AL- MUSTAQBAL UNIVERSITY COLLEGE
DEPARTMENT OF BIOMEDICAL ENGINEERING

Bio-Electronics Design Lab

BME 515

Lecture 2

- Electrosurgical Unit (Cautery) -

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Electrosurgical Unit

Properties of Electricity

Several properties of electricity must be understood in order to understand electro-surgery.

- Current flow occurs when electrons flow from one atom to the orbit of an adjacent atom.
- Voltage is the “force” or “push” that provides electrons with the ability to travel from atom to atom.
- If electrons encounter resistance, heat can be produced. The resistance to electron flow is called impedance.

Properties of Electricity

- A completed circuit must be present in order for electrons to flow.
- A completed circuit is an intact pathway through which electrons can travel.
- The original source of these electrons is the earth (ground).
- To complete the circuit the electrons must return to ground.
- Any grounded object can complete the circuit, allowing the electrons to flow to ground.

Frequency Spectrum

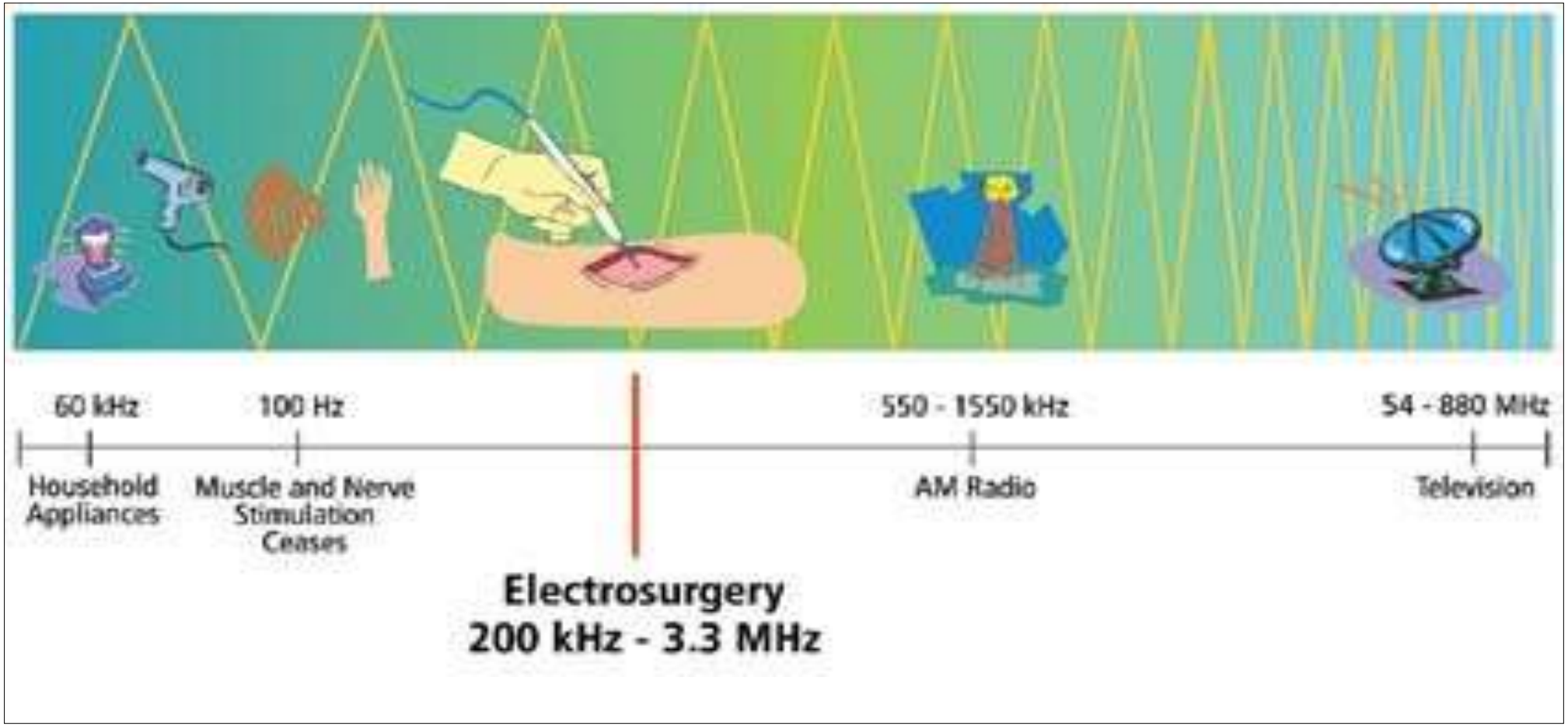
- Standard electrical current alternates at a frequency of 60 cycles per second (Hz).

- Electrosurgical systems could function at this frequency, but because current would be transmitted through body tissue at 60 cycles, excessive neuromuscular stimulation and perhaps electrocution would result.

- Because nerve and muscle stimulation cease at 100,000 cycles/ second (100 kHz), electro-surgery can be performed safely at “radio” frequencies above 100 kHz.

- An electrosurgical generator takes 60 cycle current and increases the frequency to over 200,000 cycles per second. At this frequency electrosurgical energy can pass through the patient with minimal neuromuscular stimulation and no risk of electrocution.

Frequency Spectrum



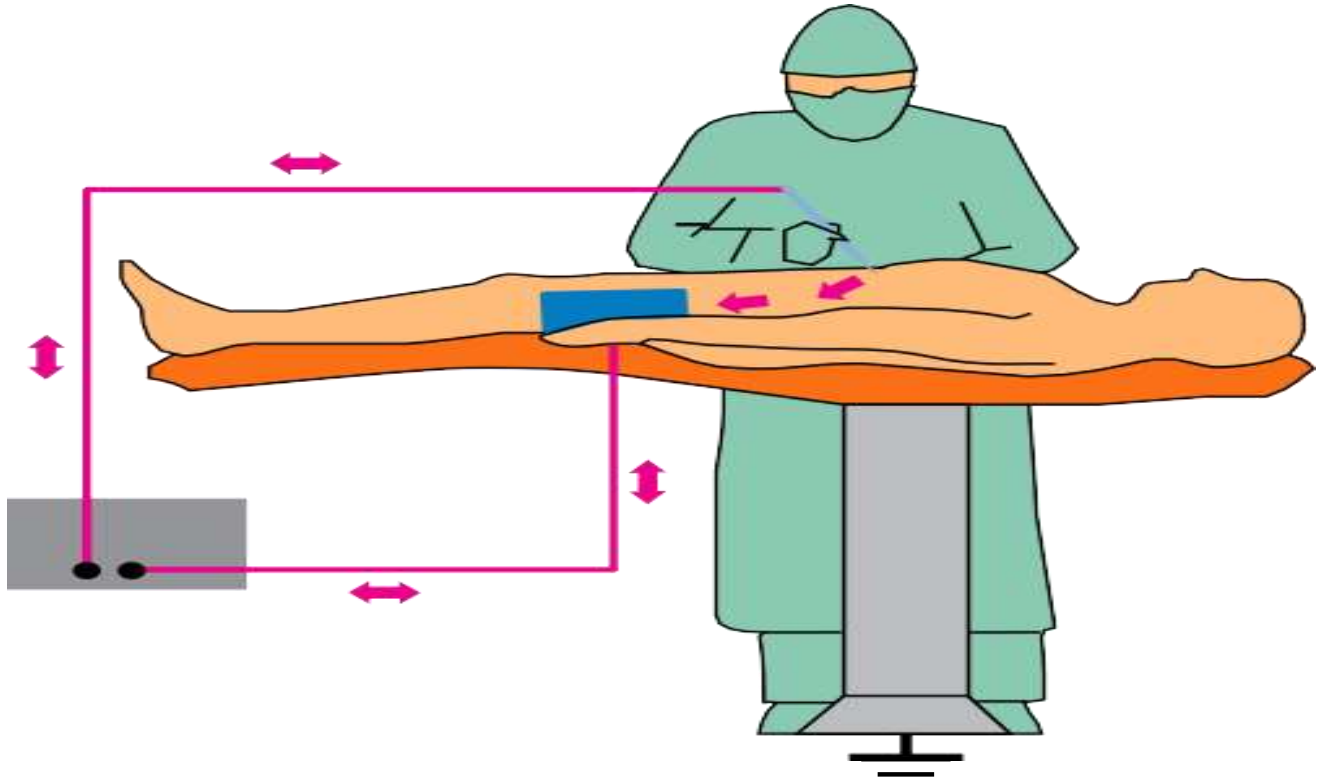
Types of electrodes

I. Monopolar Electrosurgery

- Monopolar is the most commonly used electrosurgical modality. This is due to its versatility and clinical effectiveness.
- In monopolar electro-surgery, the active electrode is in the surgical site.
- The patient return electrode is somewhere else on the patient’s body.
- The current flow through the patient to the patient return electrode.

Monopolar Circuit

This picture represents a common monopolar circuit.



Monopolar Circuit

There are four components to the monopolar circuit

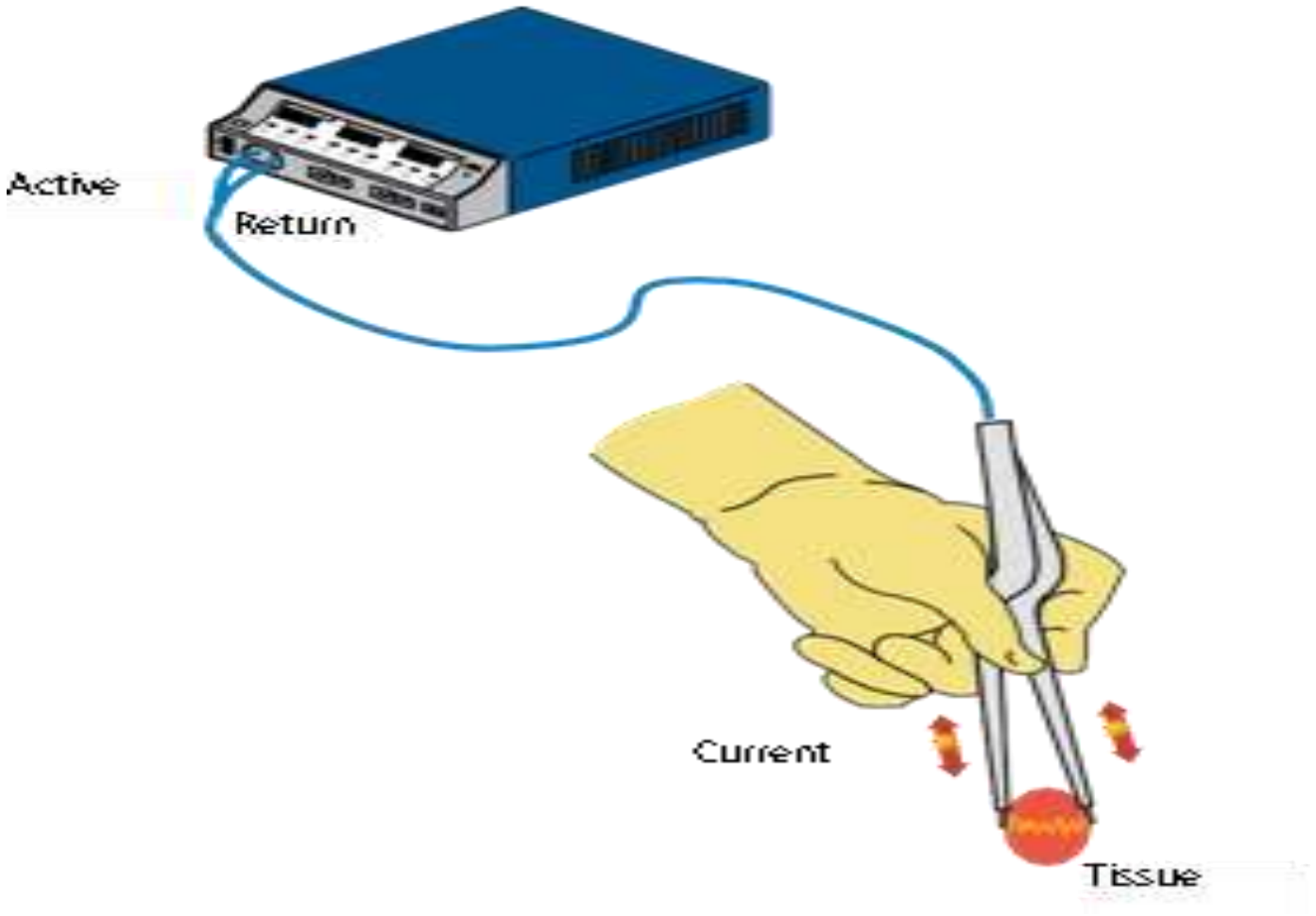
- Generator.
- Active Electrode.
- Patient.
- Patient Return Electrode.

Types of electrodes

II. Bipolar

- In bipolar electro-surgery, both the active electrode and return electrode functions are performed at the site of surgery.
- Active output and patient return functions are both accomplished at the site of surgery.
- Current path is confined to tissue grasped between forceps tines.
- Patient return electrode should not be applied for bipolar only procedures.

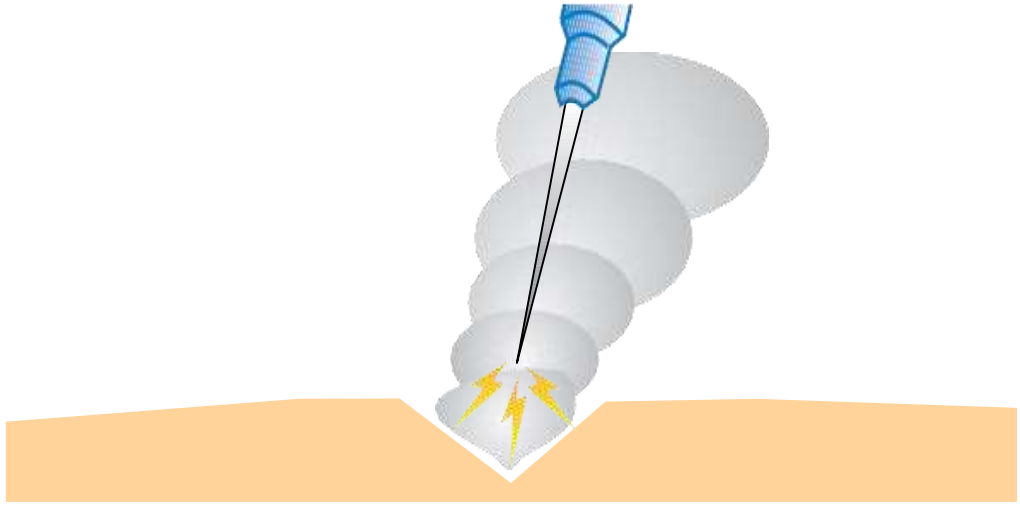
Bipolar Circuit

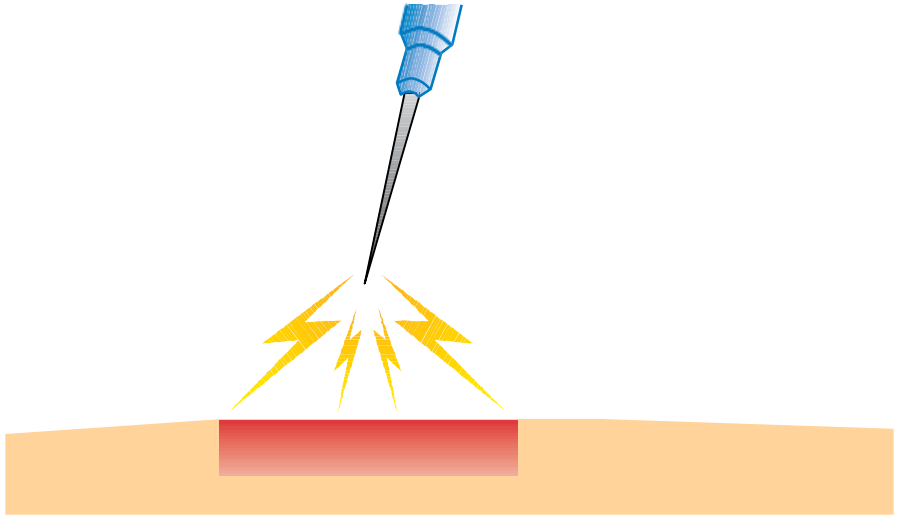


Tissue Effects

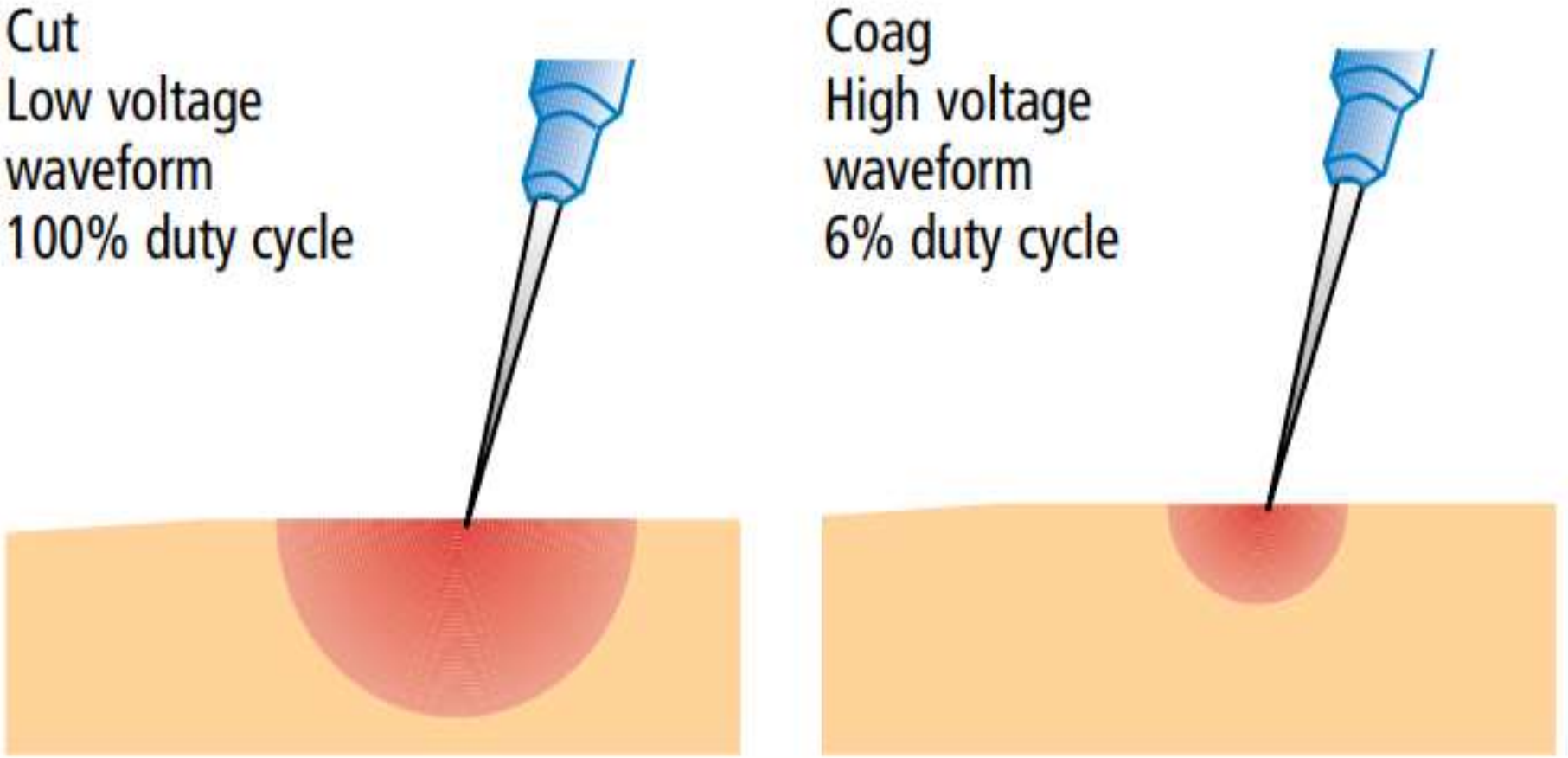
- Electrosurgical generators are able to produce a variety of electrical waveforms.
- As waveforms change, so will the corresponding tissue effects.
- Using a constant waveform, like “cut,” the surgeon is able to vaporize or cut tissue. This waveform produces heat very rapidly.
- Using an intermittent waveform, like “coagulation,” causes the generator to modify the waveform so that the duty cycle (“on” time) is reduced.

Tissue Effects

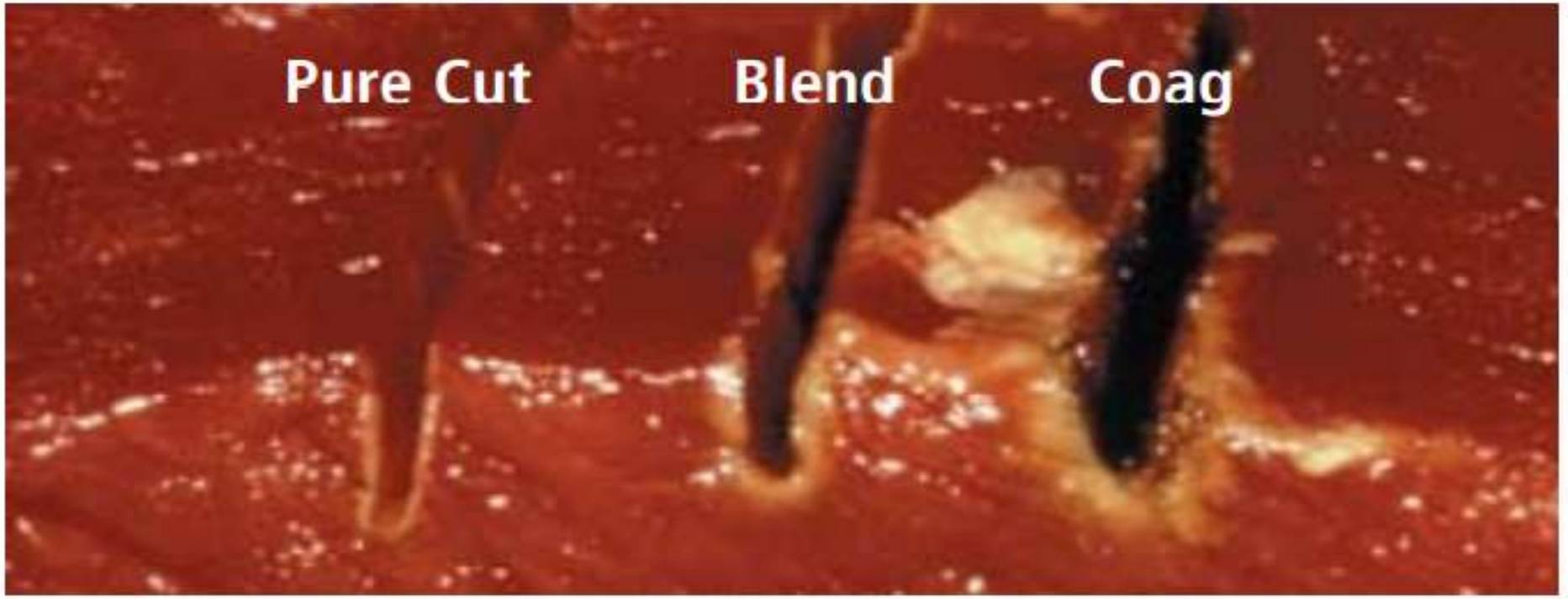




Tissue Effects



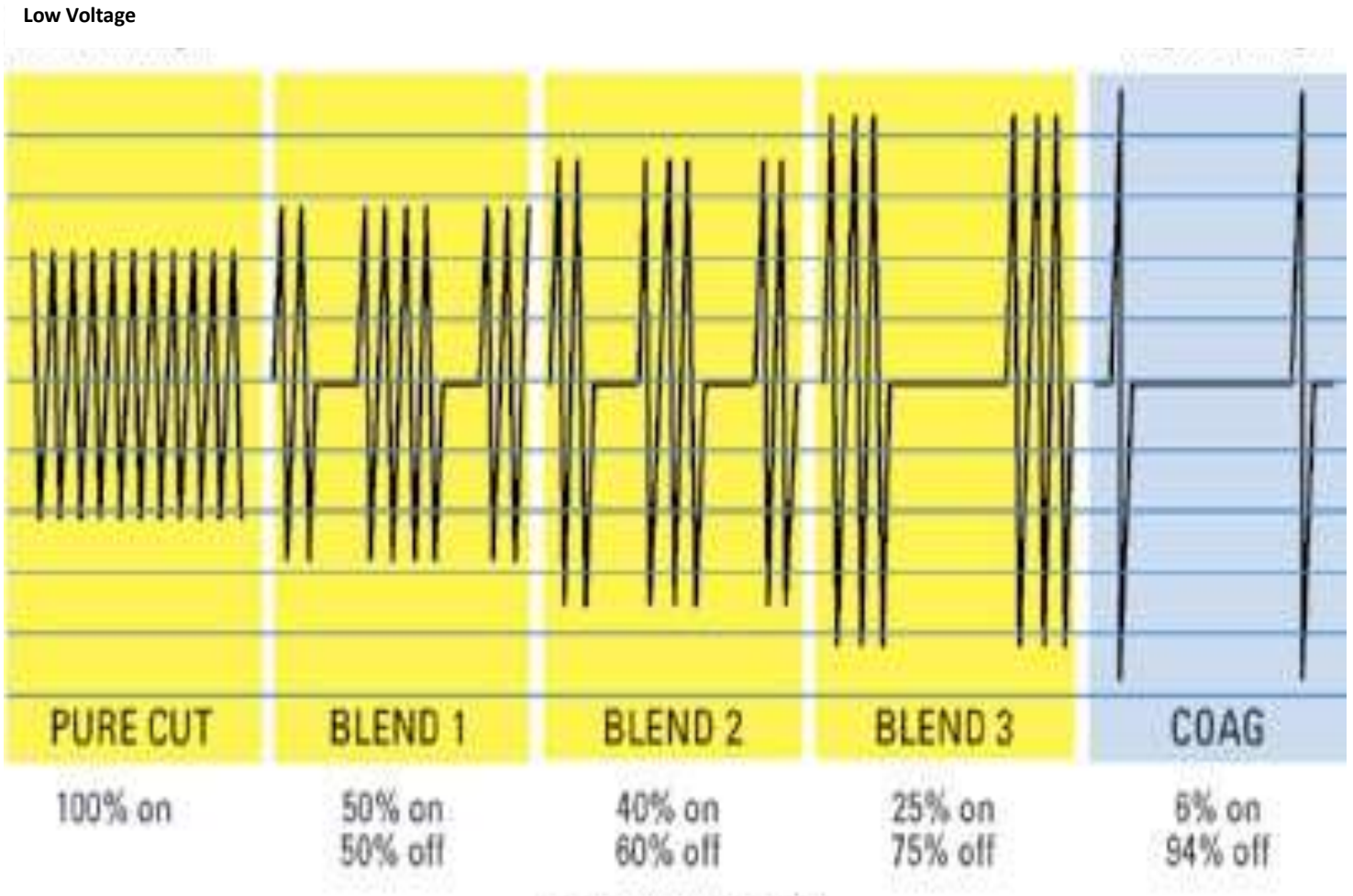
Tissue Effects



Cut, Blend, and Coagulate

- As you go from Blend 1 to Blend 3 the duty cycle is progressively reduced.
- A lower duty cycle produces less heat.
- Consequently, Blend 1 is able to vaporize tissue with minimal hemostasis whereas Blend 3 is less effective at cutting but has maximum hemostasis.
- Low heat produced more slowly creates a coagulum.

Cut, Blend, and Coagulate



Variables Impacting Tissue Effect

In addition to waveform and power setting, other variables impact tissue effect. They include:

- Size of the electrode: The smaller electrode, the higher current concentration.
- Time: At any given setting, the longer the generator is activated, the more heat is produced.
- Type of Tissue: Tissues vary widely in resistance

Grounded Electrosurgical System

- Generators operate by taking alternating current and increasing its frequency from 50 or 60 cycles/second to over 200,000 cycles/second.

- Once the current entered the patient's body, it would return to ground through the patient return electrode.

Grounded Electrosurgical System