HEALTH TECH ACADEMY

Energy Sources in Surgery

Treating the Surgical Patient

Lesson Objectives:

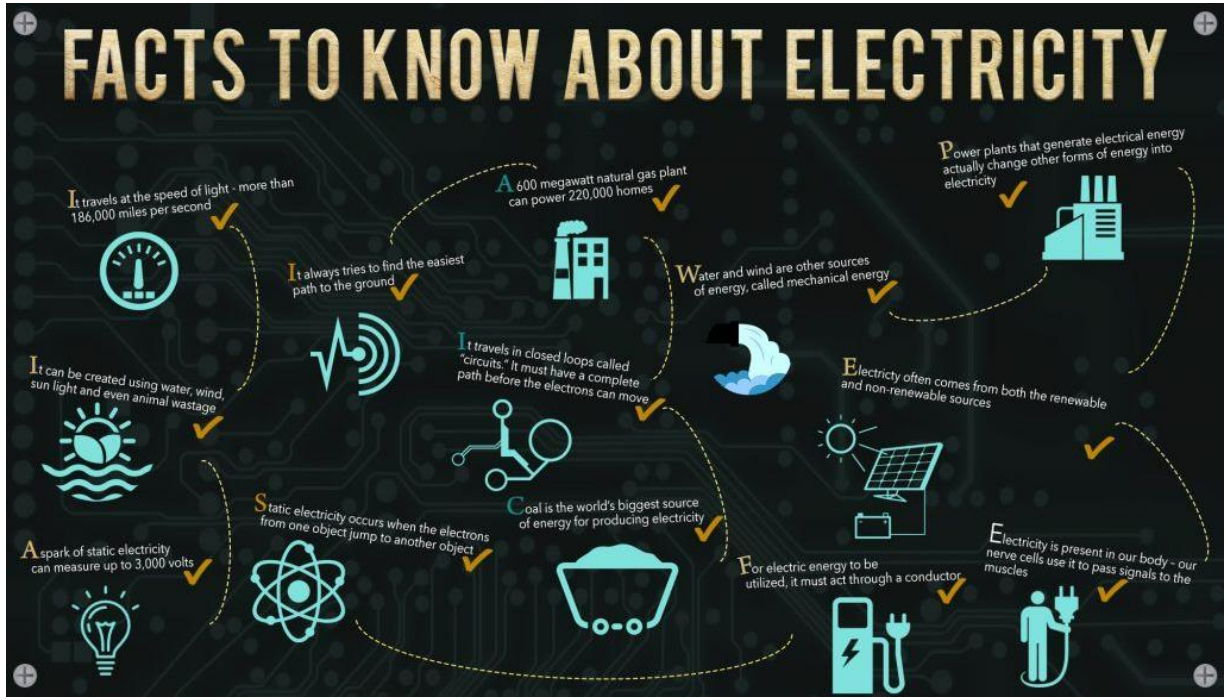
1. Review the concepts of conduction, frequency, and impedance
2. Describe the uses and components of electrosurgery
3. Distinguish between monopolar and bipolar circuits used in electrosurgery
4. Discuss the safe use of the patient return electrode
5. List the primary hazards of electrosurgery and explain how to prevent accidents
6. Distinguish between capacitive coupling and indirect coupling
7. Describe the materials in a smoke plume and how to reduce exposure to the smoke plume
8. Describe how lasers are used in surgery
9. Recognize different types of laser media
10. Discuss safety precautions used during laser surgery

Overview of Energy Technologies

- Surgical technologist deals with complex devices with potential for serious injury
- Understanding basic principles of energy tech crucial for patient safety
- **Various forms of energy used in surgery:**
  - Electrical
  - Radiofrequency
  - Ultrasonic (kinetic)
  - Thermal
  - Laser energy
- Energy used for procedures not always electrical:
  - Example: Ultrasonic waves for tissue coagulation
  - Powered by electricity but effect on tissue from vibration and friction

Electricity Review

- Free Electrons
- Conduction
  - Materials that carry electricity
- Circuits
  - Current follows path of least resistance
- Current
  - The Flow of Electricity
- Impedance
  - Resistance of the current completing a circuit
- Voltage
  - Like "Pressure" of the current/flow

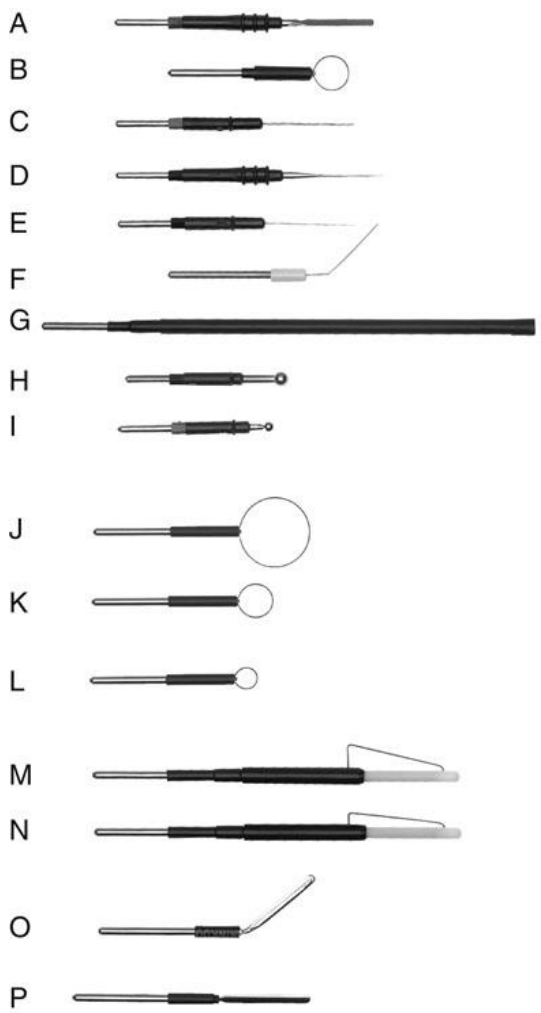


Uses of Electrosurgery

- **Electrosurgery**: Using electricity to modify or destroy tissue
- **Main uses**: Cutting tissue and coagulating small blood vessels
- **Effects of electrosurgery on tissues**:
  - Energy transformed into heat at point of contact with active electrode
  - Tissue reaction influenced by:
    - Tissue type (water content, collagen, density)
    - Exposure time
    - Current density (increases with voltage forced through small area)
    - Frequency and voltage combinations lead to different tissue effects

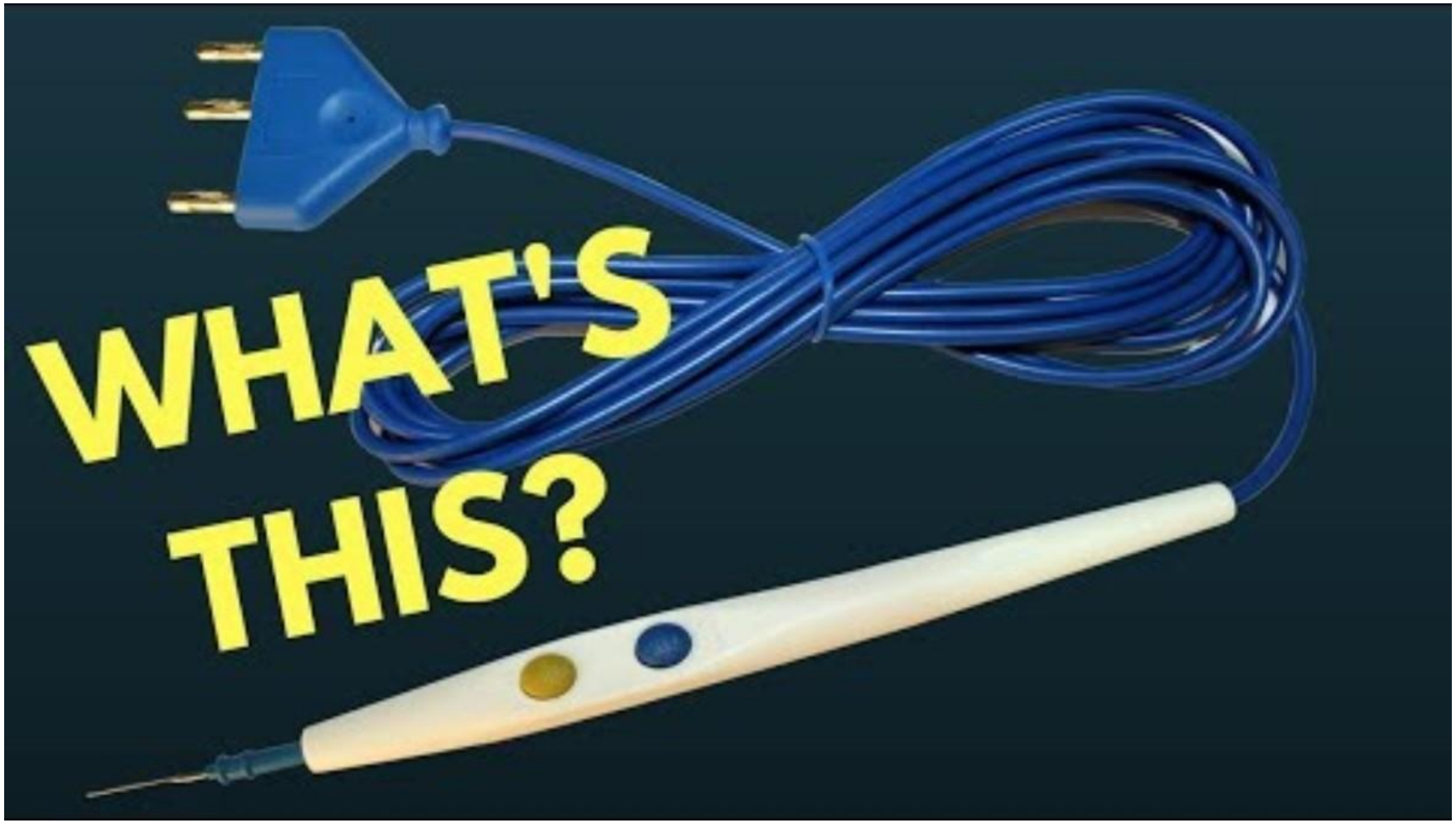
Components of the Electrosurgery Unit

- Power unit (generator)
- ESU handpiece
- Active electrode (pencil)
- Patient return electrode (Bovie pad)



Watch the "Electrosurgery and the Bovie" Video for an overview

Electrosurgery and the Bovie Video



Electrosurgery and the Bovie Video

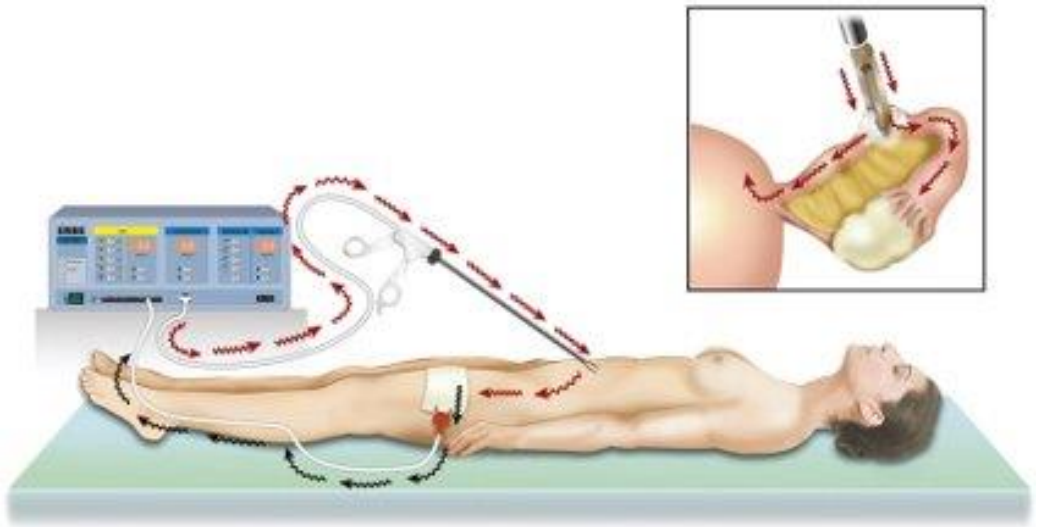
Summary of Video:

- Invented by William T Bovie. Most ESUs colloquially called the "Bovie"
- Electric current coagulates or cauterizes tissue
- Equipment:
  - Generator
  - Active Electrode: ESU Handpiece
  - Grounding Pad: Return Electrode
    - Returns current to generator completing circuit
  - Bipolar cautery has the active and return electrodes within the handpiece

Circuits used in ESU

- Circuits used in electrosurgery unit (ESU)
  - Monopolar – Requires the use of a return electrode (Bovie pad)
  - Bipolar – No grounding pad

In monopolar electrosurgical units, electrical current flows from the power source to the active electrode, through the patient's body, to the patient return electrode (PRE), which transmits it back to the power unit. This completes the circuit and prevents inadvertent patient burns.



ESU Working Modes

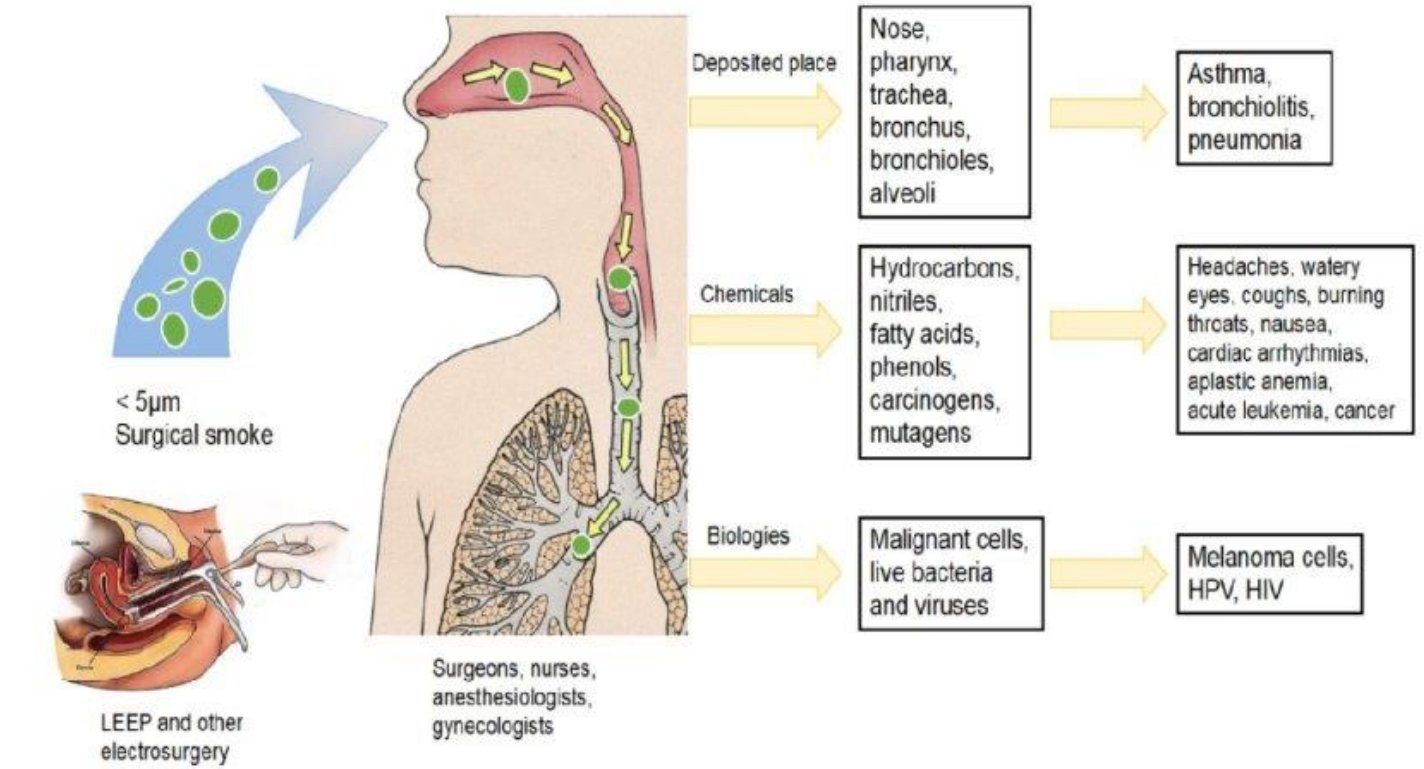
- Fulguration:
  - Pulsed application of active electrode for coagulation and tissue cutting
- Electrosurgical Bipolar Vessel Sealing:
  - Utilizes high-frequency bipolar electrosurgery and low voltage
  - Replaces clamping, suturing, and cutting with one instrument
- Argon-Enhanced Electrosurgery:
  - Focuses current with argon gas, reducing smoke plume and increasing safety
- Radiofrequency Ablation:
  - Destroys tissue using radiofrequency energy, useful for tumors and endometrial tissue
- Bipolar radiofrequency ablation (RFA):
  - Destroys tissue in hollow organs using conductive fluid medium

Hazards of Electrosurgery

- Risk for patients with implanted electrical devices
  - Pacemakers and ICDs
- Pre-op assessment may deactivate or reprogram devices to prevent interference
- "Magnet mode" for safety during surgery
- Smoke plume potential concern

The Smoke Plume

- The smoke plume
  - Infectious disease transmission
  - Toxicity
- Risk reduction
  - Inline room suction
  - Smoke evacuation system



The hazards of surgical smoke produced by electrosurgical procedures to gynecologists. Surgical smoke produced by electrocautery contain

Electrosurgery in Minimally Invasive Surgery (MIS)

- MIS performed through small incisions using telescopic instruments
- Surgical field transmitted to monitor in real time
- Electrosurgery used in all MIS procedures
- Bipolar mode necessary in MIS to avoid tissue damage

Watch the "Electrosurgery Best Practices" for an overview of potential injuries

Electrosurgery Best Practices Video

Electrosurgery Best Practices Video

- **Summary of Video:**
  - Pad Site Injury: Complete pad contact, do not place over metal implant
  - Direct Coupling: Activation of instrument in air (open circuit)
  - Capacitive Coupling: cable should not be wrapped around an instrument
  - Insulation failure: Holes in insulation can cause current injury
  - Fires: cautery is an ignition source

Capacitive and Direct Coupling

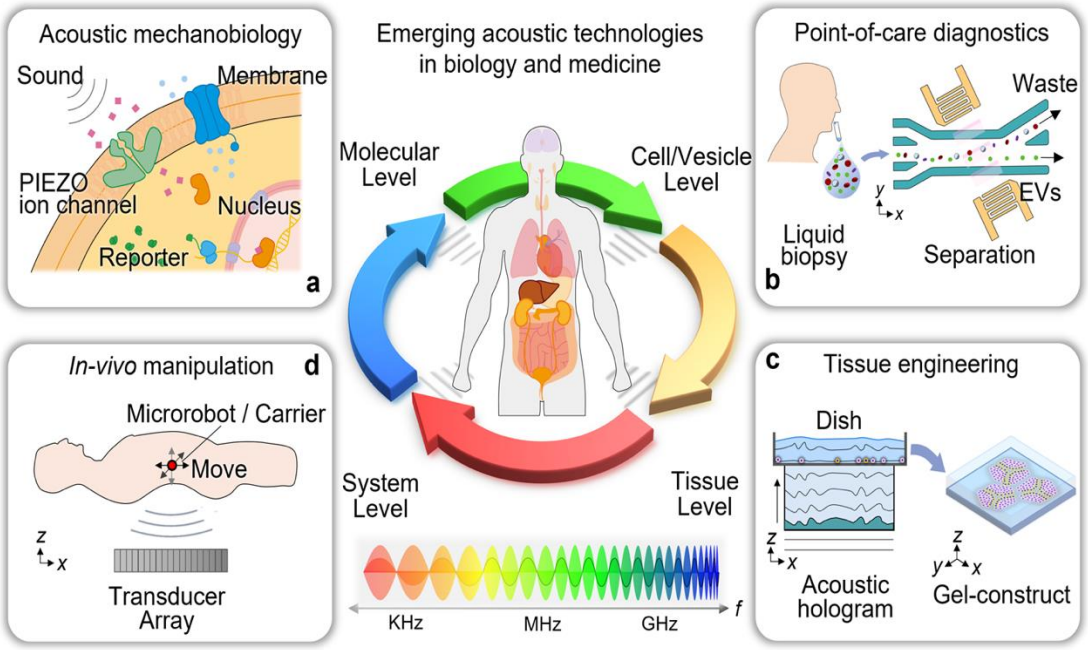
Capacitive Coupling

- Burn hazard in monopolar endoscopic surgery
- Current passes through instrument insulation to tissue
- Dangerous as injury often outside endoscope viewing area
- Prevention: metal cannulas, active electrode monitoring

Direct Coupling

- Flow of electricity between conductive substances
- Occurs due to insulation defect or instrument collision
- Dangerous if insulation failure goes unnoticed
- Prevention: frequent insulation inspection, proper instrument handling, active electrode monitoring

Ultrasonic Energy



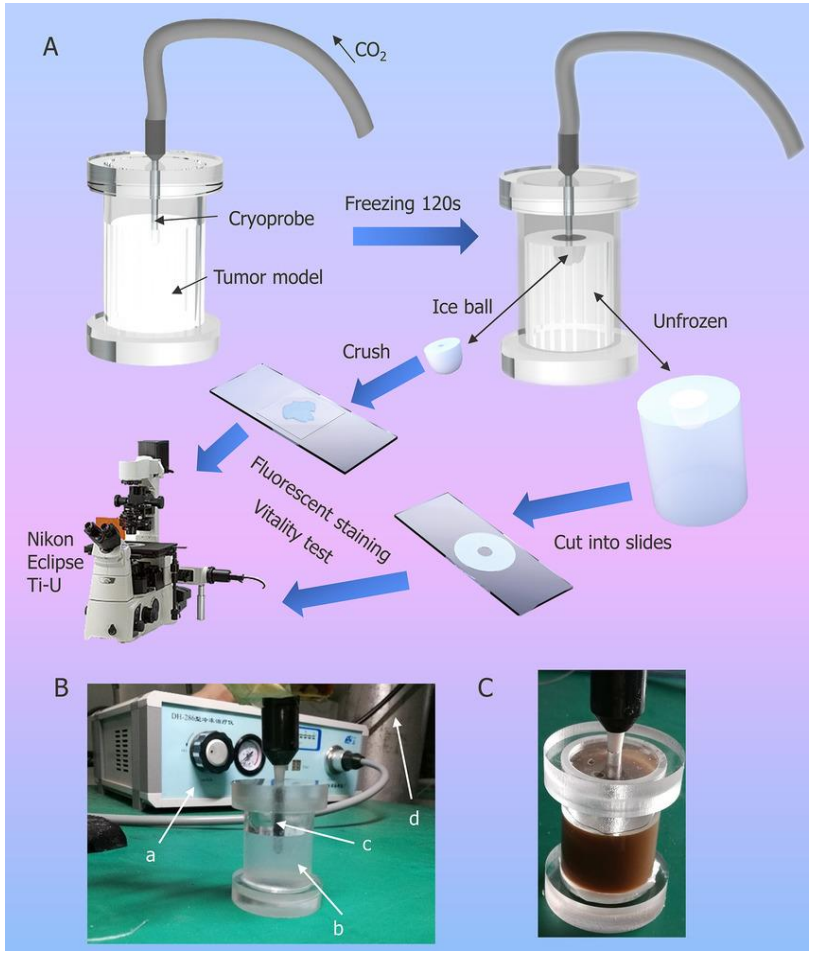
- Created from electricity transformed into mechanical energy via high-frequency vibration and friction
- Cuts and coagulates tissue simultaneously
- Vibrates at about 55,000 movements per second, rupturing protein molecules
- Cannot cut tissue without coagulating it, forming coagulum
- Examples: SonoSurg, Harmonic energy system

Ultrasonic Energy – Safety Precautions

- **Safety Precautions**
  - Blades retain heat post-use due to vibration and friction
  - Hold instrument away from tissue during cooling to prevent burns
  - Provide moist towel on surgical field for instrument placement
- **Ultrasonic Ablation**
  - Alternative to electrosurgery
  - Tumor ablation via needle probes under fluoroscopic imaging
  - Used in gynecology, endovascular surgery, neurological surgery, ophthalmology
  - Examples: CUSA for tumor ablation, phacoemulsification for cataract destruction

Cryosurgery

- Cryosurgery uses extreme cold to destroy tissue
  - Commonly employs liquid nitrogen for small skin lesions
- Cryoablation:
  - Involves inserting a probe into tumor or tissue mass
  - Utilizes high-pressure argon gas to freeze surrounding tissue
  - Destroys tissue, which is eventually absorbed by the body
- Typically performed in outpatient setting
- Often guided by fluoroscopy

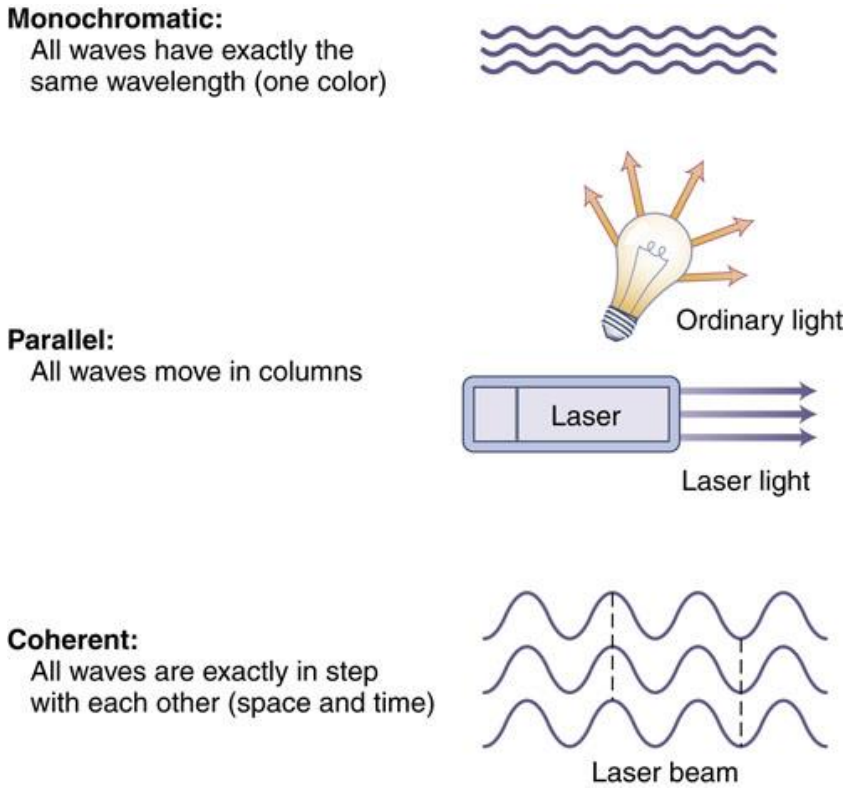


Laser Surgery

- Laser is an acronym for light amplification by stimulated emission of radiation.
- **Laser Standards and Regulations:**
  - Developed by governmental and nonprofit agencies
  - Aim to protect patients and workers
  - Establish training, rules, and regulations for laser use
- **Laser Safety in Healthcare:**
  - Laser team oversees training and implementation of rules
  - Laser safety committee plans and implements safety measures
  - Laser safety officer handles clinical questions and maintains safety standards

How Laser Works

- **How Lasers Work:**
  - Light has particle and wave characteristics
  - Laser light has waves of the same length and aligned peaks and troughs (coherency)
  - Laser energy created in sealed chamber filled with laser medium
  - Mirrors bounce photons to amplify parallel photons
  - Laser surgery uses focused beam for cutting and coagulating tissue
- **Types of Lasers:**
  - Continuous-wave lasers emit steady stream of light
  - Q-switched lasers emit light in bursts or pulses



Watch the "How a Laser Works" Video for an overview

How a Laser Works Video

How a Laser Works Video

Summary of Video:

- LASERs have:
  - Single wavelength
  - Great intensity
  - Narrow beam
- Laser Media – Ruby in this video
- Amplification between mirrors creates a beam

Effects of Laser

When laser light is directed at a surface, any of the following can occur:

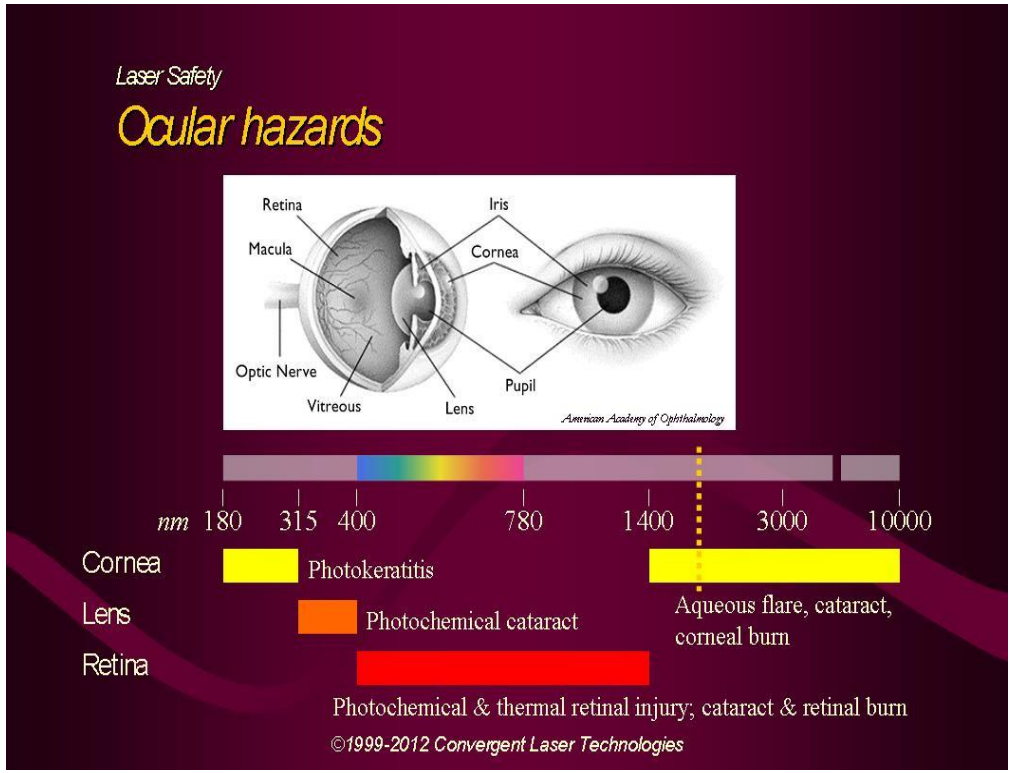
- Absorption
- Reflection
- Scattering
- Transmission

Lasers are distinguished by the functional or biophysical reaction of the target tissue. The tissue reaction depends on the following:

- The laser wavelength
- The power setting
- The absorption quality of the cells (e.g., color, density, and moisture content)

Classifications of Risks

- Laser classifications are based on the safety risks associated with their use:
  - Class 4
    - Causes permanent eye damage
  - Class 3B
    - Causes severe eye injury
  - Class 3A
    - No injury if viewed momentarily
  - Class 2
    - Normally no harm caused
  - Class 1
    - Are not hazardous for continued viewing



Precautions and Guidelines for Laser Use

Eye Safety and Skin Protection

- Protective eyewear for each specific laser
- Filter on optics
- Protection of patient's eyes
- Cover reflective surfaces and post signs
- Place protective eyewear outside the room for use
- Airway protection
  - Wrap endotracheal tube with special metallic foil
  - Decrease flow of volatile gases

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Congratulations!

Lesson 15 is complete.