PHASE ANGLE: A NEW VITAL SIGN

An Index of Frailty & Survival as Measured by PrognostiCheck™

IPG: Terminology

Impedance plethysmography (IPG) is the gathering of a variety of physiologic data based upon measured electrical values of voltage drop in ohms without any mathematical or statistical manipulation.

Impedance (Z) is the overall opposition to the electrical signal which is the combined resistance and reactance/capacitance.

Resistance (R) is the measured vector of impedance that opposes and is inversely proportionate to ECW fluid volume.

Reactance/capacitance (Xc) is the measured ability of a cell membrane to act as a capacitor and 'hold' the current resulting in its lag behind voltage and is proportionate to cell mass and ICW.

Phase angle (Pa): the measured phase shift that results from the cell membranes and water encountered by an electrical signal current as it lags behind the voltage in a circuit .

Impedance Analysis

- Measured in Ohms
- Low voltage: ~800 micro amps
- Constant Current: 50 KHz
  - Harmless (without contraindications)
- Precision: $R^2 = 0.99$
- Economical
- Immediate Results

Electrical Circuit Basics

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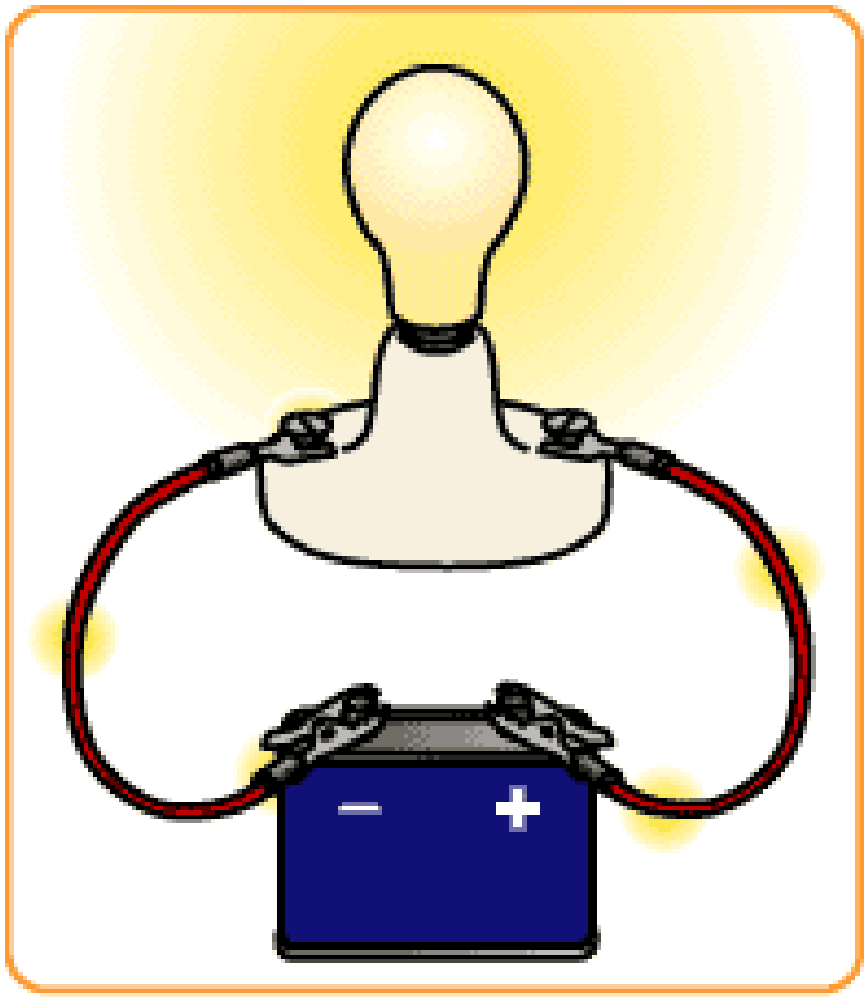

Electrical circuits involve 3 basic components:

Voltage

the force created by the separation of charges.

Resistance

is a measure of how hard it is for charges to move in the system.

Current

the movement of charges; in an electrical circuit, electrons move from the negative pole to the positive pole

PrognostiCheck™ Professional Instrument

IPG Constant Current Circuit Model: Tetrapolar Electrode Scheme

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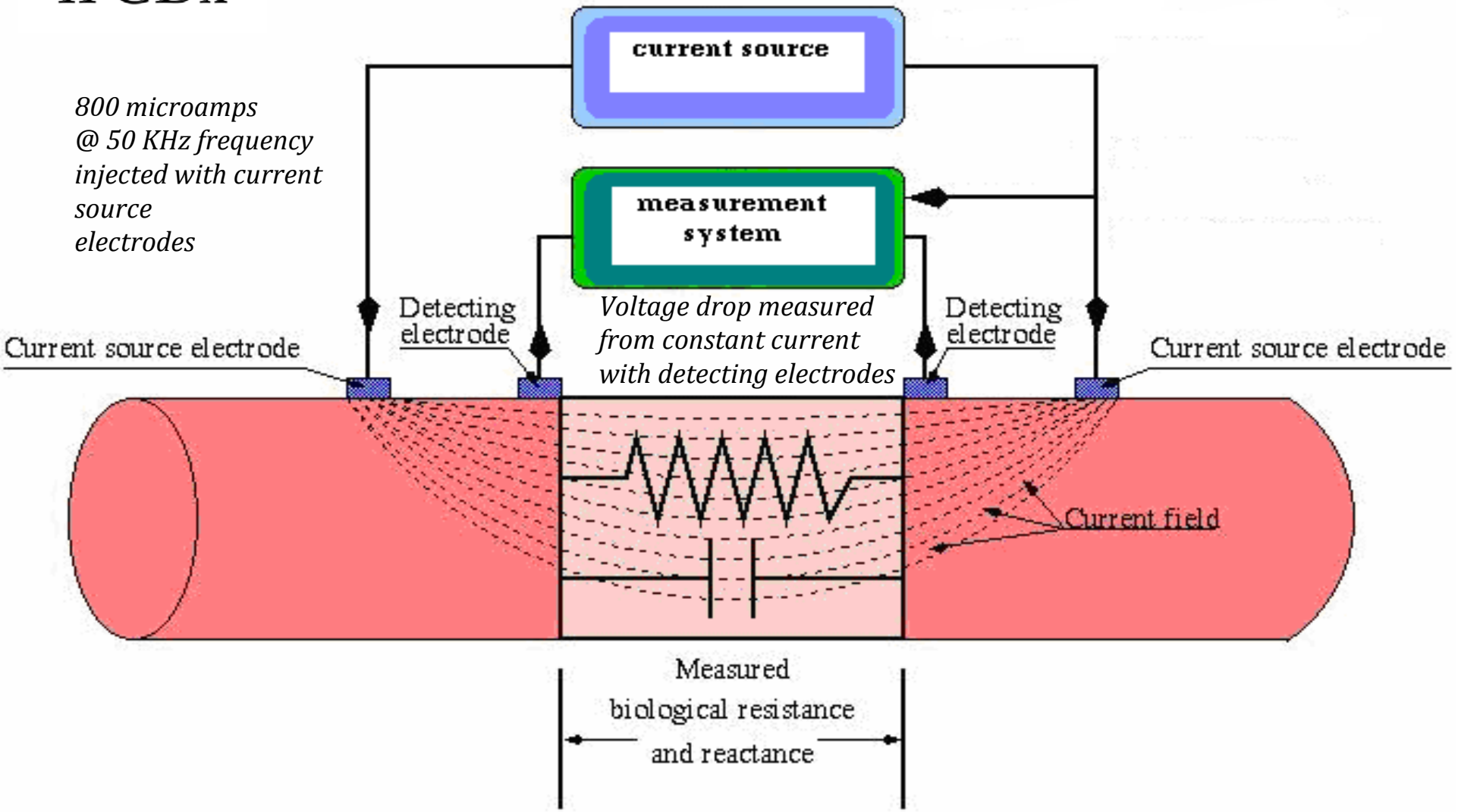
800 microamps
@ 50 KHz frequency
injected with current
source
electrodes



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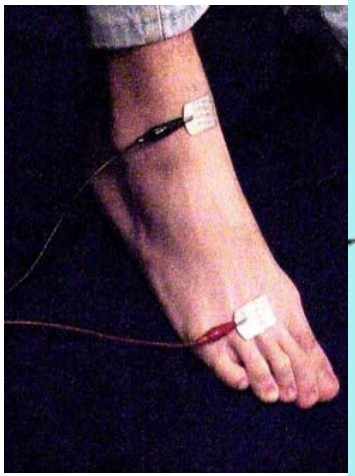
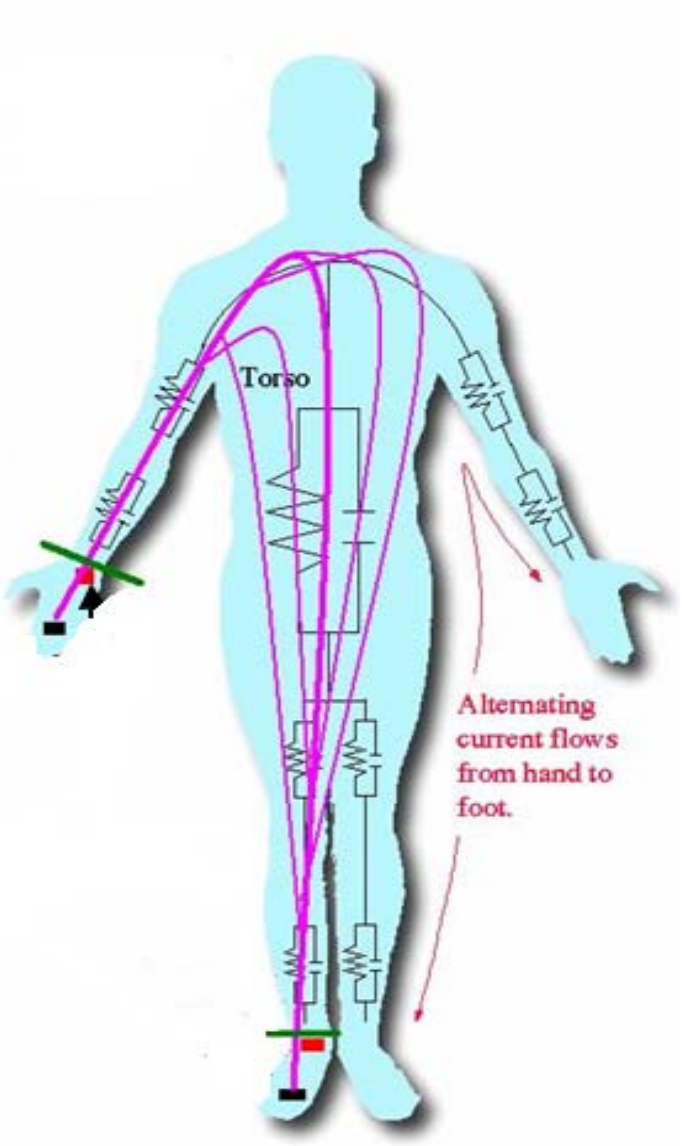
Patient Circuit Model





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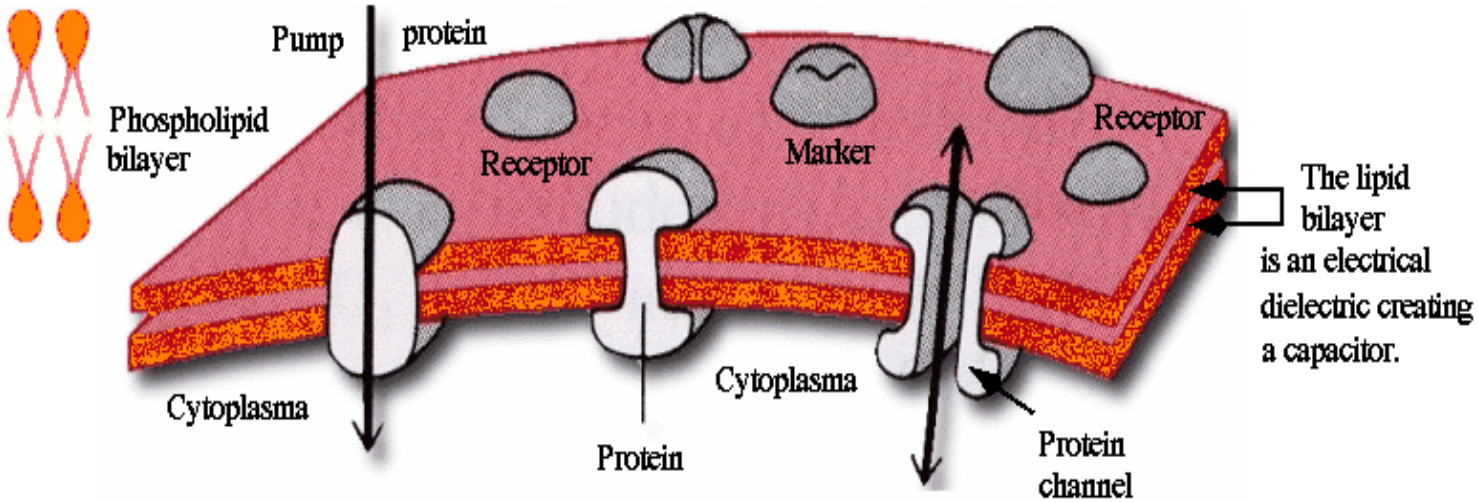
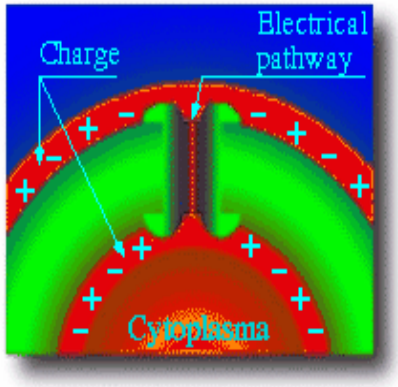
The Cell as a Capacitor





The electrical signal from a bioelectrical impedance analyzer (BIA) is leaked through the protein channel charging the inside of the cells lipid bilayer. The same charge with opposite polarity exists on the outside of the cells bilayer. This forms a capacitor that gives BIA instruments reactance values. When the cell dies reactance is reduced to zero.

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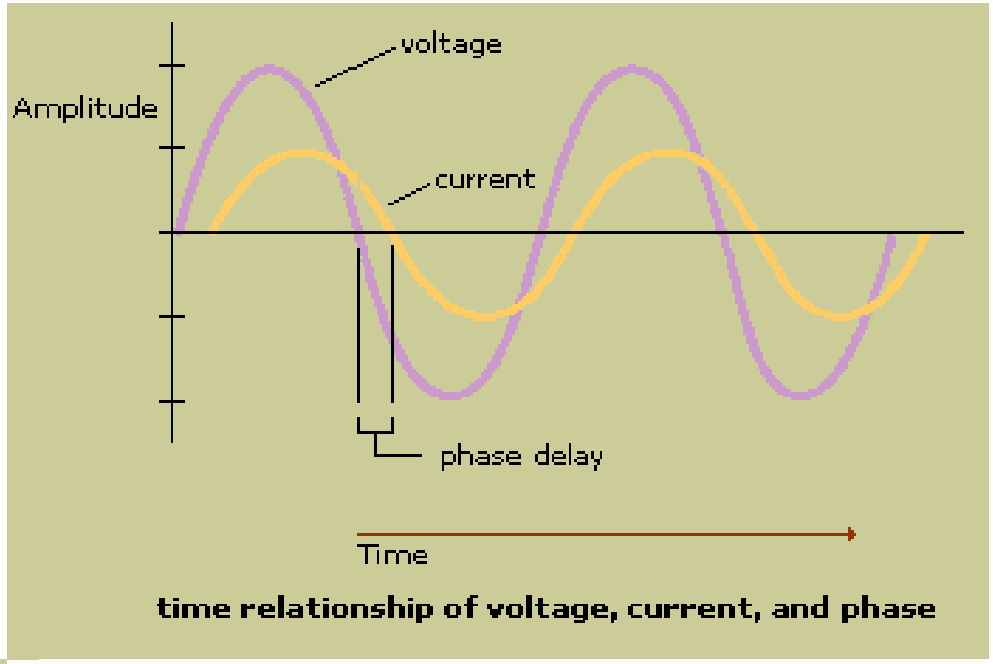
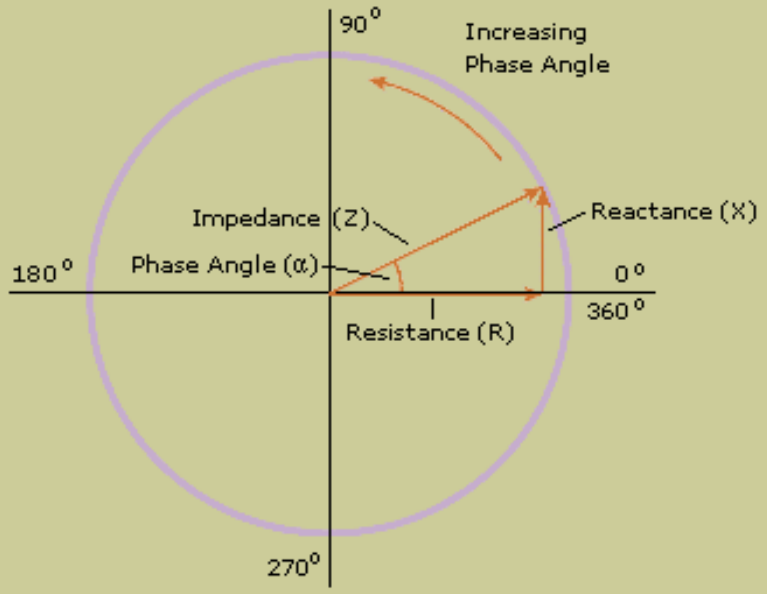
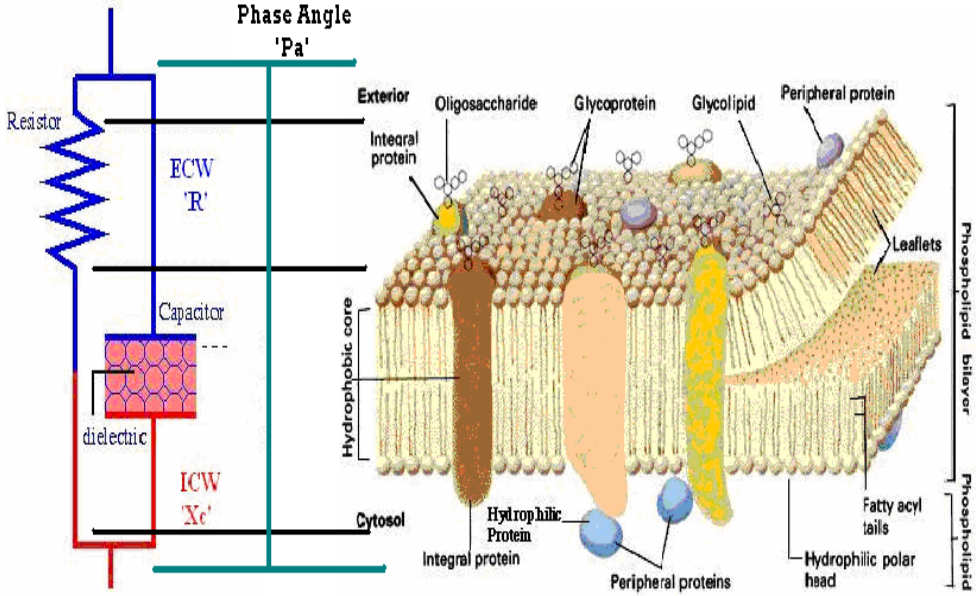


time relationship of voltage, current, and phase



polar coordinates showing relationship between impedance, resistance, reactance, and phase angle



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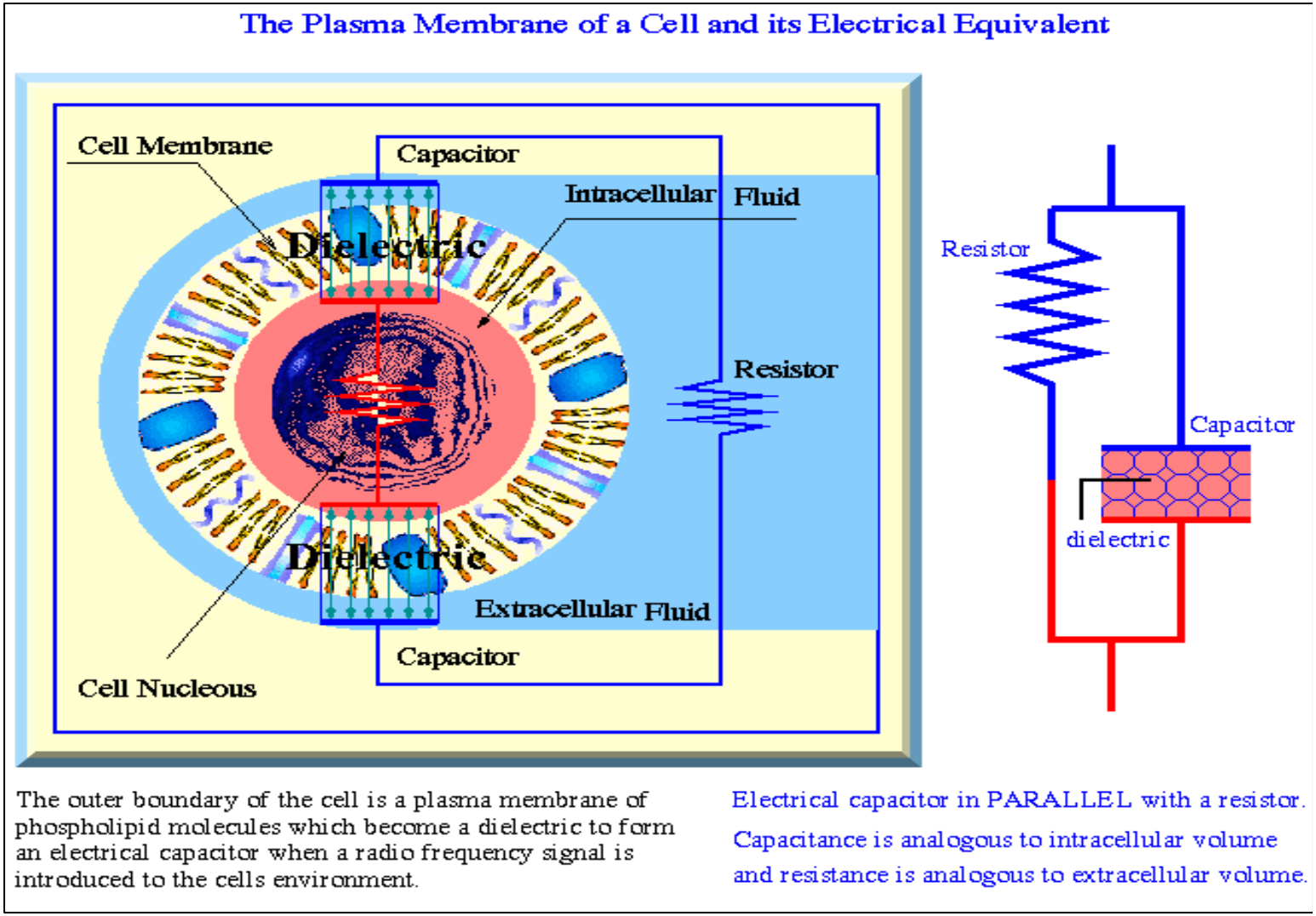
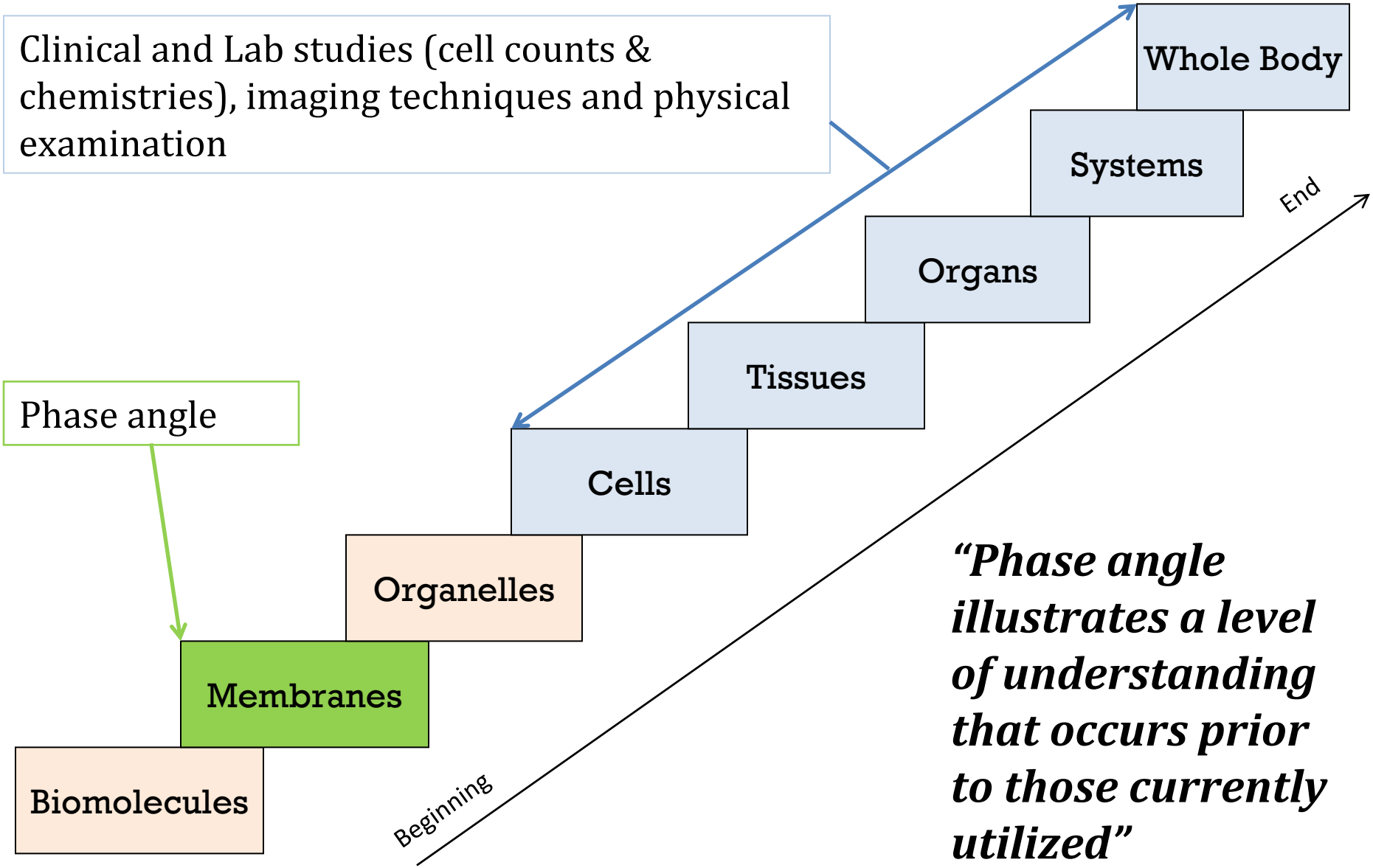
Plasma Cell Membrane



Clinical Studies and the Hierarchical Organization of the Body

Clinical and Lab studies (cell counts & chemistries), imaging techniques and physical examination



"Phase angle illustrates a level of understanding that occurs prior to those currently utilized"

Overall Health and Phase Angle Values

Phase angle illustrates the vitality of cell membranes by their ability to act as an electrical capacitor.

The ability of a patient's cell membranes to act as an electrical capacitor is proportional to their frailty and survival.

Higher phase angle values are associated with greater robustness and longer survival.

Lower phase angle values are associated with greater frailty and shorter survival.

Phase angle is related to age and gender , it is reduced with age, lower in females and on average ranges from 5° to 9° degrees.

Optimal phase angle values in females are >8° and in males >9°.

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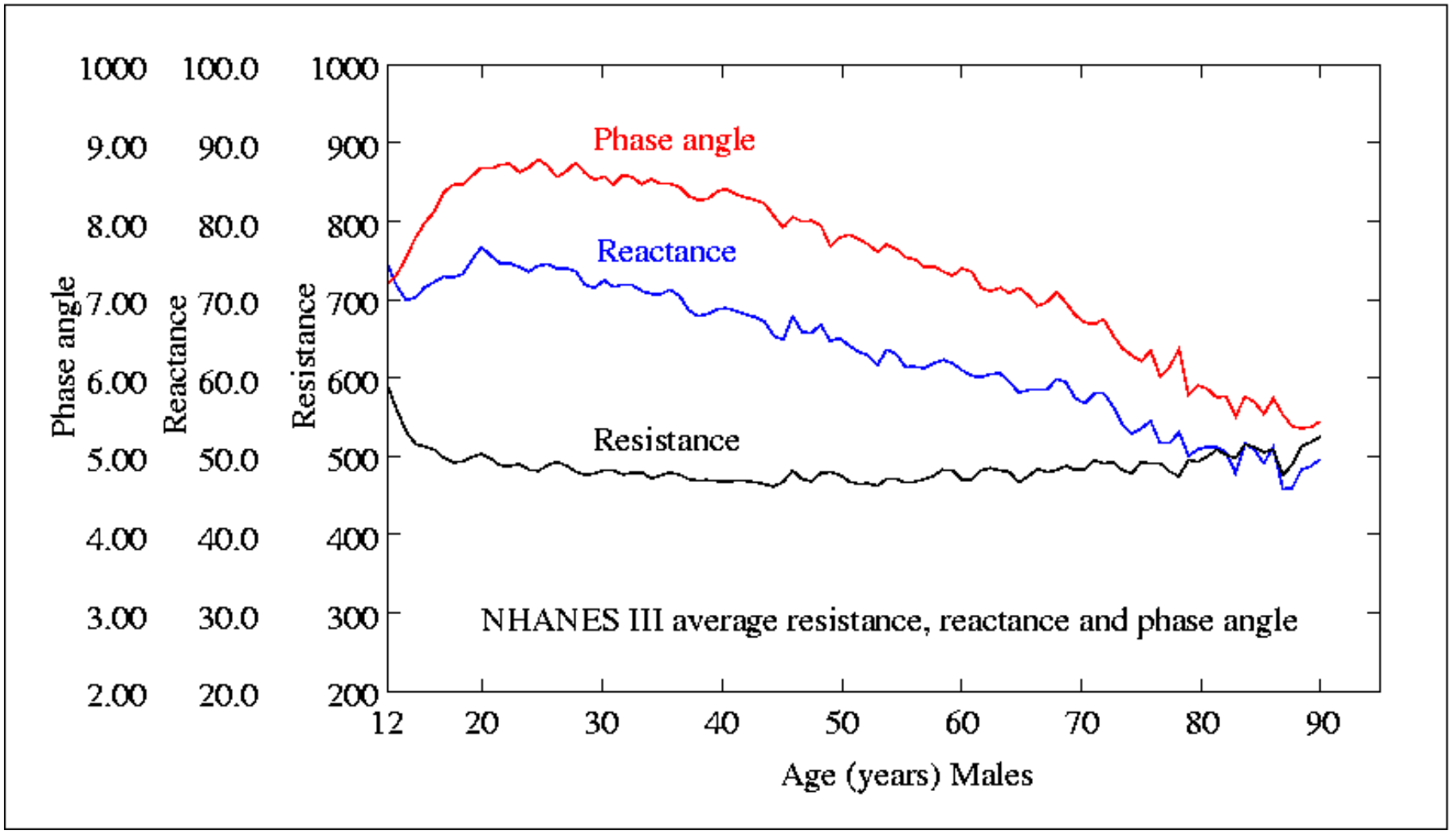
Average Impedance Values for Males



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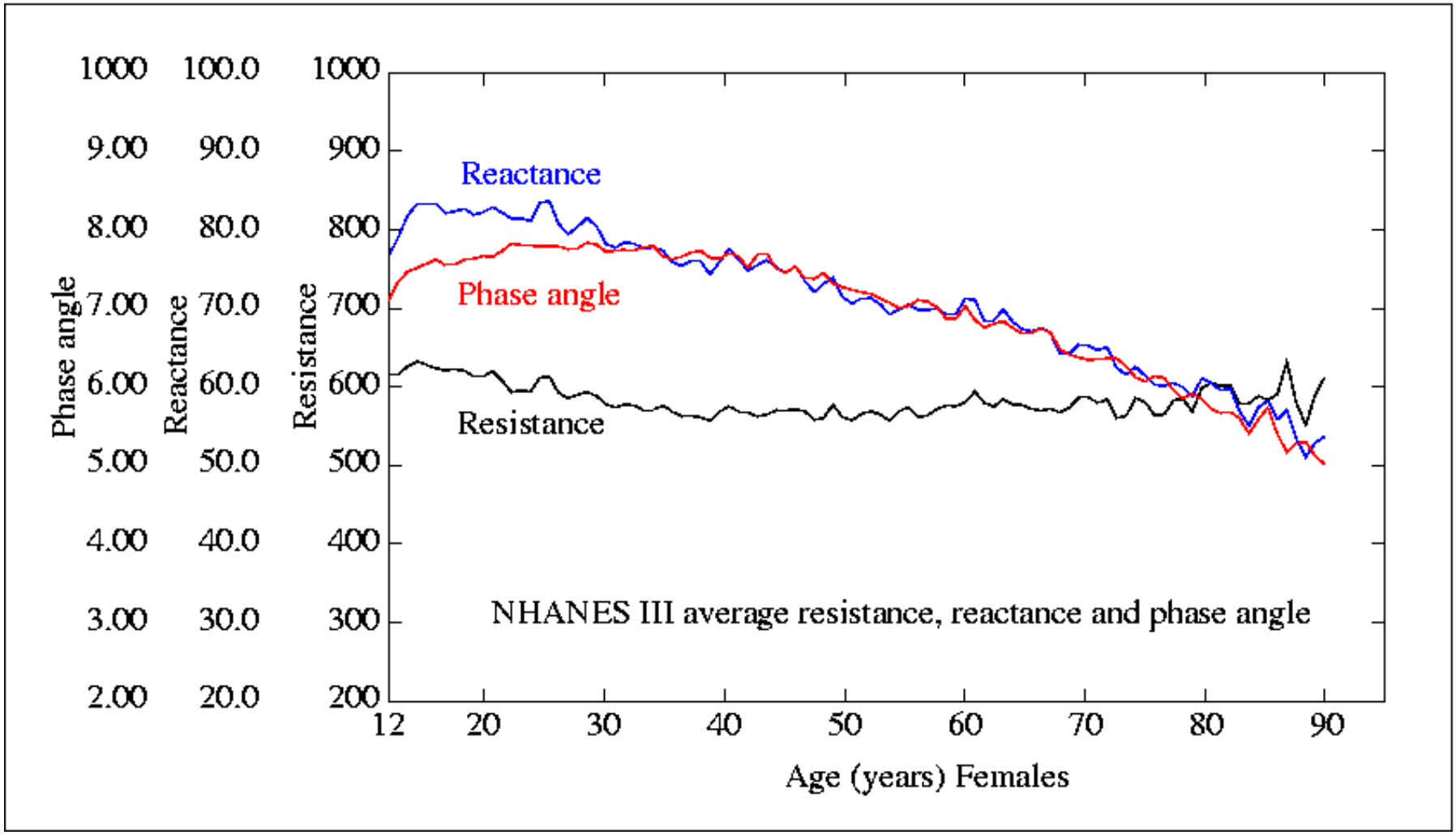
Average Impedance Values for Females



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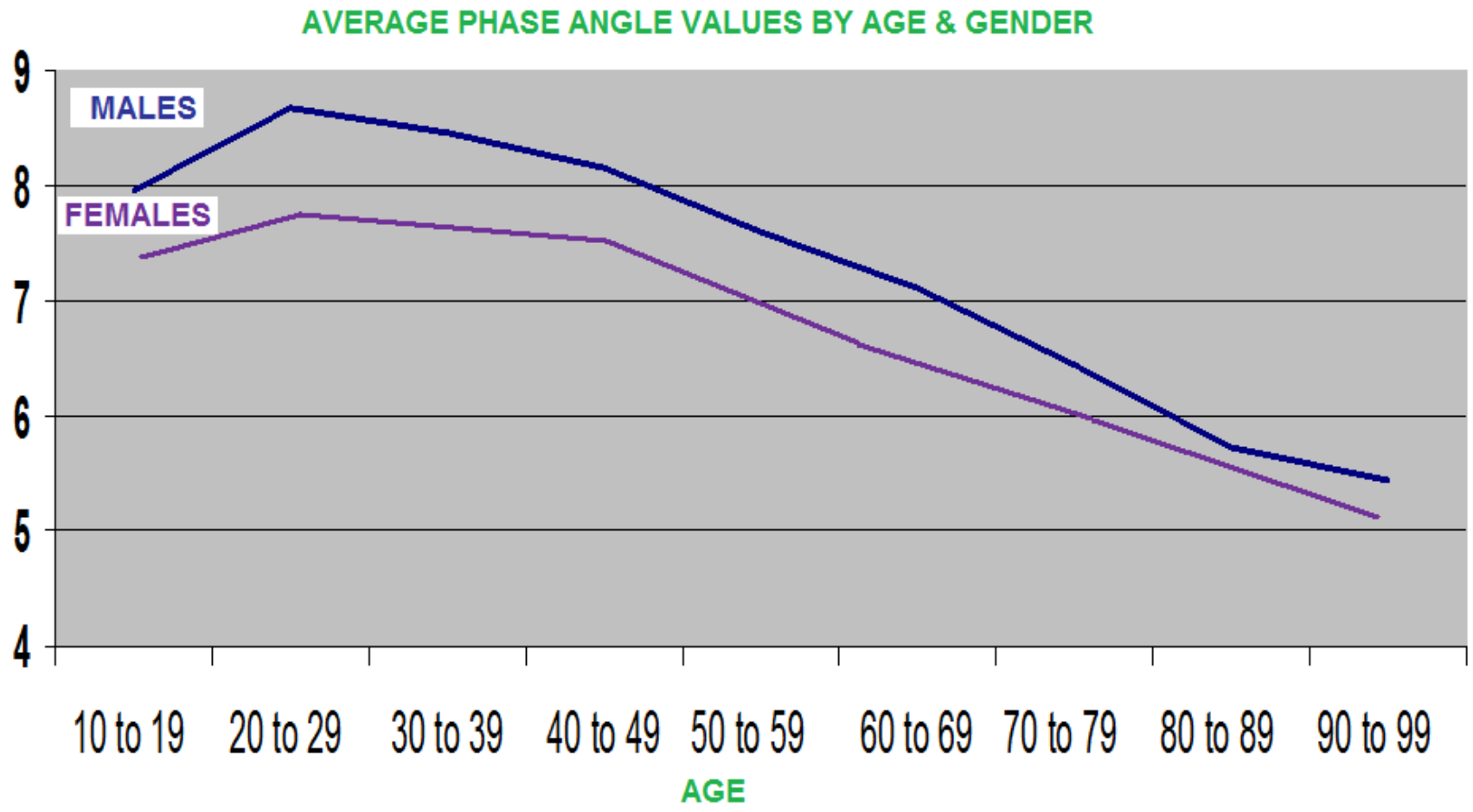
Relationship of Phase Angle Values to Age in the General Population



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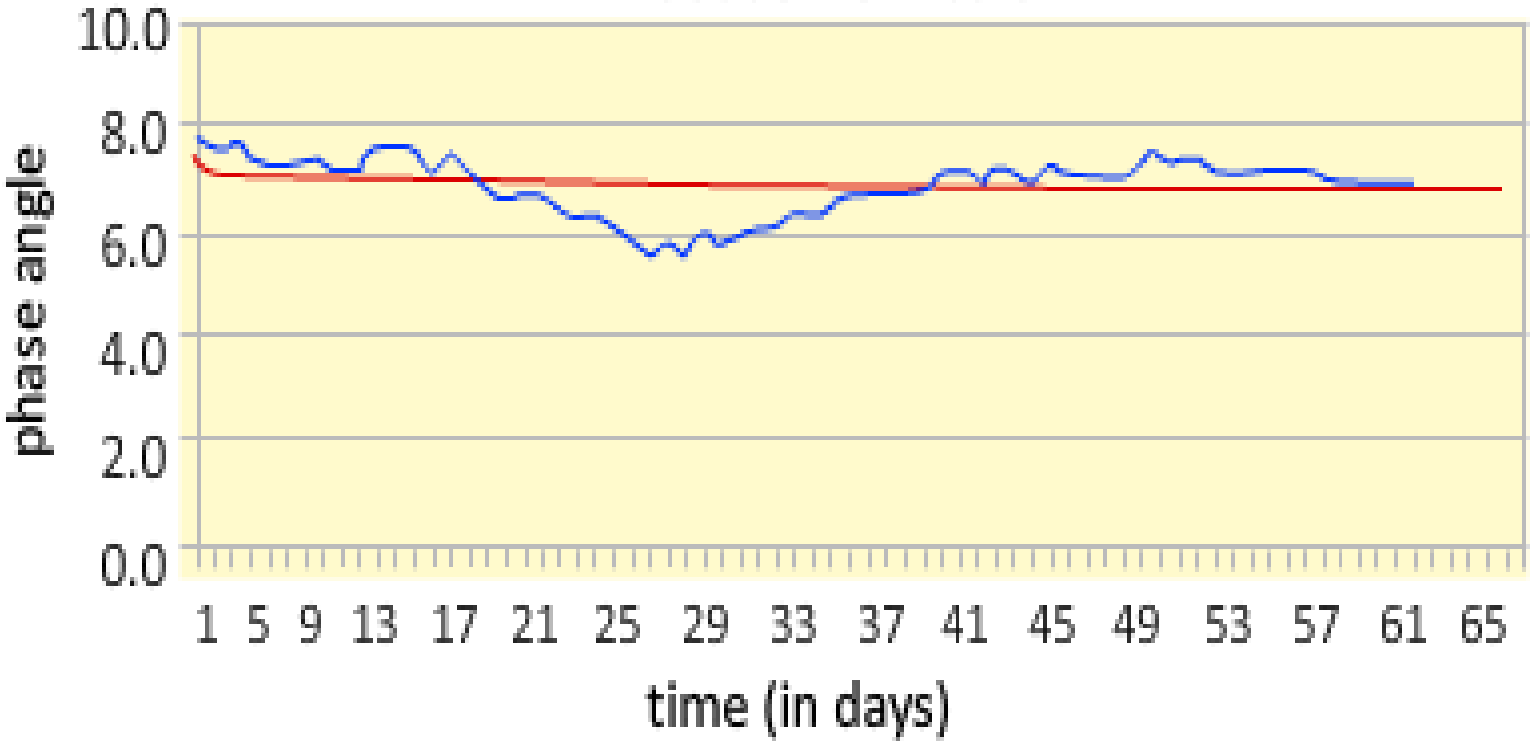
Serious Illness with Recovery Upon Effective Treatment



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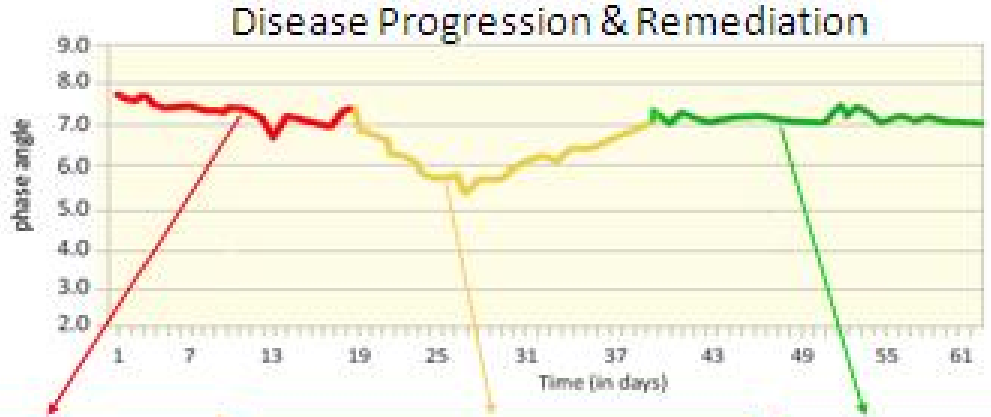
Phase Angle Response to Remediation of Disease

Disease Progression & Remediation



Slow Descent Day 1 through 19-20	Plateau Descent Day 23-31	Ascent Day 31-35 on
• Deceleration of phase angle in the individual with the disease. • Disease is progressing.	• Drug therapy has arrested the descent. and now plateaued. • Disease progression is arrested. • The effects of the drugs are beginning to be seen.	• Patient begins to feel better. • Drug therapy was successful.

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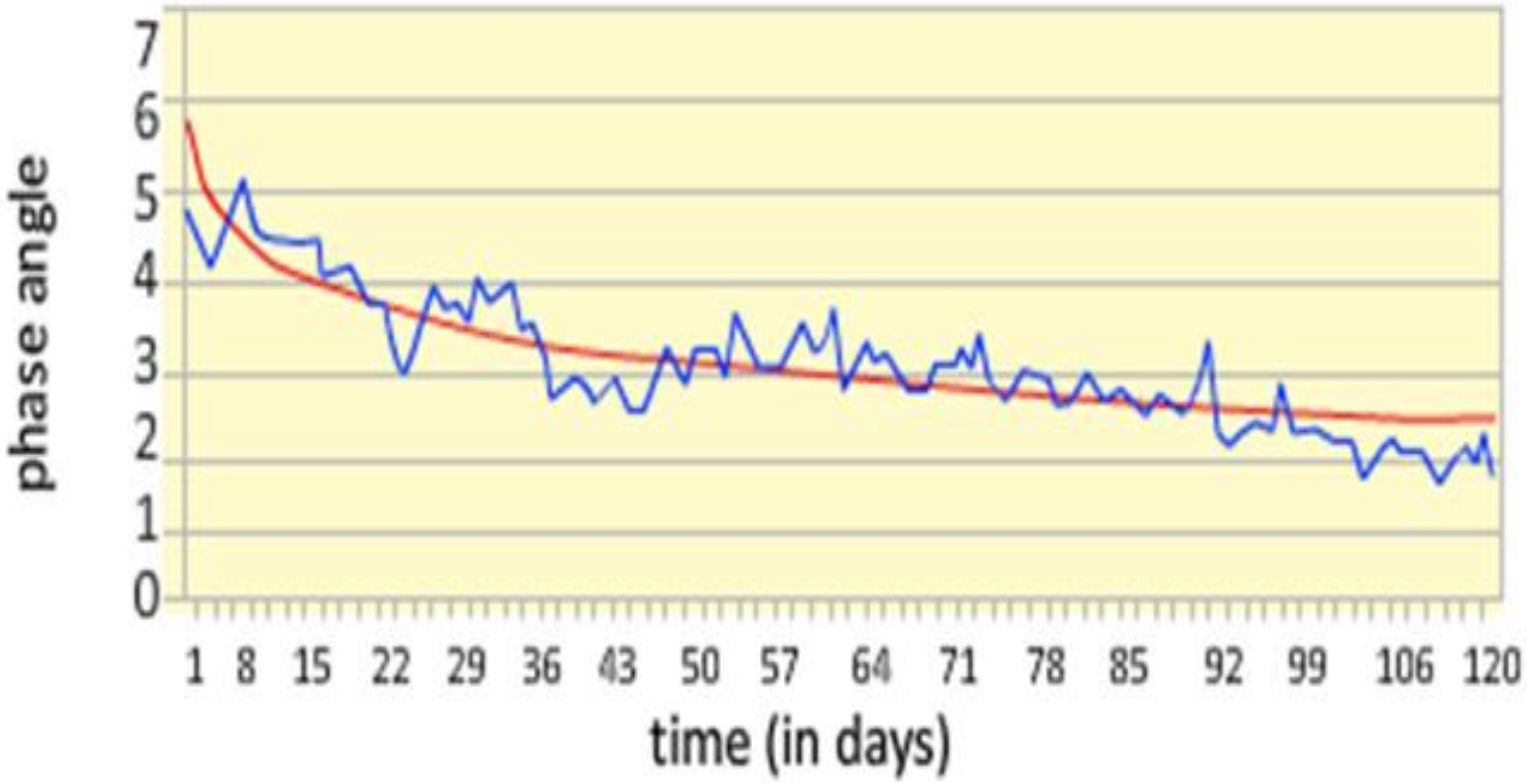
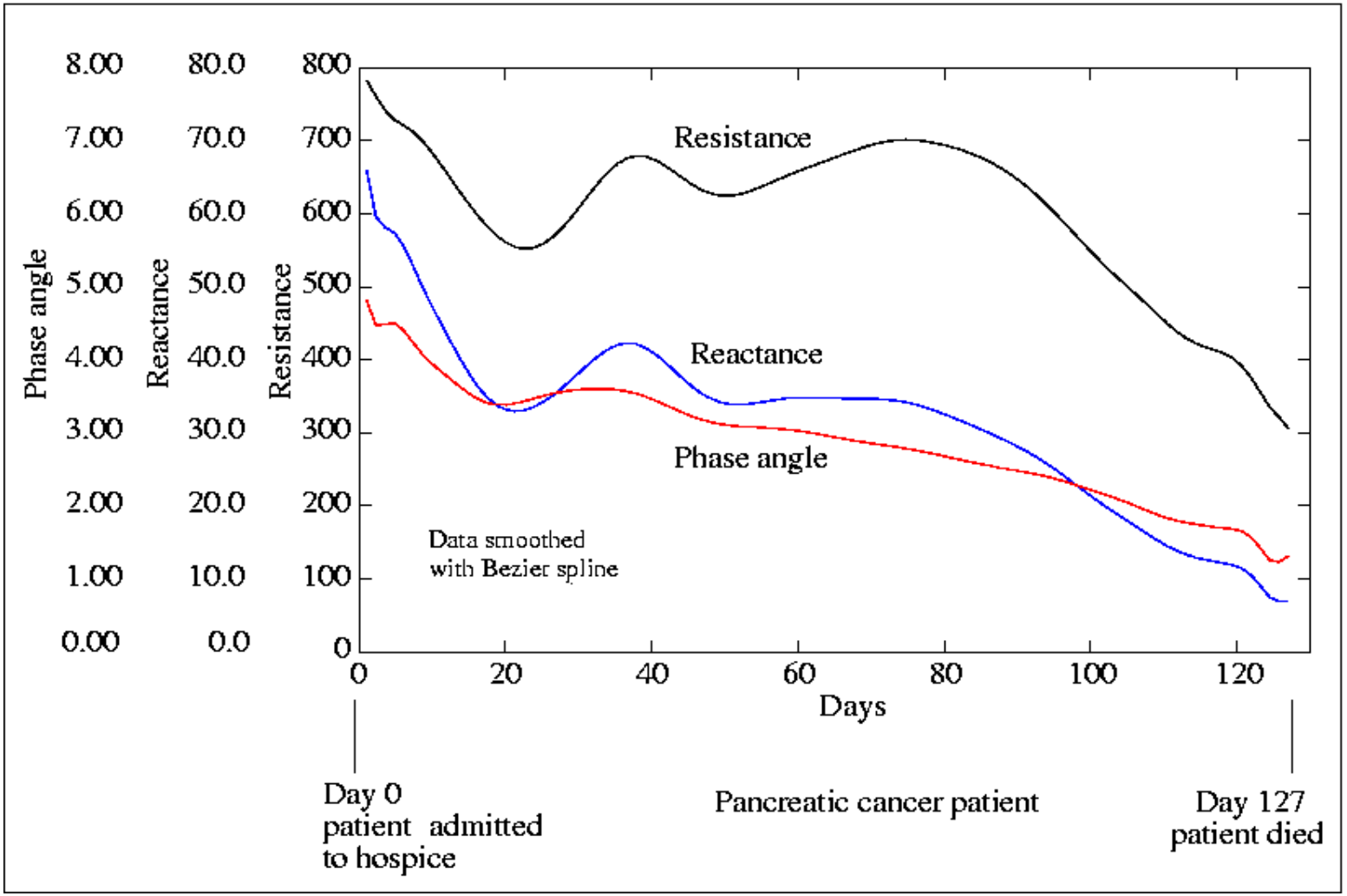
End of Life Trajectory with Death at Day 120 (phase angle < 2.0)



Impedance Values and Relationship in End of Life Trajectory

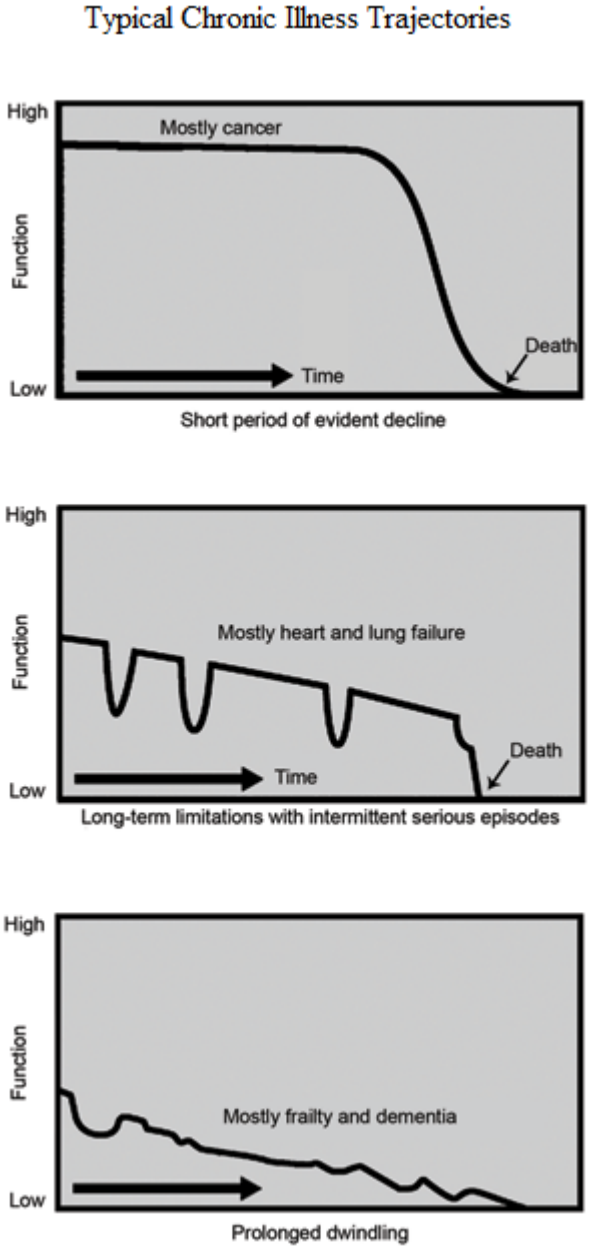


Frailty = Burden of Disease

Frailty is measured by subtracting the patient's phase angle value from the average for their age and gender.

If the average value is 7° and the measured value is 5.5° then the Frailty index is 1.5

The reduced value on the vertical axis is the lost vitality and reduced distance to mortality.



PrognostiCheck™ and Phase Angle Summary

Phase angle is a highly precise and sensitive index of a patient's individualized expression of their disease condition that includes the cumulative frailty (Burden of Illness), disease progression , treatment effectiveness and timing of non-acute death (survival). It provides the Physician, Patient and Family with better information sooner enabling better healthcare decisions.