazards

- Hazard levels for eyes are determined by a value known as the MPE – Maximum Permissible Exposure (MPE) level for the cornea or retina.
- Safety Glasses Optical Density value is designed to keep the MPE below the hazard level.
- Laser Safety Glasses do NOT guarantee protection from direct impacts of the laser into the eyes through the glasses (reflections only).

*Laser Safety

Eye - (MPE) Maximum Permissible Exposure Limits

- Exposure limit used in skin & eye safety calculations.
- Where the MPE is exceeded, that defines the Nominal Hazard Zone (NHZ).
- For wavelengths that transmit into the eye, the exposure to the surface is multiplied by 100,000 times to compare to the MPE.

*Laser Safety

Retinal Hazards - Depends on Wavelength

- All wavelengths which pass through fluid
- Incorporates all visible light lasers
- Between approximately 400-1400nm
- Practical difference between hazards of visible vs. infrared. (Because of aversion response)
- Ho:Yag on up are Retina Safe, & Ar:Fl on down
- Lens of eye increases power density on Retina by 100,000 times.

*Laser Safety

Patient Eye Protection

- Corneal Shields (anodized metal shields) used when working within the bony orbit of the eye. (ANSI recommendation) – most secure protection.
- Alternative Patient Eye protection depending on type of laser use:
 - Laser Safety Glasses
 - External Eye shields of some type
 - Plastic “Laser Resistant” goggles
 - Metal EYESHIELDS (best)
 - Disposable adhesive laser eye protection

*Laser Safety

Aversion Response

- The body’s reaction to “jerk” away from bright light sources (aversion to bright light)
- Considered to be 0.25s
- Those visible lasers that cannot exceed the MPE (Maximum Permissible Exposure level) within this time are considered eye-safe
- The aversion response time is not fast enough to guarantee protection from Class IV lasers, but it would reduce one’s exposure

*Laser Safety

Corneal Hazards – Depends on Wavelength

- All wavelengths which do NOT pass through fluid
- From 1400nm on up, and 400nm on down
- Includes CO₂, Er:Yag, Ho:Yag and Ar:Fl excimer as corneal hazards.

*Laser Safety

Laser Protective Eyewear

- Should always be worn within the NHZ
- Does NOT guarantee protection from direct impacts from the laser beam for retinal hazards (It is MOST IMPORTANT to not allow the beam to be directed toward one's face)
- Must be labeled according to the Wavelengths & Optical Density (O.D. or degree of protection).
- O.D. is a logarithm. I.E $10^4 = OD\ 4$, so a change from 4-7 is a 1000 fold increase in attenuation. (tenfold for each unit of O.D.) Higher numbers offer more protection.

*Laser Safety

IPL Eye Hazards

- IPL's do NOT present the same level of risk as lasers because they are NOT point sources of light. (non-laser light source)
- However, they DO still present eye hazards and eye protection is required.
- Used for a variety of procedures including hair removal, skin rejuvenation, treatment of pigmentary and vascular issues, etc.

*Laser Safety

Laser Safety Eyewear Labeling

- Must be labeled with both wavelength ranges of protection, AND Optical Density (O.D.) of degree of protection.
- O.D. is a logarithm, so the difference in each unit of O.D. is a factor of 10. In other words the difference of an O.D. of 4 to 6 is a factor of 100 in attenuation. Higher numbers are more protection.

*Laser Safety

Safety Practices Glass Transmission

- Lasers that don't transmit through glass include CO₂, Er:Yag, Ar:Fl, and present superficial corneal burn hazards.
- Glass in optics of scopes & instruments afford protection to the viewer
- Window glass affords protection to outside viewers so that no coverings are required (for those lasers listed above)

*Laser Safety

Window Coverings

- Must be flame retardant when used
- Applies only to wavelengths that transmit through glass
- Required only when the window is located within the NHZ of the room.
- Any material opaque to the wavelength is sufficient
- Consideration given to use of barriers at doorways in special circumstances

*Laser Safety

Safety Practices – Instrument Reflections

- Not a major practical problem, but a consideration around sensitive areas (esp. the eye).
- Ebonizing instruments just creates a black color and doesn't affect the reflection much – especially from IR lasers.
- Anodizing an instrument creates a “roughened” micro-surface on the instrument that helps to disperse the reflection.
- The major problem is reflection from a flat metal surface in close proximity to a sensitive area (i.e. eye, teeth, etc.)

*Laser Safety

Fire Hazards

- Water available for quenching flames (irrigation solutions on backstand are OK)
- Fire Extinguisher immediately available (does not have to be in the room)

*Laser Safety

Treatment beam & Guide-Light Alignments

Some lasers are infrared and therefore invisible to the eye. These laser use visible (usually red) guide lights so that one can see where the treatment laser is aimed. ANSI standards require that the alignment of the treatment and aiming beams be checked prior to EACH case.

*Laser Safety

Laser Plume (smoke)

- Although Laser hair removal may produce odors, it generally does NOT produce laser plume that needs to be evacuated.
- ANSI standards require that whenever a laser plume is generated (such as ablative skin resurfacing) that "local exhaust ventilation" (smoke evacuators) be used.
- For odors generated by Laser or IPL hair removal, room electrostatic precipitators (room air cleaners) may be effective to eliminate odor.
- Masks that filter to viral sizes are generally considered by ANSI to be ineffective as the sole protection from Laser Plume.

*Laser Safety

ANSI Laser Safety Practice Guidelines

- ANSI Guidelines deal SOLELY with a laser safe environment for personnel.
- ANSI Guidelines DO NOT deal with ANY clinical treatment safety practices nor treatment guidelines.

*Laser Safety

ANSI Guidelines – Laser Safety Training

- Provided to ALL health care personnel responsible for ALL perioperative activities related to laser.
- Essentially this means that anyone that might be in the laser room, or even might HAVE OCCASION to be in a laser room shall be provided with Laser Safety training.

Laser Hair Removal

Content Outline and Objectives

International Aesthetic & Laser Association Guidelines

Aug 30, 2008, Gregory Absten

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OVERALL CONTENT OUTLINE: 16.0 Contact Hours

- 1) Hair & Skin Biology
- 2) Practical Laser Biophysics & Energy Concepts
- 3) Hair removal lasers, light sources & devices
- 4) Laser & Light based hair removal concepts
- 5) Clinical before and after photos and comparisons
- 6) Cautions, complications and contra-indications
- 7) Laser Safety

COURSE OBJECTIVES:

1. List 4 different types of lasers used for hair removal
2. Compare and discuss the differences between the types of lasers and how they relate to patient selection
3. List 3 unique properties of laser light
4. Recognize the pertinent structures and biology of skin as they relate to hair removal
5. Discuss specific tissue interactions to the type of laser (wavelength)
6. Explain the various factors that affect energy densities (radiant exposure) used in patient treatment
7. Discuss the concept of selective PhotoThermolysis
8. Explain the relationship of laser pulse lengths to selective PhotoThermolysis and Thermal Relaxation Times
9. Identify the role of the Laser Safety Officer
10. Explain eye safety precautions used with various lasers
11. Explain general laser safety procedures as recommended by the American National Standards Institute
12. Discuss skin type classification and relate this to patient selection for laser hair removal
13. Compare laser and intense pulsed light hair removal techniques to other methods of hair removal
14. Discuss possible complications of laser hair removal

SPECIFIC COURSE CONTENT OUTLINE – Laser Hair Removal:

Gregory Absten, August 2008
Professional Medical Education Association
www.lasertraining.org

1) Hair & Skin Biology

- a) Key Layers and Components within the skin
 - i) Epidermis
 - (1) Stratum Corneum
 - (a) 15-40 layers of cells
 - (b) Renews about once per month or so
 - (c) Waterproof protective barrier layer
 - (2) Keratinocyte
 - (3) Melanin at dermal/epidermal junction
 - (a) Melanocytes
 - (b) Melanosomes
 - (4) Langerhans Cells – macrophages
 - (5) Merkel Cells
 - ii) Dermis
 - (1) Papillary Dermis
 - (a) Pink – stop here for superficial ablations
 - (2) Reticular Dermis
 - (a) Yellow “chamois cloth” – for deep ablations but go no further.
 - (b) Basement membrane of Reticular Dermis – heat damage past this may cause 3rd degree burns and scarring.
 - iii) Subcutaneous Tissue
 - (1) Hair Bulb
 - (2) Apocrine glands
 - (3) Eccrine glands
- b) Fitzpatrick scale for skin typing, and implications for laser wavelengths and energy settings.
 - i) Type I Fitzpatrick – Very fair, almost transparent. Always burns, never tans. Almost any laser type or IPL will work on types I-III, and the lower the skin type the higher the energy that may be used. Caveat on red & blonde hair.
 - ii) Type II Fitzpatrick – Fair, Always burns, sometimes tans with difficulty
 - iii) Type III Fitzpatrick – Fair to light olive, Sometimes burns mildly, tans slowly
 - iv) Type IV Fitzpatrick – Olive to light brown, Rarely burns, tans easily
This is generally associated with ethnic skin (Latino, Asian, Mediterranean) and marks the possible transition from shorter wavelengths of the Alexandrite Laser to that of the 810nm diode or 1064nm Nd:Yag lasers)

- v) Type V Fitzpatrick – Dark brown, Very Rarely burns, always tans. 810nm diode lasers possible, 1064nm Nd:Yag preferred. IPL use risky.
- vi) Type VI Fitzpatrick – Black, Never burns, always tans. ONLY the Nd:Yag laser. Don't even consider an IPL.
- vii) Fitzpatrick scale a reflection of sun sensitivity rather than skin color per se.
- c) Lance Ethnicity Scale (LES)
 - i) Incorporates ethnicity and hair color
 - ii) More useful as indication for ablative procedures laser exposures
- d) Hair
 - i) Velus Hairs
 - ii) Terminal Hairs
 - iii) Hair Follicle
 - (1) Sheaths of the hair follicle
 - (a) Inner root sheath – protects the hair and molds it's shape
 - (b) Outer root sheath
 - (2) Helical Protein Keratin made by cells in bulb
 - (3) Protofibril – 4 of the Keratin helices twisted together
 - (4) Microfibril – 11 of the Protofibrils twisted together.
 - (5) Macrofibril – Protofibrils twisted together
 - (6) Regions of the hair shaft
 - (a) Inner medulla
 - (b) Middle cortex (contains melanin)
 - (c) Outer cuticle
 - iv) Hair bulb
 - (1) Matrix blood and nerve supply to hair bulb
 - v) Hair Bulge
 - (1) Stem cells for regeneration of hair follicle
- e) Hair Growth, Cycles & Body Areas
 - i) Anagen
 - (1) Most susceptible to laser damage
 - ii) Catagen
 - (1) Bulb shrivels and shrinks
 - iii) Telogen
 - (1) Dormant phase – where hair sheds
 - iv) Hair Growth Cycle Duration according to body area

2) Practical Laser Biophysics & Energy Concepts

- a) L-A-S-E-R acronym and relation to ionizing radiation
- b) Spontaneous vs Stimulated emission of radiation
- c) Unique aspects of laser light and relevance to medical use
 - i) Coherence
 - ii) Collimation

- (1) Inverse square law of light
- (2) Collection of power of emitted beam
- (3) Point source of light to create highly focused spots to diffraction limited spot size.
- (4) Unit of measurement in Radians – angular measurement.
 - (a) Lasers typically 0.5 – 10 milliradians
- iii) Monochromaticity
 - (1) Areas of medicine where monochromaticity more relevant
- d) Wave nature of light
 - i) Wavelength (color)
 - (1) Units in Angstroms, Micrometers and Nanometers and conversion from each
 - ii) Frequency (function of wavelength)
 - iii) Amplitude (brightness)
 - iv) Velocity (186,000 mps in a vacuum – slower in optics)
- e) Electromagnetic Energy
 - i) One of Four primary forces in physics
 - ii) Span the range from short cosmic and xrays to long wavelength radio and TV waves
 - iii) Visible light 400-700nm from the purple to red
 - iv) UV wavelengths below about 351 nm
 - v) IR wavelengths from about 800 – 10,600 nm for medical lasers
- f) Comparison of all the medical laser/light systems and their color/wavelengths and typical uses
 - i) ArFl
 - ii) XeCl
 - iii) Argon
 - iv) KTP
 - v) CuBr
 - vi) Tunable Dye
 - vii) HeNe
 - viii) Krypton
 - ix) Ruby – Hair Removal
 - x) Alexandrite – Hair Removal
 - xi) Diode – 810nm Hair Removal
 - xii) Nd:Yag – Hair Removal
 - xiii) Er:Glass
 - xiv) Ho:Yag
 - xv) Er:Yag
 - xvi) YSGG
 - xvii) CO₂
 - xviii) IPL – Hair Removal
- g) History of Laser Development
 - i) Einstein – theory of stimulated emission, early 1900's
 - ii) Schawlow-Townes, - Theoretical physics paper on “optical masers” – simultaneous with two Russian physicists. Abt 1958

- iii) Ted Maimon – 1st laser – Ruby in 1960
 - iv) Leon Goldman MD – father of Lasers in Medicine
 - h) Energy Concepts
 - i) Power in WATTS – rate of energy delivery
 - ii) Energy in JOULES – how much energy is delivered
 - (1) Joules = Watts per second
 - iii) IRRADIANCE – Power Density – expressed in watts/cm²
 - (1) Spot size and Power.
 - (a) Spot size produces the most rapid changes
 - (2) Spot size control by delivery system
 - (a) Focus / defocus lenses
 - (b) Fiber divergence
 - (c) Collimated Derm handpieces such as for Laser Hair Removal and selection of handpiece for desired spot size.
 - (d) Larger spots require higher laser powers/energies to maintain the same treatment Radiant Exposure.
 - iv) RADIANT EXPOSURE – Joules/cm² - commonly but incorrectly called Fluence
 - (1) Treatment parameter for aesthetic laser procedures including hair removal
 - v) FLUX – rate of energy delivery in high bolus delivery
 - (1) Implications for pulsing laser energy
 - vi) Pulsing time frames & terms
 - (1) Seconds down to tenths of a second – CW mode
 - (2) Milliseconds (10^{-3} s) – pulsed lasers such as for laser hair removal
 - (3) Microseconds (10^{-6} s) – pulsed laser such as for lithotripsy or superpulse on Co₂ lasers.
 - (4) Nanoseconds (10^{-9} s) – pulsed laser such as Q-switched tattoo and ophthalmic lasers
 - (5) Gated Pulse – timer on a CW laser beam exposure
 - vii) Beam Shapes
 - (1) TEM₀₀ – sinusoidal, mostly surgical
 - (2) “Flat Top” – dermatology / aesthetic procedures including hair removal
- 3) Hair Removal Lasers, Light Sources & devices
- a) Ruby Lasers – 694nm
 - i) Not the most common hair removal laser
 - ii) Best used on red and blonde hair
 - b) Alexandrite Lasers – 755nm
 - i) One of the most common hair removal lasers
 - ii) Best used on skin types I-III, used on skin types IV with caution
 - iii) NOT to be used on skin types V or VI
 - c) 810nm Diode Lasers
 - i) Works reasonably well on most skin types
 - ii) Can be used on skin type IV, and with caution on type V
 - iii) Should NOT be used on skin types VI

- d) Nd:Yag lasers – 1064 nm
 - i) Can be used safely on all skin types, but not as effective on lighter types
 - ii) Preferred laser for type V skin
 - iii) Only laser to use on type VI skin
- e) IPL's – use filters from 755 to 1064nm depending on wavelength
 - i) Best for skin types I-III
 - ii) Use on type IV skin with caution
 - iii) Do not use on skin types V or VI
- f) Radio Frequency (RF) to augment hair removal
 - i) RF heat generation and sequencing with laser exposure
- g) Artificial Chromophores
 - i) Meladine
- h) Photodynamic Therapy (use of levulan (20%) with red light source)
 - i) Pilot study that shows that this photochemical treatment using red light (for treatment to the depth of the hair bulb) can result in a 40% reduction in hair, regardless of color, at the first treatment. – Still experimental.

4) Laser & Light Based Hair Removal Concepts

- a) Thermal destruction of the hair bulb and bulge
- b) Definition of “permanent” hair reduction by FDA terminology
- c) Melanin in and around the hair follicle is the target for laser
- d) Melanin at the dermal/epidermal junction is primary obstruction and hazard.
- e) Laser wavelength based upon skin type/color, and somewhat on hair color
- f) Selective Photothermolysis – basis of selective destruction of target based upon wavelength absorption by target and competing chromophores, and of pulse width for TRT of structure.
- g) Darker skin is harder to treat safely, but can be done.
- h) The darker the hair and lighter the skin the easier and safer it is to treat.
- i) Thermal relaxation times versus hair diameters and pulse length on the lasers.
- j) Techniques of Pre, Post and Parallel skin cooling during laser/ipl hair removal
- k) Pulse stacking as a source of skin heating, and staggered pulsing in laser pattern generators
- l) Larger laser spots (at equivalent or lower Radiant Exposures) as a more effective and safer means of laser hair removal.
- m) Multiple treatments required for effectiveness, primarily because of stages of hair growth.
- n) Use of topical anesthetics, precautions, pros and cons, and potential hazards.
- o) Potential desired endpoints in laser hair removal
 - i) Perifollicular edema
 - ii) “sparking” of the individual hair follicles
 - iii) Ejection of the hair follicle during treatment
 - iv) Localized “stinging” at each hair follicle
- p) Relevance of Thermal Relaxation Times (TRT) to hair removal
 - i) Time it takes for a structure to get hot, and then dissipate that heat
 - ii) Larger structures have longer TRT's and take longer to heat up and cool down.

- iii) Smaller structures have shorter TRT's and more quickly heat up and cool down.
 - iv) Typical TRT of most hair is 40-100 ms
 - v) Typical TRT of the melanosomes in the epidermis is 1-10 ms.
 - vi) To "kill" a structure deliver the energy in a time period shorter than the TRT
 - vii) To "spare" a structure deliver the energy in a time period longer than the TRT
 - viii) Classic window for Laser hair removal is 10-40ms.
 - ix) Thicker terminal hairs require longer pulse widths
 - x) Thinner vellus hairs require shorter pulse widths
 - xi) Shorter pulse widths are more effective on light skin, and darker skin requires longer pulse widths for safety to prevent burns.
- q) Cooling Techniques
- i) Cooling gels – least effective but most common
 - ii) Cryogen spray – such as the dynamic cooling device on Candela and other devices
 - iii) Cold Air – Refrigerated air blown directly on the skin
 - iv) Contact Cooling – cold sapphire plates and chilled metal rollers.
- r) Treatment Protocol
- i) Patient History
 - (1) Local infections
 - (2) Scarring
 - (3) Recent hair removal
 - (4) Skin type
 - (5) Allergies
 - (6) Medications (prednisone, cyclosporine, accutane, hair producing meds, minocin)
 - (7) Vitiligo
 - (8) Immuno suppression
 - (9) Psoriasis
 - (10) Hirsutism
 - (11) Hormone abnormalities
 - ii) Pretreatment assessment
 - (1) Physical Examination
 - (a) Skin type
 - (b) Hair color
 - (c) Hair type
 - (i) Texture
 - (ii) Thickness
 - (d) Hair Density
 - (e) Tan
 - (f) Nevi
 - (g) Tattoos
 - (2) Pre-op Instructions

- (a) Patient Instructions
 - (i) Do NOT remove hair
 - (ii) Avoid tanning
(bleach regimen)
- (b) Immediate Pre-Op
 - (i) Discuss procedure
 - (ii) Take Photographs – helps the patient remember the hair density and hair diameters prior to treatment – this helps with patient satisfaction
 - (iii) Mark Skin (don't use black marker– red is better)
 - (iv) Shave – remove all hair and sanitize skin
Lotions, cosmetics and other skin preparations should be avoided on the day of the procedure
 - (v) Anesthesia (some creams may require application 30 minutes or more in advance)
 - (vi) Safety Eyewear for patients and staff
 - (vii) Perform test shots
- s) Treatment Technique
 - i) Skin tension
 - ii) Handpiece placement
 - iii) Sufficient pressure (on contact devices)
 - iv) Acceptable overlap of impacts (Scanners are the best)
- t) Post-Op assessment and protocol
 - i) Mild burning sensations treated with ice packs and oral analgesics
 - ii) If blistering occurs, a topical antibiotic and non adherent dressing used
 - iii) Sun exposure should be avoided, and SPF 15 or greater sunblock used if exposed to the sun.
 - iv) Resist scratching or rubbing the treated areas
 - v) Moisturizing lotions and makeup may be applied the following day, provided blistering has not occurred.
- u) Side Effects
 - i) Damaged hair follicles and hair shafts may shed or extrude themselves in the weeks following treatment, and may be misinterpreted as early regrowth of hair by the patient. Areas with thick, coarse hair are most prone to this. Patients should be pre-warned about this.
 - ii) Erythema and Edema around the hair follicles – this is common and will usually resolve in a few hours. The longer wavelength lasers create what looks like goose bumps around the follicles. This is a normal end point sign.

- iii) Superficial blistering may occur – especially on tanned or dark skin. These also may experience transient pigment changes (lighter or darker) which may last for weeks or even months.
- iv) The risk of infection is low, but does exist if blistering occurs

5) Clinical before and after photos and comparisons

6) Cautions, Complications and Contra-indications

a) Possible complications

- i) Scarring (the thinner the area of skin and higher the fluence the more likely)
- ii) Hypopigmentation (skin turning a lighter color)
- iii) Hyperpigmentation (skin turning a darker color)
These usually resolve within about two-six months, and are fluence & skin color dependent
- iv) Perifollicular erythema / edema – (Reddening & Swelling around the hair)
This is common and is a useful end point. It resolves in hours or days
- v) Local blisters – especially with high fluence / dark skin
- vi) Crusting of skin – most notably after slight blistering

b) Possible Contra-Indications

- i) History of Keloidal scarring
- ii) Patients who have healed poorly after other laser treatments
- iii) Those prone to skin discoloration (a relative contra-indication)
- iv) Active infections: Herpetic infections, cold sores
(place on anti-viral medication before the treatments)
- v) Tattoos, permanent make-up, pigmented lesions
(you can treat around these, but if you treat over them you'll most like raise blisters and/or alter the coloring of the tissue. Electrolysis is perfect for these areas)
- vi) Use of photosensitizing medications such as Accutane (isotretinoin), tetracycline and Retin-A
- vii) Electrolysis, Waxing or Plucking of the area within the last six weeks
(you've removed the target chromophores for the laser)
- viii) Tans – this is a relative contra-indication. They can be treated but with caution as described.
- ix) Extreme sun sensitivity – this is a relative contra-indication. Particularly watch the test spots these patients for signs of allergic type reactions and extreme swelling and erythema of the tissue. If this occurs you should treat only small areas at a time, if at all.
- x) Pregnant patients – no data nor information exists to suggests that this is really a problem, and in fact other surgical laser procedures are performed on pregnant patients (30 years of history) with no complications. However, in the interest of

conservatism, it is the common practice to avoid use of lasers for hair removal on pregnant patients.

xi) Patients with gray or white hair (the laser treatment would be ineffective and risk damage to the skin)

c) Laser Complications

i) Burns and blistering

ii) Scars & infection (secondary to burns and blisters)

iii) Crusting

iv) Hypopigmentation

v) Hyperpigmentation

vi) Urticaria, allergic light reactions and hypersensitivity

(1) Photosensitizing agents

(2) Sun sensitivity, especially in Type I individuals

vii) Management of complications

7) Laser Safety

a) Regulations, standards and professional guidelines for development, implementation and monitoring of a laser safety program

b) Determining the hazards associated with health care laser systems based on risk assessment and knowledge of tissue effects

c) Identifying the administrative, engineering and procedural control measures required for compliance with national standards to ensure a safe working and treatment environment.

d) Structure and function of the laser safety program at each facility

e) The function of the medical laser safety officer (MLSO)

f) Applicability of the ANSI 136.3 safety standards to health care facilities and hair removal clinics.

g) Training and credentialing levels including certificates of training, laser certifications, and state licensure.

h) A.N.S.I. Laser Safety standards versus Patient treatment safety practices.

i) MLSO risk assessment and NHZ determinations

j) MPE (Maximum Permissible Exposure limit), its relevance to the NHZ, and requirements for establishing the NHZ by the MLSO.

k) Relevance of the aversion response to laser safety.

l) Corneal vs retinal eye hazards and the lasers and wavelengths that pose those respective risks.

m) Laser Safety Eyewear labeling requirements

n) ANSI Laser Hazard Classification scheme

o) Patient eye safety options

p) Requirements for the Laser Treatment Controlled Area (LTCA)

i) Laser Danger signs on all entry ways

ii) Room occupied only by authorized personnel trained in laser safety

iii) Safety eyewear made available upon entry, and worn in the NHZ

iv) Supervised by a person trained in laser safety

v) Windows covered when inside the NHZ and of a wavelength that passes through glass

- q) Non-beam laser hazards
 - i) Laser dye solutions
 - ii) Laser gases
 - iii) Laser plume
 - iv) Electrical
- r) Laser related fire risks
 - i) Contact with dry materials
 - ii) CO₂ & Er:Yag lasers at a distance
 - iii) Water available for quenching flames
 - iv) Fire extinguisher generally available (but not in room)
 - v) Fiber breakage