

### Puzzle 1

A 55-year-old patient with chronic knee osteoarthritis reports pain relief after sessions using a device delivering pulsed biphasic currents at 2-100 Hz, modulating gate control theory to block nociceptive signals. What low-frequency current is likely applied, and how does it achieve analgesia?

**Answer:** Transcutaneous Electrical Nerve Stimulation (TENS). It stimulates large-diameter A-beta fibers, activating spinal inhibitory interneurons to close the "pain gate" and release endorphins at higher intensities.

### Puzzle 2

In a rehabilitation clinic, a therapist uses a constant direct current to facilitate iontophoresis, driving anti-inflammatory medication like dexamethasone into inflamed tissues. What low-frequency current enables this, and what polarity principle guides electrode placement?

**Answer:** Galvanic current. Like charges repel; the medication (negatively charged) is placed under the cathode for transdermal delivery into positively charged tissues.

### Puzzle 3

A post-surgical patient with muscle atrophy undergoes stimulation with surged alternating currents at 50-100 Hz to induce tetanic contractions without fatigue. What low-frequency current is used, and why is surging important?

**Answer:** Faradic current. Surging allows gradual intensity increase, mimicking voluntary contractions to strengthen muscles while preventing discomfort from abrupt onset.

### Puzzle 4

For a patient with deep-seated hip pain, two sets of electrodes deliver currents at 4000 Hz and 4100 Hz, creating a 100 Hz beat frequency in tissues for analgesia. What high-frequency current technique is this, and how does it reduce skin impedance?

**Answer:** Interferential therapy (IFT). High carrier frequencies penetrate skin with low resistance; amplitude modulation produces low-frequency interference for deeper stimulation.

### Puzzle 5

A therapist treats a frozen shoulder with continuous high-frequency electromagnetic waves at 27.12 MHz, generating deep heat via dielectric heating. What high-frequency current modality is applied, and what physiological effect promotes tissue extensibility?

**Answer:** Shortwave diathermy (SWD). It induces molecular friction, increasing blood flow, collagen plasticity, and metabolic rate for pain relief and improved range of motion.

### Puzzle 6

In managing Bell's palsy, a clinician applies interrupted direct current at 0.1-1 Hz to evoke muscle twitches and prevent denervation atrophy. What low-frequency current variation is this, and how does it differ from constant galvanic?

**Answer:** Interrupted galvanic current. Unlike constant flow causing chemical effects, interruptions produce phasic contractions, stimulating nerve regeneration without electrolysis risks.

### Puzzle 7

A patient with chronic back pain experiences paresthesia and warmth from a device using 2450 MHz microwaves focused on superficial tissues. What high-frequency current is involved, and why is it preferred over ultrasound for certain depths?

**Answer:** Microwave diathermy (MWD). It heats via electromagnetic absorption in water-rich tissues; suitable for 1-3 cm depths, avoiding bone interfaces that reflect ultrasound.

### Puzzle 8

During therapy for edema reduction, a low-frequency pulsed current at 1-10 Hz is used to enhance lymphatic drainage via muscle pumping. What current type facilitates this, and what waveform optimizes venous return?

**Answer:** Neuromuscular Electrical Stimulation (NMES), often using Russian current (2500 Hz modulated at low frequency). Biphasic rectangular waves induce rhythmic contractions, promoting fluid mobilization.

### Puzzle 9

A burn patient receives high-frequency currents at 100 kHz via capacitive electrodes to promote wound healing without direct contact. What modality is this, and how does it accelerate epithelialization?

**Answer:** Pulsed shortwave diathermy (PSWD). Non-thermal effects like increased cellular metabolism and ATP production enhance fibroblast activity and collagen synthesis.

### Puzzle 10

In treating diabetic neuropathy, a therapist employs biphasic pulses at 80-150 Hz for sensory modulation. What low-frequency current is key, and what parameter adjustment prevents accommodation?

**Answer:** High-rate TENS. Frequency modulation or burst mode varies stimulation, maintaining nerve excitability by avoiding habituation.

### Puzzle 11

For deep tissue heating in a large area like the lower back, inductive coils deliver 13.56 MHz currents inducing eddy currents. What high-frequency method is used, and what safety concern arises with metal implants?

**Answer:** Inductive shortwave diathermy. Magnetic fields induce currents in conductive tissues; contraindications include pacemakers or metals, risking overheating or interference.

### Puzzle 12

A post-stroke patient with foot drop uses a device triggering peroneal nerve stimulation at 20-50 Hz during gait. What low-frequency functional current is this, and how does it integrate with movement?

**Answer:** Functional Electrical Stimulation (FES). Synchronized with heel strike via sensors, it evokes dorsiflexion, improving ambulation and neuroplasticity.

### Puzzle 13

In a spa setting, high-frequency currents at 500 kHz are applied via glass electrodes for skin rejuvenation, producing ozone. What cosmetic electrotherapy current is involved, and what is its bactericidal effect?

**Answer:** High-frequency violet ray or Tesla current. Ozone generation disinfects pores, stimulating circulation and lymphatic drainage for acne treatment.

### Puzzle 14

A patient with temporomandibular joint pain receives amplitude-modulated currents at 4 kHz carrier with 50 Hz modulation for anti-inflammatory effects. What high-frequency current variant is this, and why is it superior for obese patients?

**Answer:** Medium-frequency interferential current. Higher frequencies overcome adipose impedance, allowing deeper penetration than low-frequency alone.

#### Puzzle 15

For muscle re-education after ACL repair, surged sinusoidal currents at 50 Hz are used to build strength progressively. What low-frequency current is applied, and what ramp time minimizes discomfort?

**Answer:** Sinusoidal current (similar to faradic). A 1-2 second ramp-up allows accommodation, enabling higher intensities for effective contractions.

#### Puzzle 16

In palliative care for cancer pain, low-frequency bursts of 2 Hz containing high-rate pulses provide endorphin-mediated relief. What TENS mode is this, and how does it mimic acupuncture?

**Answer:** Acupuncture-like TENS (AL-TENS). Low-frequency bursts activate A-delta fibers, stimulating descending pain inhibition via opioid pathways.

#### Puzzle 17

A therapist treats cellulite with high-frequency currents at 1 MHz using roller electrodes, promoting lipolysis. What modality combines electrotherapy with mechanical action, and what thermal effect aids fat breakdown?

**Answer:** Radiofrequency (RF) therapy. Resistive heating increases metabolism, enhancing collagen remodeling and lymphatic drainage.

#### Puzzle 18

In managing spasticity in cerebral palsy, biphasic currents at 100-200 Hz are used to fatigue hyperactive muscles. What low-frequency current technique is this, and what is the underlying H-reflex modulation?

**Answer:** High-frequency NMES or TENS for spasticity. It inhibits Ia afferents via presynaptic inhibition, reducing reflex excitability.

#### Puzzle 19

For postoperative wound healing, pulsed monophasic currents at 100  $\mu$ s pulse width and 35 Hz are applied to enhance tissue repair. What low-frequency current is key, and what cellular mechanism is stimulated?

**Answer:** High-voltage pulsed current (HVPC). It upregulates growth factors, angiogenesis, and macrophage activity, accelerating granulation.

#### Puzzle 20

A patient with rheumatoid arthritis undergoes non-thermal high-frequency therapy at 27 MHz in pulsed mode to reduce joint stiffness without heat risks. What current type is used, and how does it modulate inflammation?

**Answer:** Pulsed electromagnetic field therapy (PEMF). It influences ion channels and cytokine release, decreasing pro-inflammatory mediators like TNF-alpha.