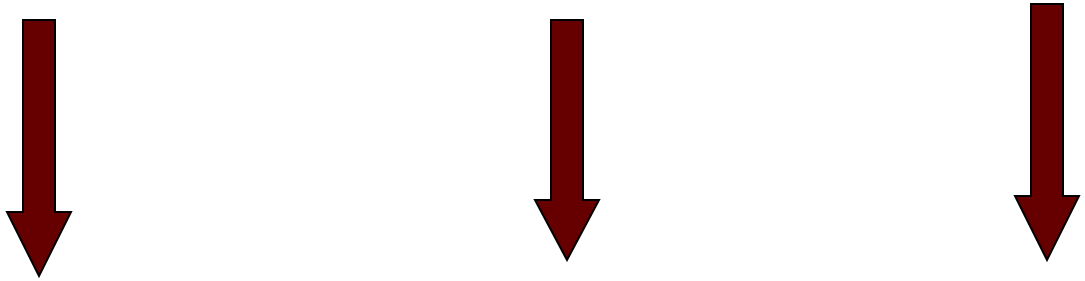
ELECTROMYOGRAPHY

EMG- BIOFEEDBACK

ELECTROMYOGHAPHY

ELECTRO + MYO + GRAPHY



ELECTRICITY MUSCLE WRITE

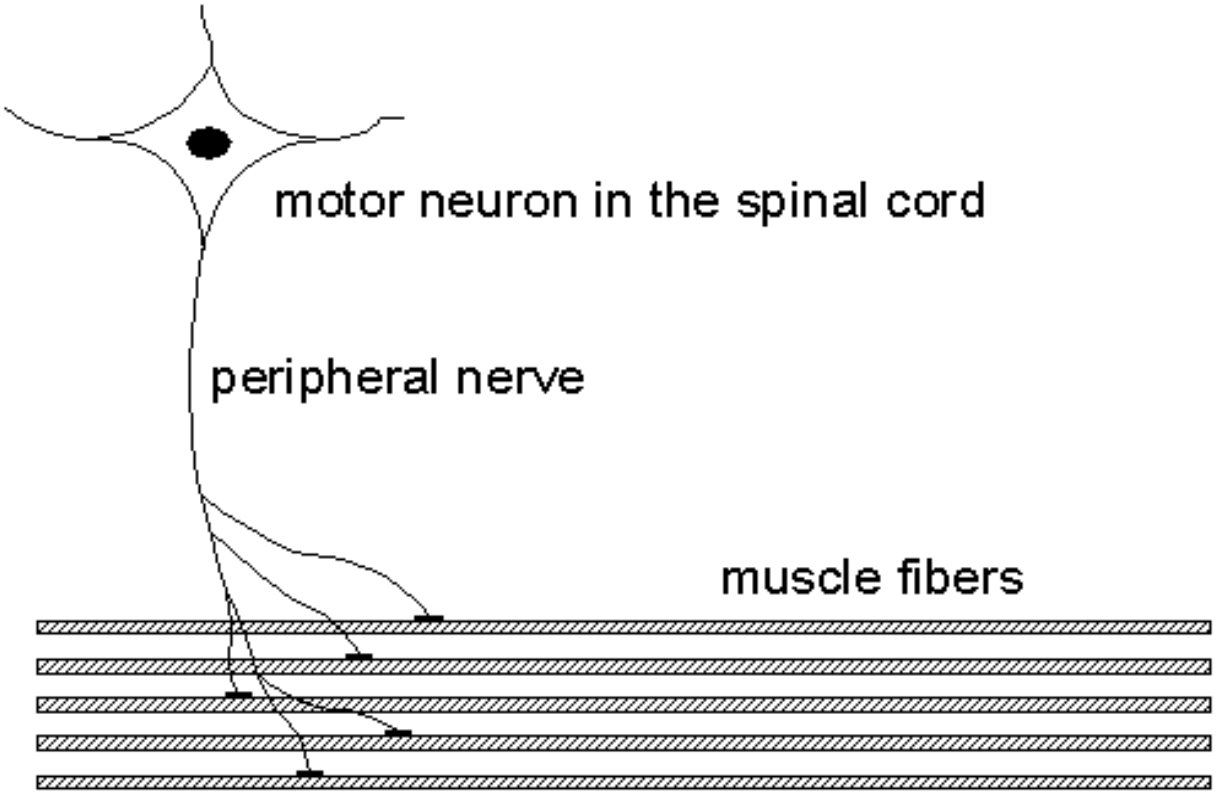
DEFINITION

- Study of motor unit activity
- Recording of AP of muscle fibres firing near the needle electrode in a muscle

INTRODUCTION

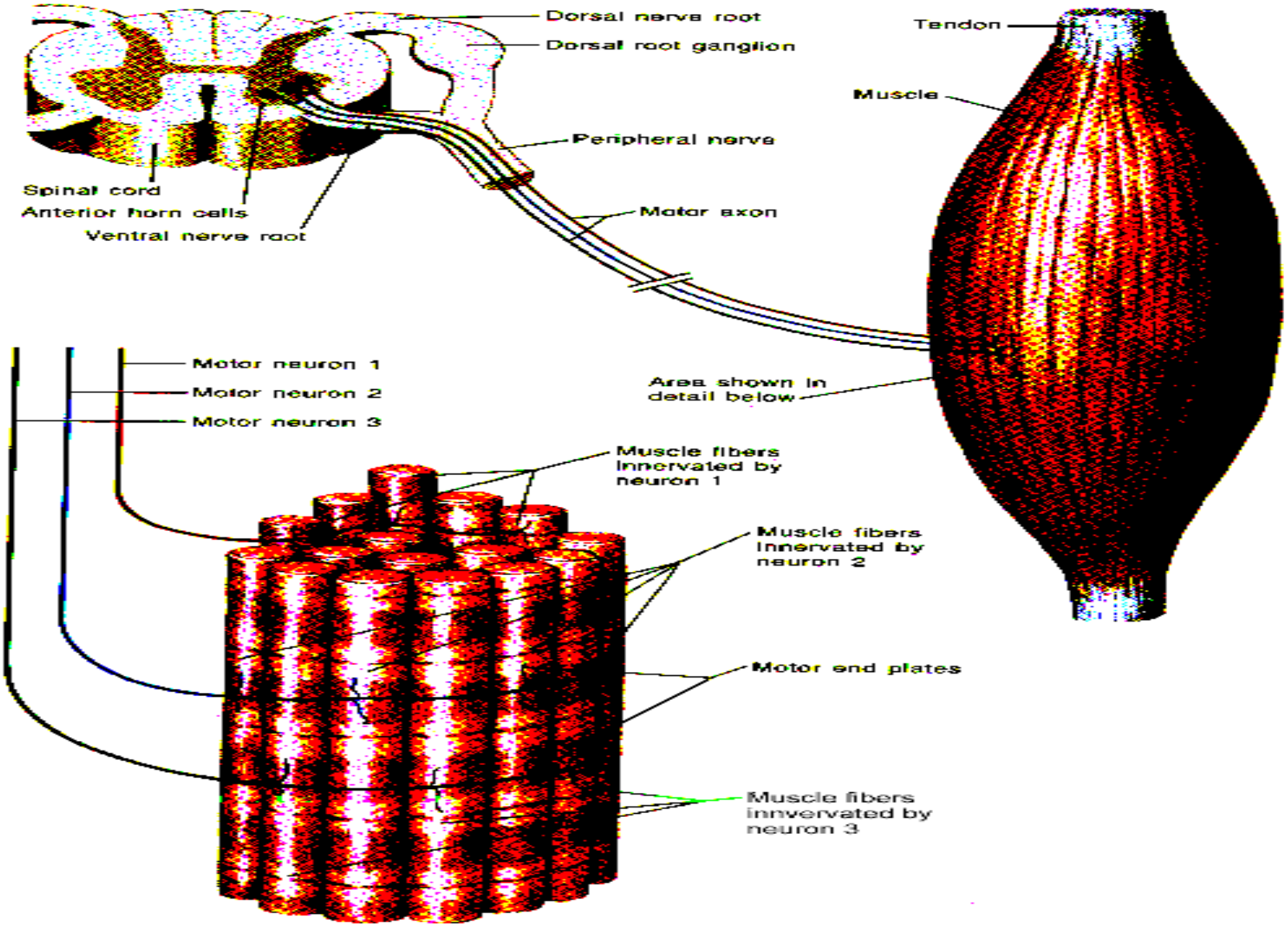
- Luigi Galvani – 1791
- EMG
  - Clinical EMG
  - Kinesiology EMG

MOTOR UNIT

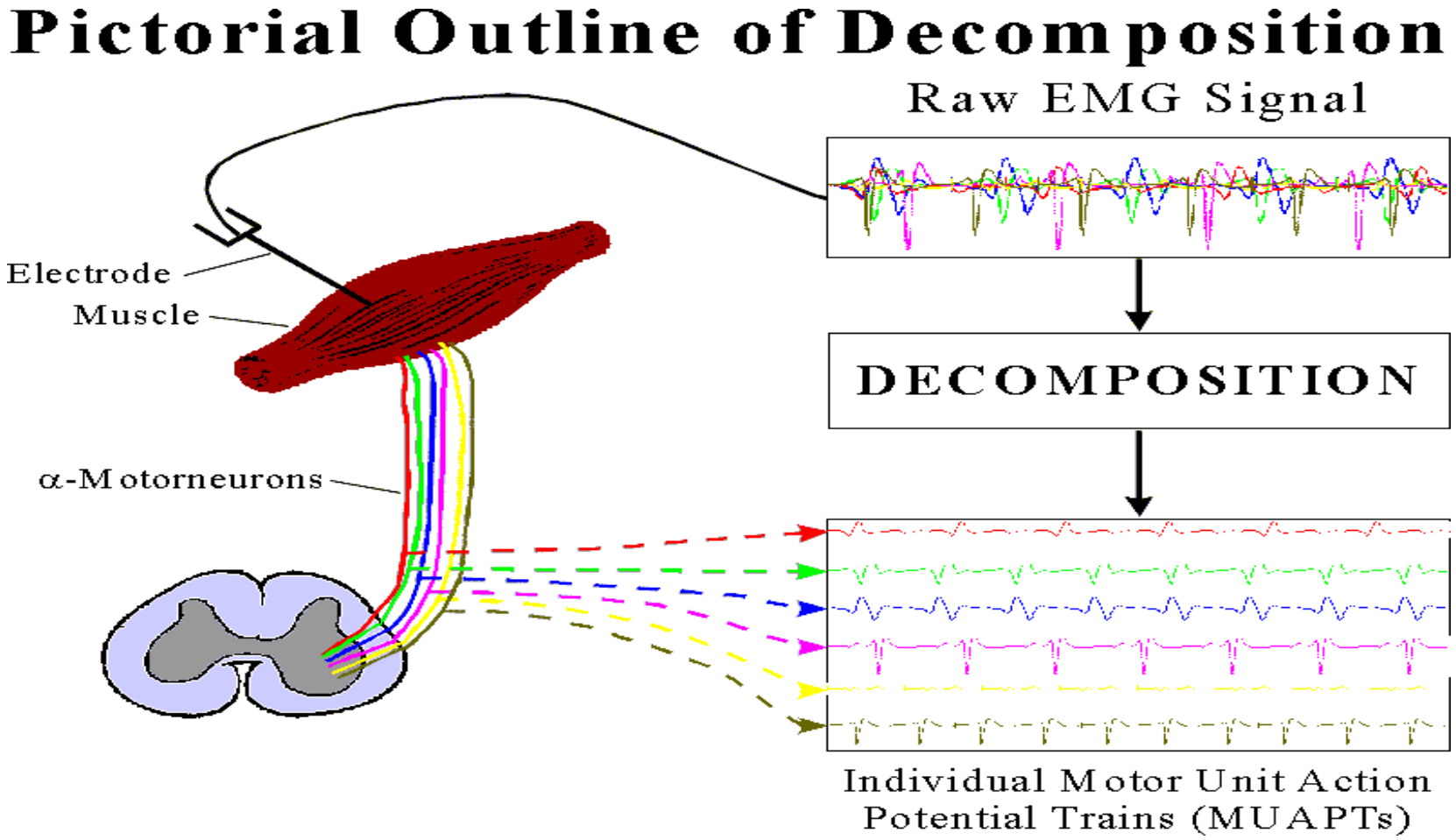

motor neuron in the spinal cord
peripheral nerve
muscle fibers

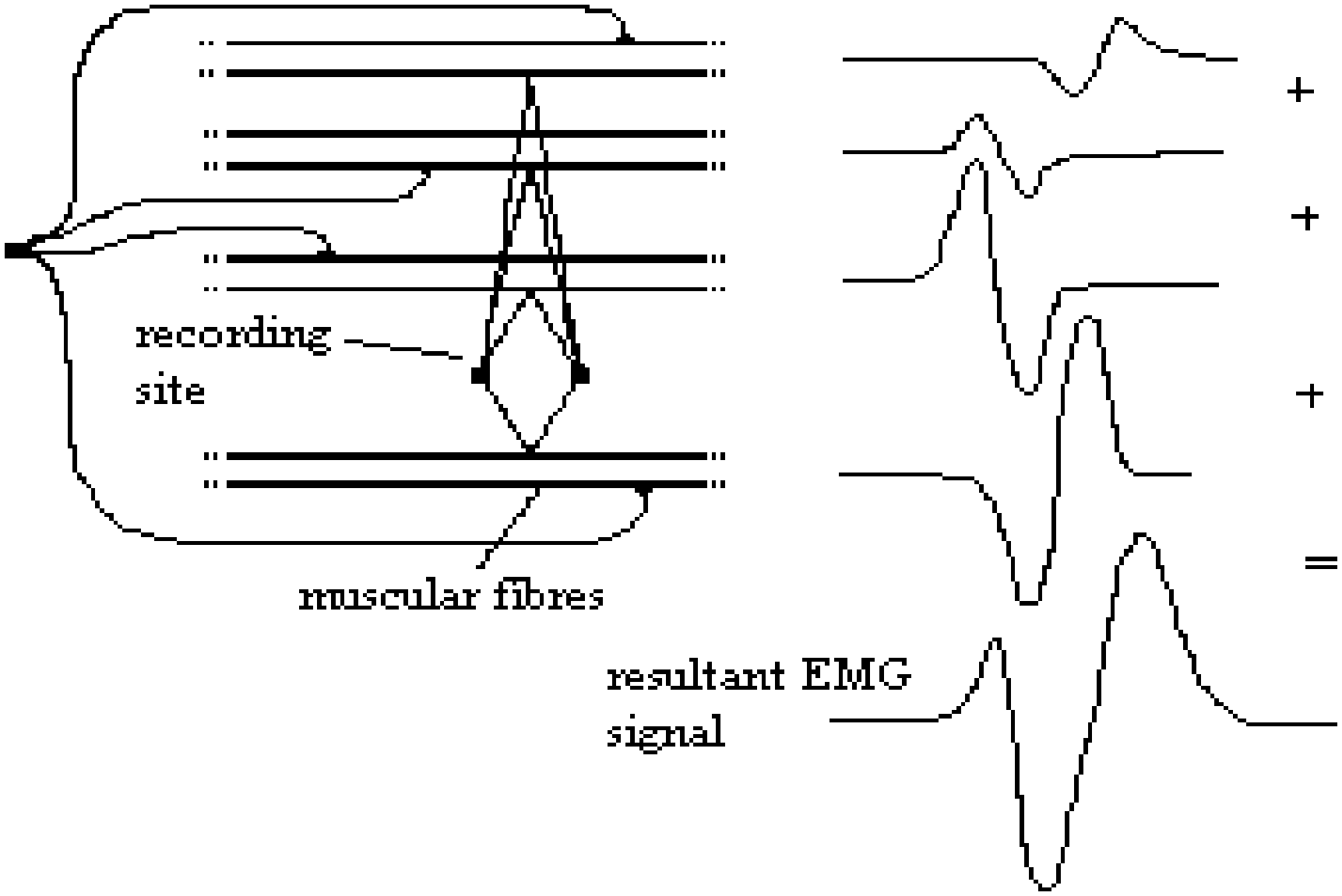
SIZE PRINCIPLE

- The muscle contraction depends on the “size principle”
- It states that “the motor neurons are recruited in order of size from small to large”


Dorsal nerve root
Dorsal root ganglion
Peripheral nerve
Spinal cord
Anterior horn cells
Ventral nerve root
Motor axon
Tendon
Muscle
Area shown in detail below
Motor neuron 1
Motor neuron 2
Motor neuron 3
Muscle fibers innervated by neuron 1
Muscle fibers innervated by neuron 2
Motor end plates
Muscle fibers innervated by neuron 3

MOTOR UNIT ACTION POTENTIAL



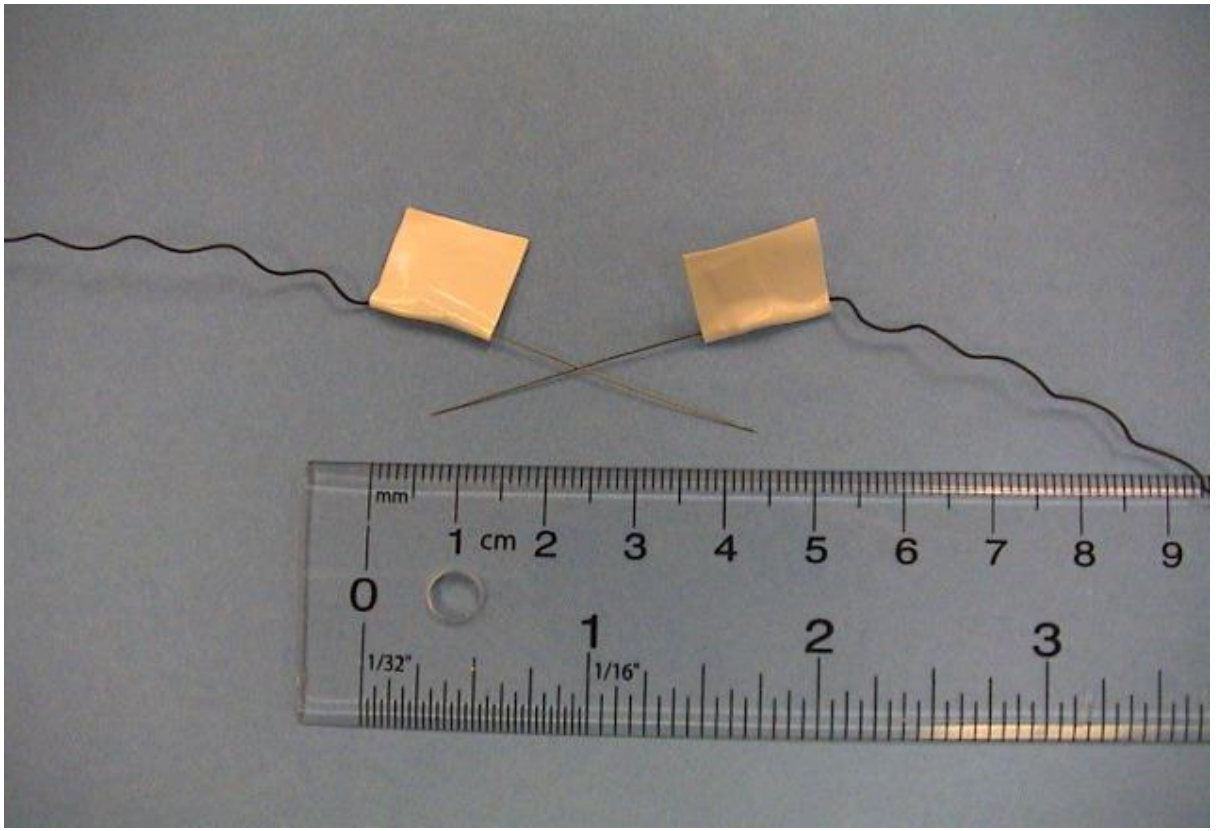

recording
site
muscular fibres
+
+
+
=
resultant EMG
signal

- Recording an EMG includes 3 phases system
- Input phase
- Processor phase
- Output phase

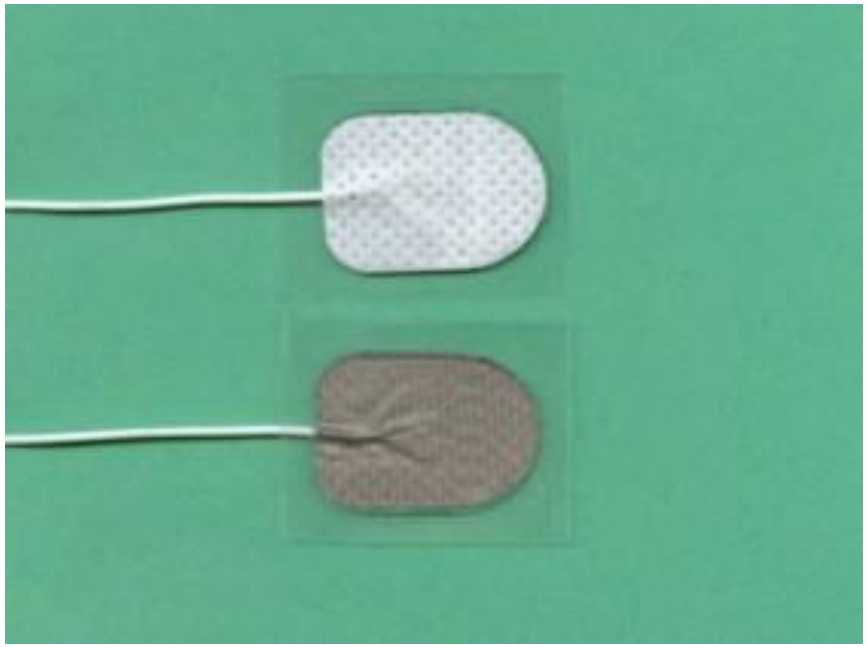
INSTRUMENTATION

- ELECTRODES
- Surface electrodes
- Needle electrodes
- Fine wire indwelling electrodes

FINE WIRE INDWELLING ELECTRODE



SURFACE ELECTRODES



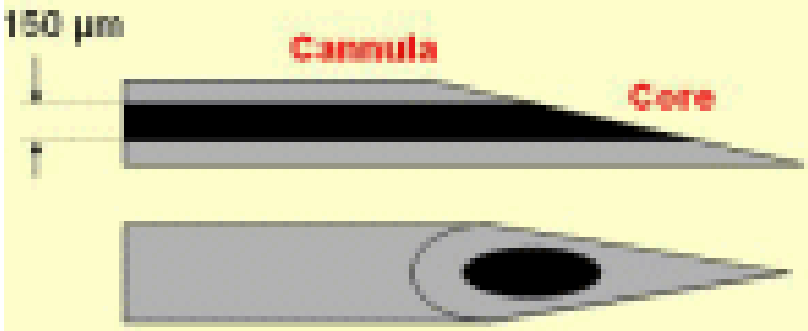
NEEDLE ELECTRODES

- CONCENTRIC NE
- MONOPOLAR NE
- SINGLE FIBRE NE
- MACRO NE

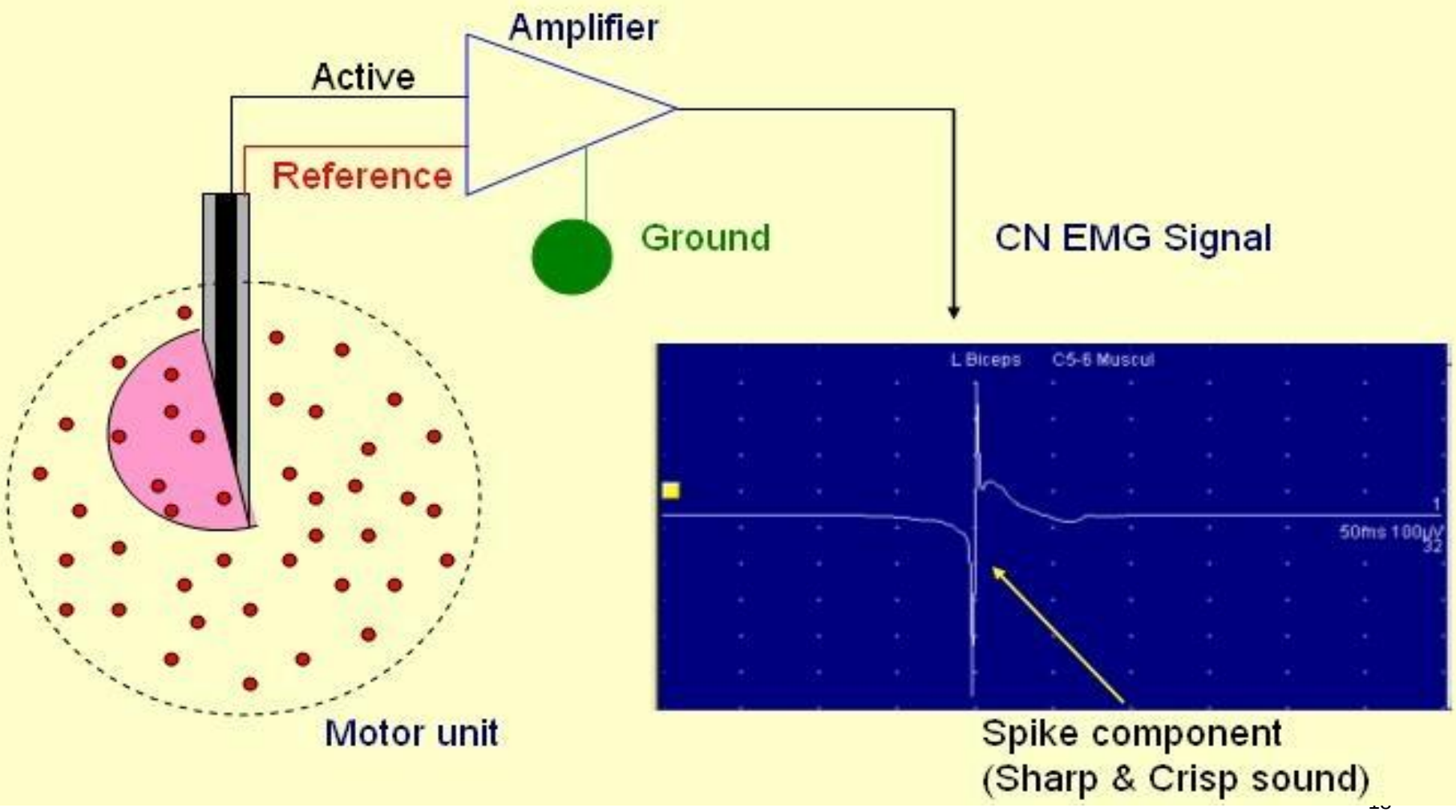
3 ELECTRODES ARE USED

- ACTIVE ELECTRODE
- REFERENCE ELECTRODE
- GROUND ELECTRODE

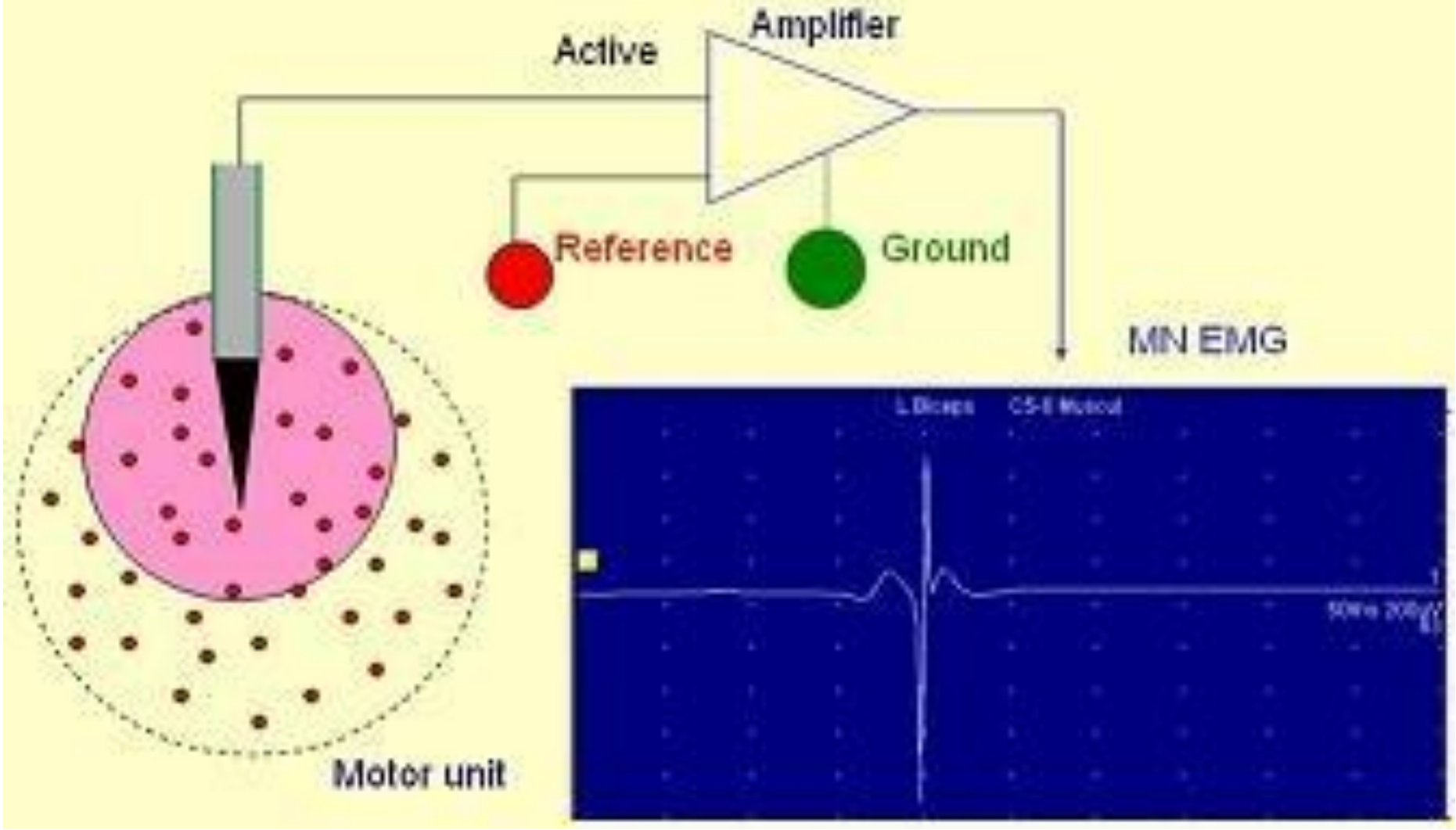
Concentric Needle Electrode

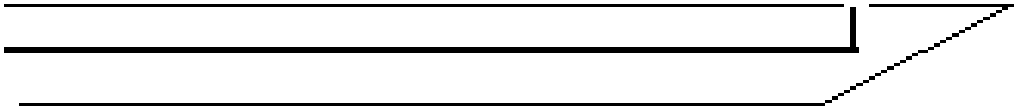


Concentric Needle Electrode



Monopolar Needle Electrode





AMPLIFYING THE EMG SIGNAL

- Amplifier- converts the electrical potential seen by electrodes to a voltage signal large enough to be displayed

- Differential amplifier-Rejects common mode voltages which appear between both input terminals and common grounds

- Common mode rejection ratio- It is a measure of how much the desired signal voltage is amplified relative to the unwanted signal

- Signal-to-noise ratio- It is the ratio of the wanted signal to unwanted signal
- Gain- Ratio of output signal level to input level. A higher gain will make a smaller signal appear larger on the display

Input impedence-

It is a resistive property, opposing current flow , which occurs in alternating current circuits.

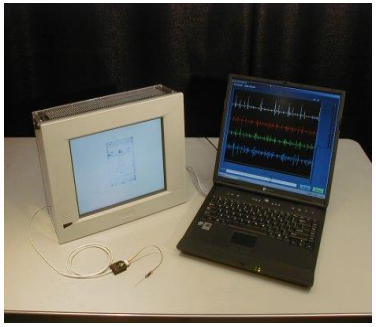
Affected by-

- ✓ Electrode material
- ✓ Electrode size
- ✓ Length of the leads
- ✓ Electrolyte

- Frequency bandwidth- Bandwidth is the difference between highest and lowest frequency that will be processed.
- ✓ Amplifier must be able to respond to signals between 10 and 10000 Hz

Displaying the EMG signal

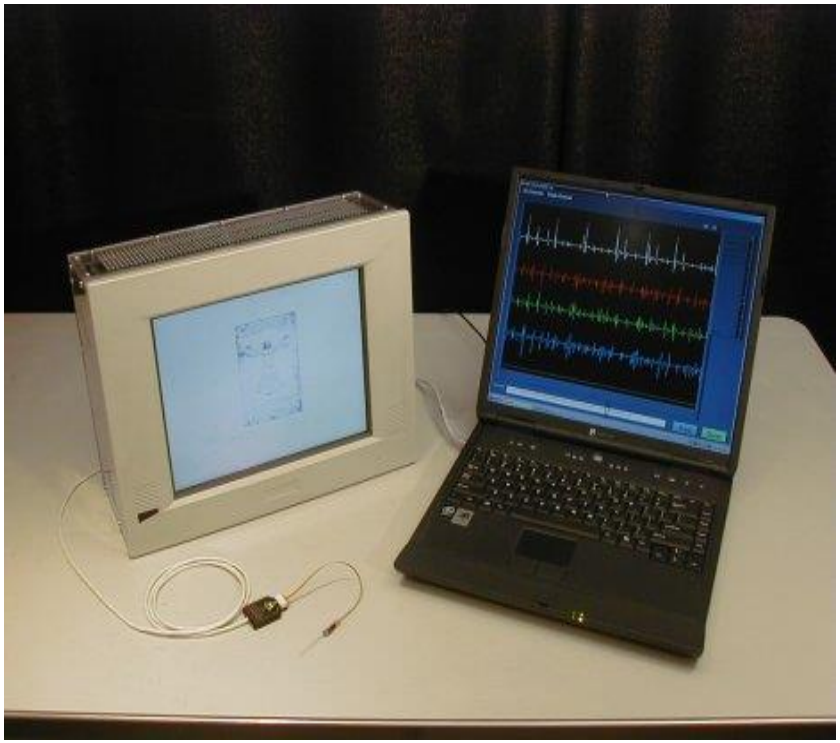
- The form of output used is dependent on the type of information desired and instrument available



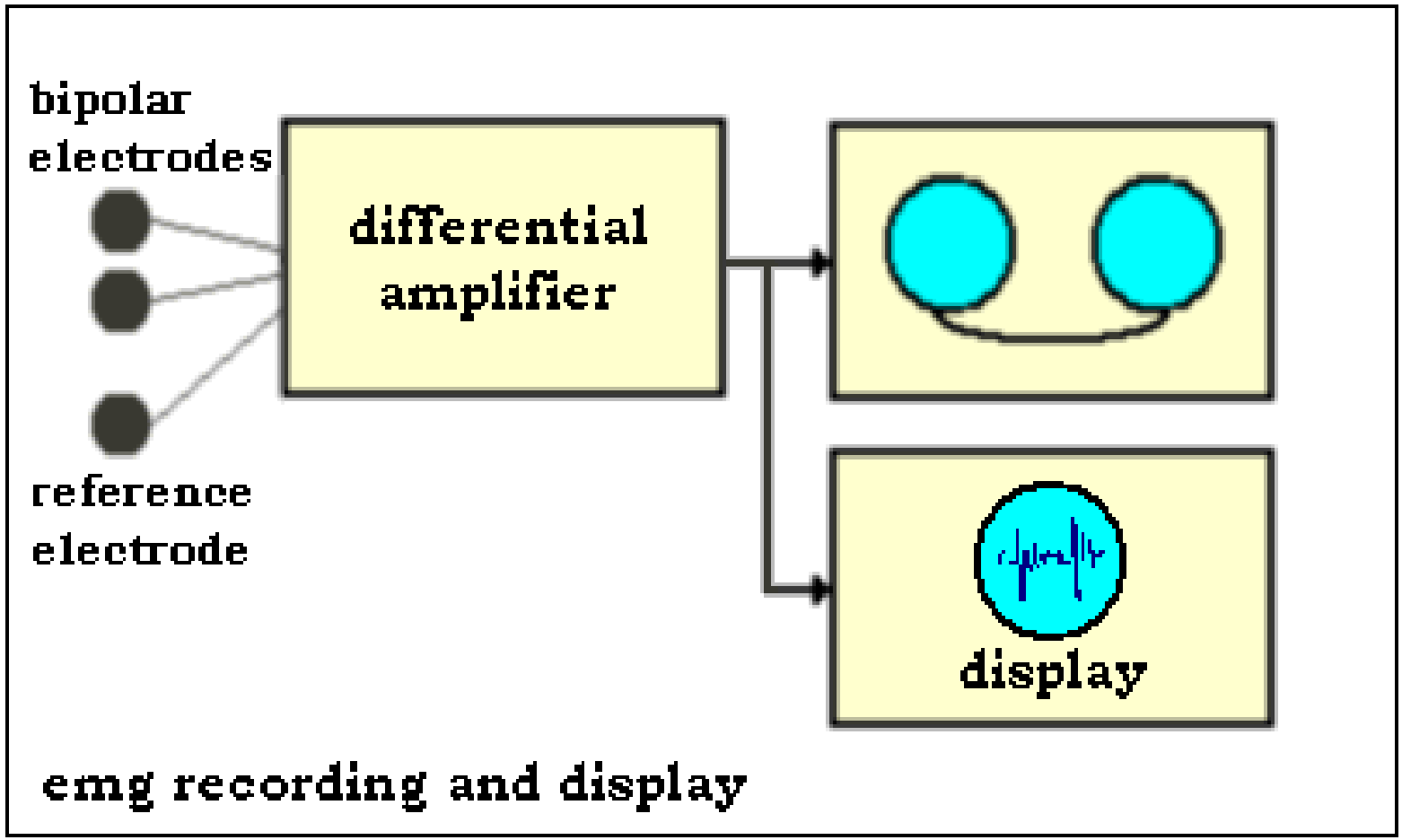
WAVEFORM DISPLAY

- 2 forms are used

1. Analog oscilloscope display
2. Computer based digital video display



EMG- RECORDING & DISPLAY



FACTORS AFFECTING OUTCOME OF RECORDING

- Age of the patients
- Properties of the muscle under study
- Limb temperature
- Electrical specifications of the needle electrodes and the recording apparatus. e.g. filter settings

INDICATIONS

- Neurogenic disorders
- Neuromuscular junction disorders
- Myogenic disorders
- Metabolic disorders

CONTRAINDICATIONS

- Recurrent systemic infections
- Bleeding disorders – hemophilia, thrombocytopenia, patient on anticoagulant therapy
- Localized inflammation
- Skin lesions

- ↑serum creatinine kinase level- repeated examination causing inflammation and focal myopathic changes.
- Transient bacterimia following needle examination may lead to endocarditic in patients with valvular disease or prosthetic valves.

ELECTROMYOGRAPHY EXAMINATION

Select the muscle

↓

Locate the needle insertion point

↓

Insert the needle quickly in a relaxed state

↓

Patient briefly activates the muscle to confirm the placement

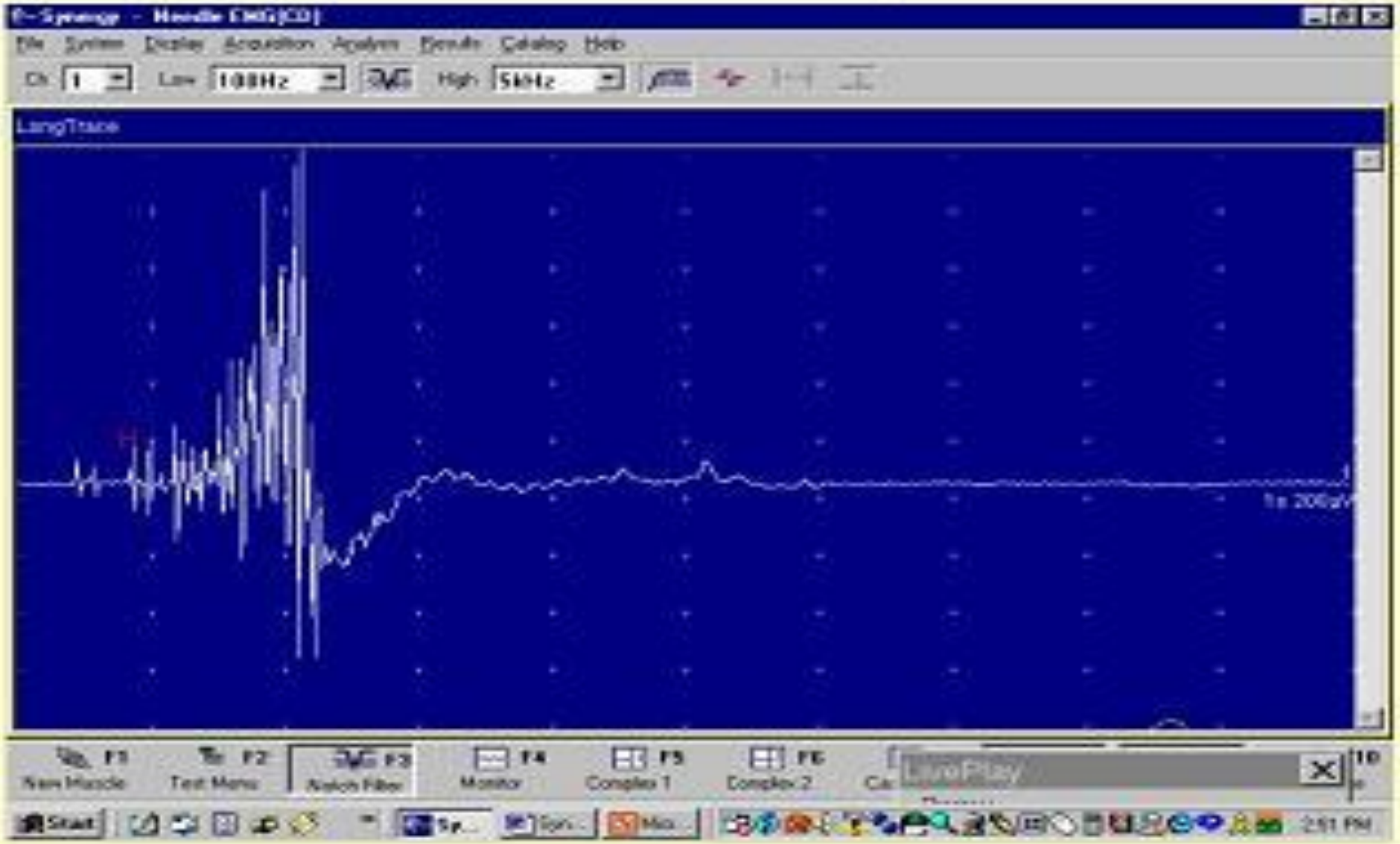
ACTIVITIES

- Insertional Activity
- Spontaneous Activity
- Minimal Volitional Activity
- Maximal Volitional Activity

INSERTIONAL ACTIVITY

- It is the measure of muscle excitability.
- Spontaneous burst of potentials (muscle fibre depolarization) usually lasting less than 300ms after needle movement ceases.
- Positive and negative high frequency spikes in a cluster are seen.

Insertional Activity



SPONTANEOUS ACTIVITY

- MINIATURE END PLATE POTENTIALS(MEPP): End plate noise
- END PLATE SPIKES- Nerve potentials

ABNORMAL SPONTANEOUS ACTIVITY

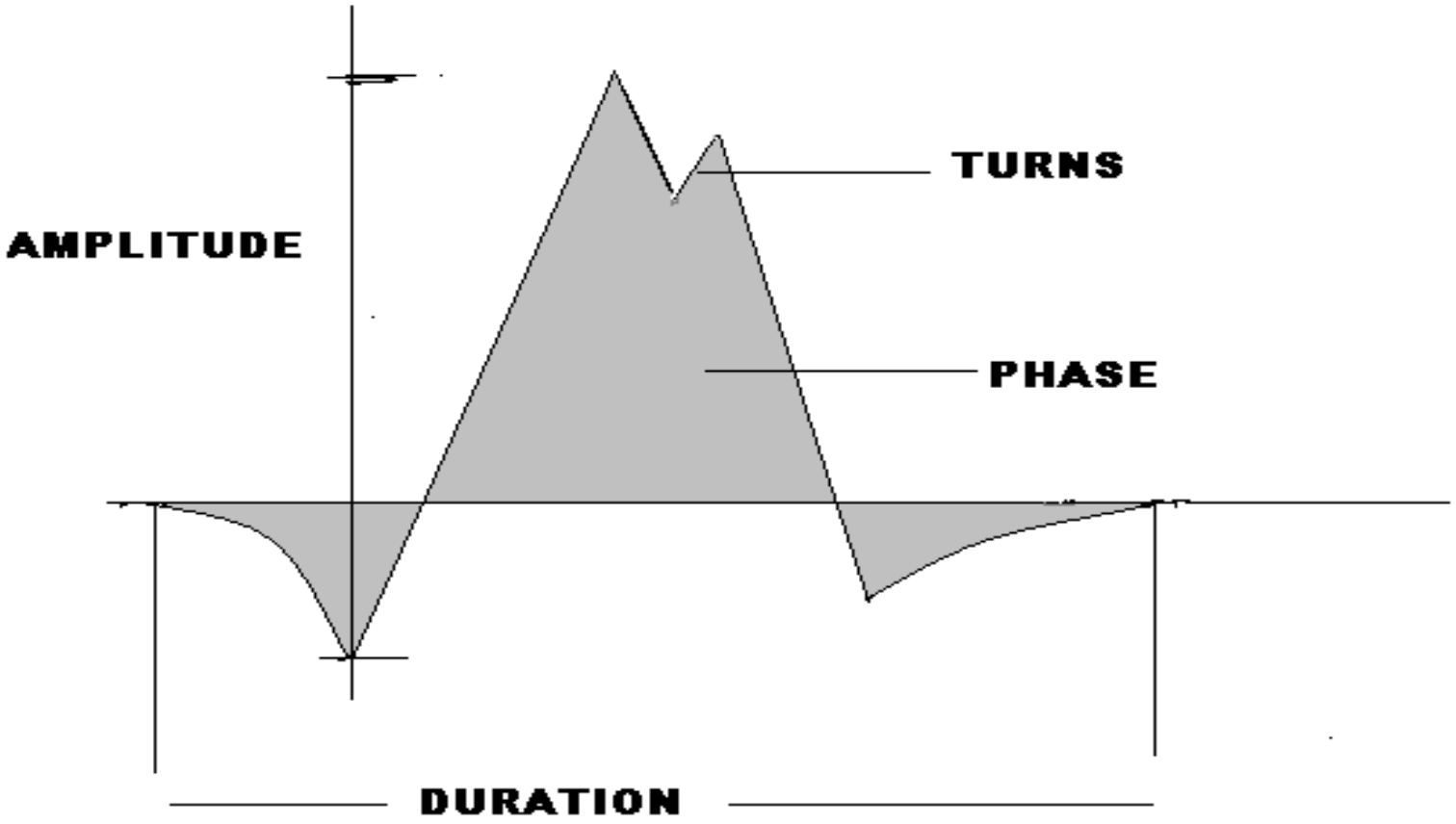
- FIBRILATION POTENTIAL
- POSITIVE WAVES
- COMPLEX REPETITIVE DISCHARGES
- MYOTONIC DISCHARGES
- FASCICULATION

- MYOKYMIC DISCHARGES
- CRAMPS
- NEUROMYOTONIA

MINIMAL VOLITIONAL ACTIVITY

- Motor unit action potential- voluntary contraction
- Recruitment

MOTOR UNIT ACTION POTENTIAL



PHYSIOLOGIC FACTORS

- Age
- Inherent properties of motor unit itself
- Spatial relationship between the needle and the individual muscle fibres
- Resistance and capacitance of intervening tissues
- Intramuscular temperature

NON PHYSIOLOGIC FACTORS

- Type of needle electrode
- Size of the recording surface
- Electrical properties of the amplifier
- Choice of oscilloscope sensitivity
- Sweep or filters
- Methods of storage and display

MUAPs

- Morphology -Amplitude, duration, phase, initial deflection
- Stability
- Firing characteristic

AMPLITUDE

- It is measured from peak to peak .
- 100μV-2mV
- It is determined by
  - Primarily by limited number of fibres located close to the electrode tip.
  - Size and density of the muscle fibre
  - Synchrony of firing .

- Age of the subject
- Muscle examined
- Muscle temperature-Decreasing muscle temperature results in higher amplitude and longer duration of MUPs

DURATION

- Measured from initial take off to the point of return to the baseline.
- Usually 5-15 ms
- It reflects the number of muscle fibres within a motor unit and is the most reliable measure to use when judging MUAP morphology.

- The duration of MUP is a measure of
  - Conduction
  - Length of muscle fiber
  - Membrane excitability
  - Synchrony of different muscle fibres of a motor unit

- Duration increases with age and cold temperature.

- Distal muscles have longer duration MUAPS than proximal ones .

RISE TIME OF MUP

- It is the duration from initial positive to subsequent negative peak
- Indicator of the distance of needle electrode from the muscle fibre
- <500µs is acceptable

- A greater rise time is due to resistance and capacitance of the intervening tissue which acts as high frequency filter and results in dull sound on the loudspeaker of EMG equipment. This indicates the need to reposition needle closer to the muscle fibres

PHASE OF MUP

- It is defined as the portion of MUP between departure and return to the baseline.i.e no. of baseline crossings +1.
- Typical shape of an MUAP is diphasic or triphasic.

- A MUP more than 4 phases is called as polyphasic.
- The normal MU will fire up to 15/sec with strong contraction.

SATTELITE POTENTIAL

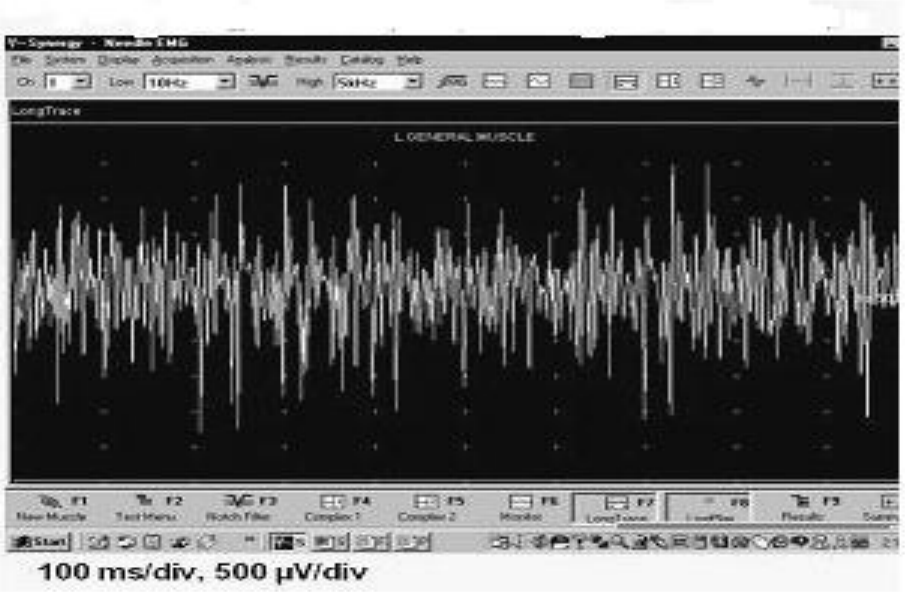
- They are the late potentials which are time locked to the main motor unit potential.
- The satellite potential is generated by a muscle fibre in a motor unit with a long nerve terminal, narrow diameter or distant end plate region

- Stable
- Semi-rhythmic firing pattern

MAXIMAL VOLITIONAL ACTIVITY

- Interferance Pattern

Interferance pattern



- The spike density and average amplitude of the summated response are determined by a number of factors:
  - Descending input from the cortex
  - Number of motor units capable of discharging
  - Firing frequency of each motor unit
  - Waveform of individual potentials
  - Probability of phase cancellation

VARIABILITY IN MUP

- Short duration
- Long duration
- Polyphasic
- Mixed pattern
- Doublets and multiplets

SHORT DURATION

- The short duration MUPs are those with a duration shorter than that for the muscle of corresponding age

- Usually have low amplitude and have rapid recruitment at minimal effort

- They are found in the disorders associated with loss of muscle fibres
- 2 chief pathologies are-
  - Myopathies and neuromuscular junction disorders
  - Early stage of reinnervation after nerve damage

LONG DURATION MUPS

- The duration of MUPs exceeds the normal values for the corresponding muscle & age
- Have high amplitude & poor recruitment
- Associated with increase in fibre density, loss of synchrony of firing of muscle fibre & increase in the number of muscle fibre

- Seen in
  - Motor neuron disease
  - Axonal neuropathies with collateral sprouting
  - Chronic radiculopathies
  - Neuropathies
  - Chronic myositis –polymyositis

POLYPHASIC MUP

- There is 4 or more phases in a MUP
- Seen in myopathies where there is regeneration of fibres and increased fibre density.

MIXED PATTERN

- Comprises of short ,long, polyphasic MUPs
- Found in both Myogenic and Neurogenic abnormalities

DOUBLETS OR TRIPLETS

- MUPs are fired 2 or more times at an interval of 10-30 ms
- Seen when there is hyperventilation, tetany, motor neuron disease, other metabolic diseases ischemia

CLINICAL IMPLICATIONS OF EMG

REFERANCES

PHYSICAL REHABBILITATION:
ASSESSMENT AND TREATMENT

Susan B.O’sullivan

CLINICAL NEUROPHYSIOLOGY

UK Mishra

DIAGNOSTIC TESTING IN NEUROLOGY

Randolph W. Evans

ELECTRODIAGNOSTIC TESTING

Kimura

EMG-BIOFEEDBACK

DEFINITION

- A technique of using equipment (usually electronic) to reveal human beings some of their internal psychological events, normal and abnormal, in the form of visual and auditory signals in order to teach them to manipulate these otherwise involuntary or unfelt events by manipulating the displayed signals.

  John V.Basmajian

OBJECTIVES AND GOAL

- TO IMPROVE MOTOR PERFORMANCE BY FACILITATING MOTOR LEARNING

PRINCIPLES OF MOTOR LEARNING

MOTOR LEARNING

- SCHIMDT defined it as “a set of processes associated with practice or experiences leading to relatively permanent changes in the capacity for responding”

- Four primary factors that influence motor learning are

1. Stage of learner
2. Type of the task
3. Feedback
4. Practice

TYPES OF FEEDBACK

- INTRINSIC FEEDBACK
- EXTRINSIC FEEDBACK-

1. KNOWLEDGE OF RESULTS
2. KNOWLEDGE OF PERFORMANCE

EQUIPMENTS USED

- The basic EMG biofeedback device includes one ground and two surface electrodes, an amplifier, an audio speaker and a video display.

The quality of the machine and its output are chiefly governed by

- Electrodes used
- Input impedance
- Common mode rejection ratio
- Bandwidth
- Gain
- Noise level
- Ability to cope with non EMG artifacts

TECHNICAL LIMITATIONS

- RELEVANCY
- ACCURACY
- RAPID TO ENHANCE MOTOR LEARNING

BIOFEEDBACK IN REHABILITATION

When using the biofeedback the patient should

- Understand
- Practice
- Perform

- CLOSE LOOP
- OPEN LOOP
- SCHEDULED LOOP

Biofeedback can assist rehabilitation process by:

1. Providing a clear treatment outcome
2. Permitting the therapist and patient to experience with various strategies that generate motor patterns
3. Reinforcing appropriate motor behavior.
4. Providing a process oreinted, timely and accurate KP or KR of the patients' efforts.

CONDITIONS

- STROKE
- SPINAL CORD INJURIES
- CP AND TBI
- MULTIPLE SCLEROSIS
- DYSTONIAS AND DYSKINESIS
- PERIPHERAL NERVE DENERVATION
- PAIN MANAGEMENT

THERAPEUTIC INTERVENTION

TREATMENT SESSION

- PATIENTS FUNCTIONAL ASSESSMENT
- PROBLEM IDENTIFICATION
- THERAPEUTIC INTERVENTION

REFERANCES

PHYSICAL REHABBILITATION: ASSESSMENT AND TREATMENT

Susan B.O'sullivan

BIOFEEDBACK PRINCIPLES AND PRACTICE FOR CLINICIANS

John V. Basmajian

PHYSICAL MEDICINE AND REHABILITATION-PRINCIPLES & PRACTICE

Joel A. Delisa

THANK YOU