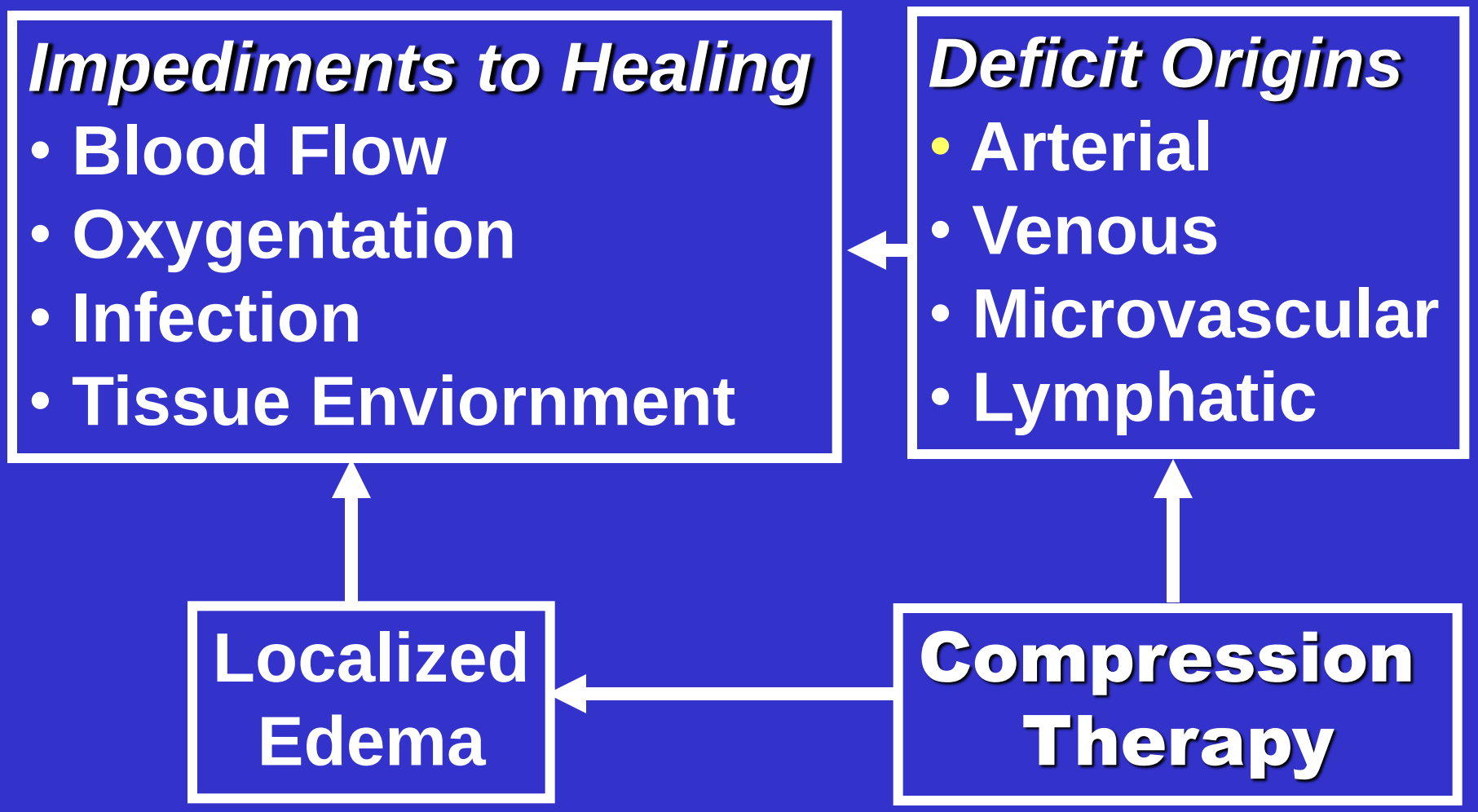
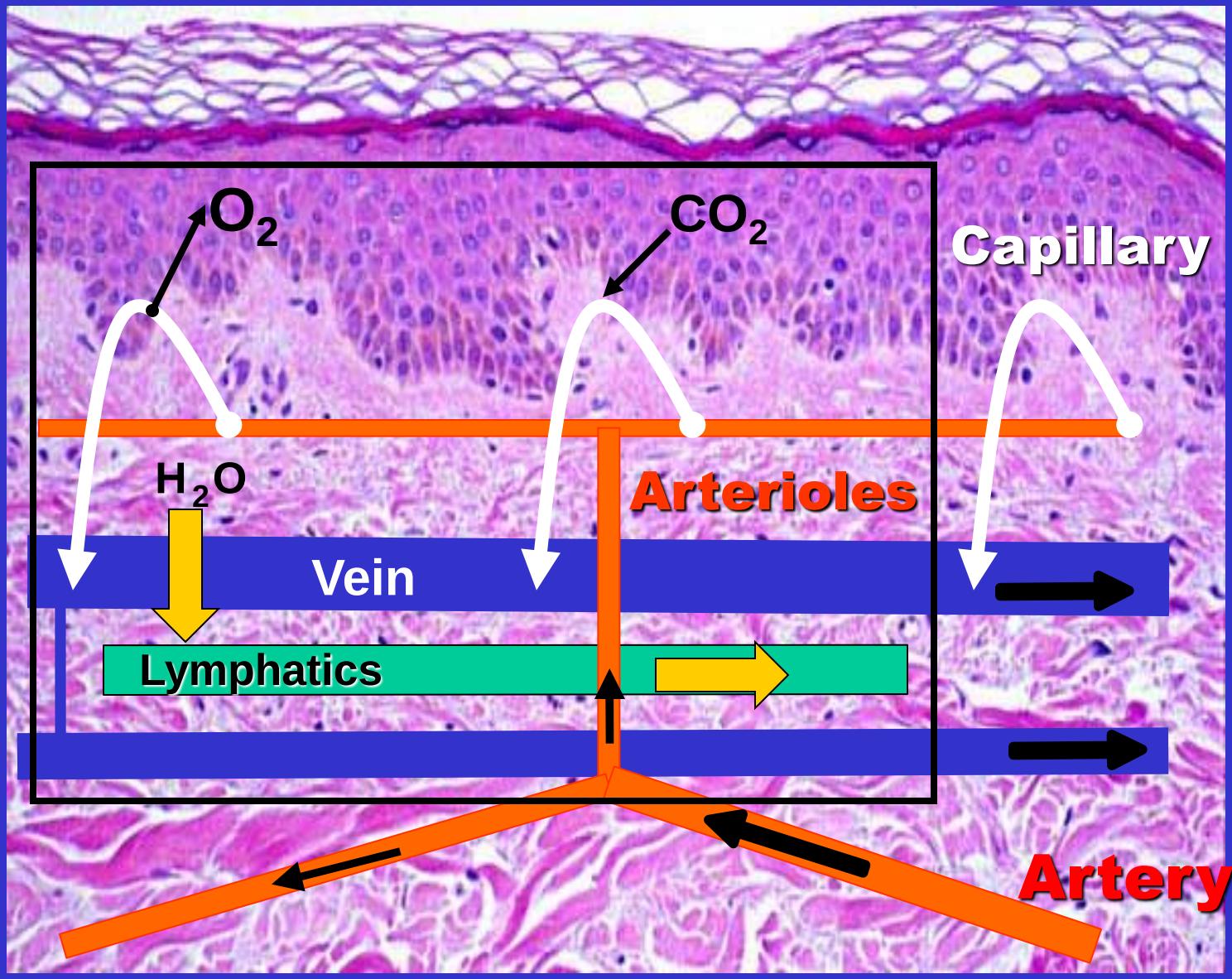
Physiological Principles of Therapeutic Compression

Harvey N. Mayrovitz, Ph.D.

Relationship to Wound Healing



Circulation Schema



Dr. HN Mayrovitz

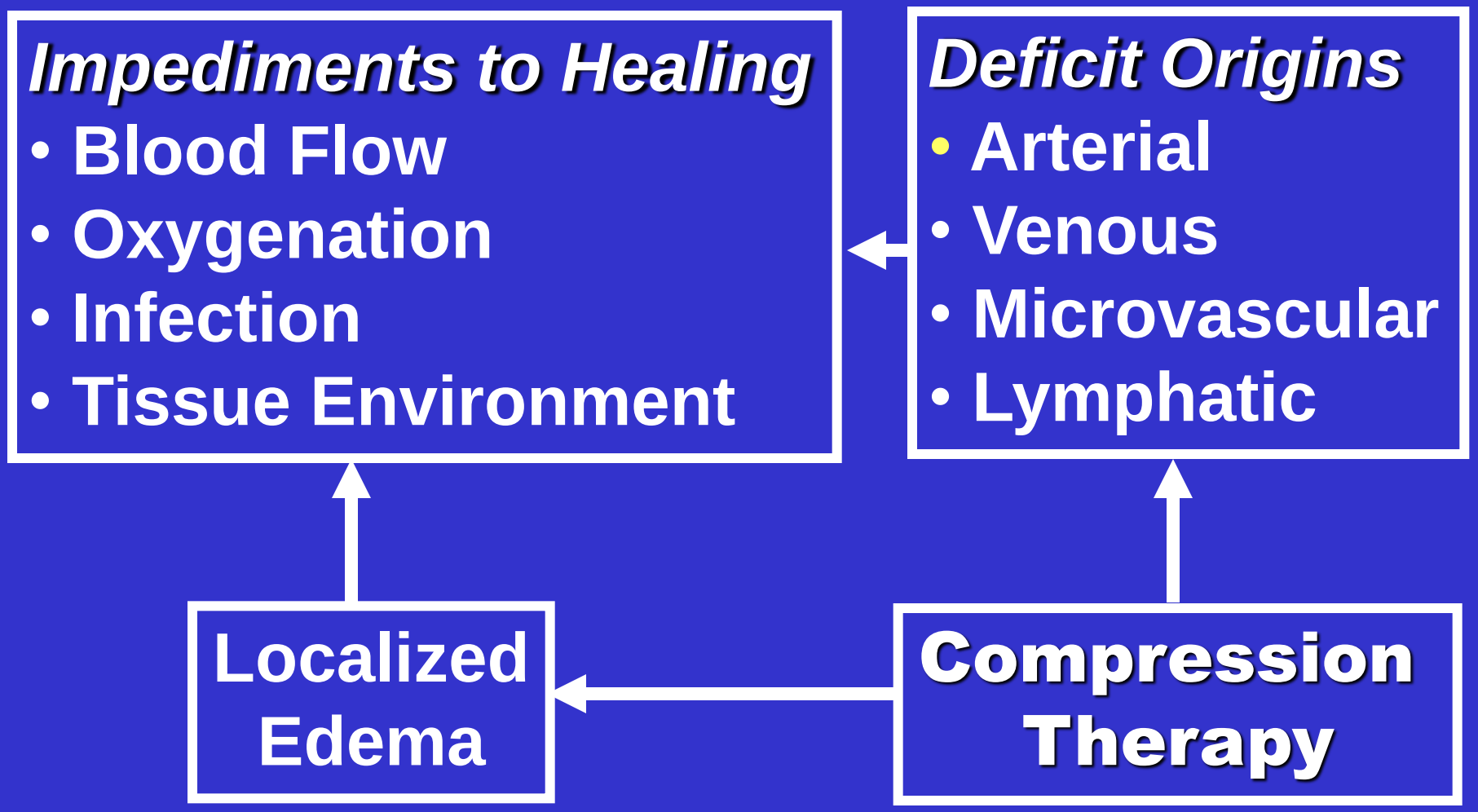
At the completion of this presentation participants will be able to:

1. State the difference between edema and lymphedema
2. State at least one process that can cause edema
3. Describe the basic processes involved in lymphatic transport
4. Describe long-stretch and short-stretch bandages and their use
5. Contrast the effects of resting vs. working pressures
6. Describe Laplace's law as it applies to bandaging

Types of Compression

- Bandage → Short-Stretch, Long -Stretch
- Bandage-like → Short-Stretch
- Pumps → Dynamic
- Stockings → Prevention, Maintainance

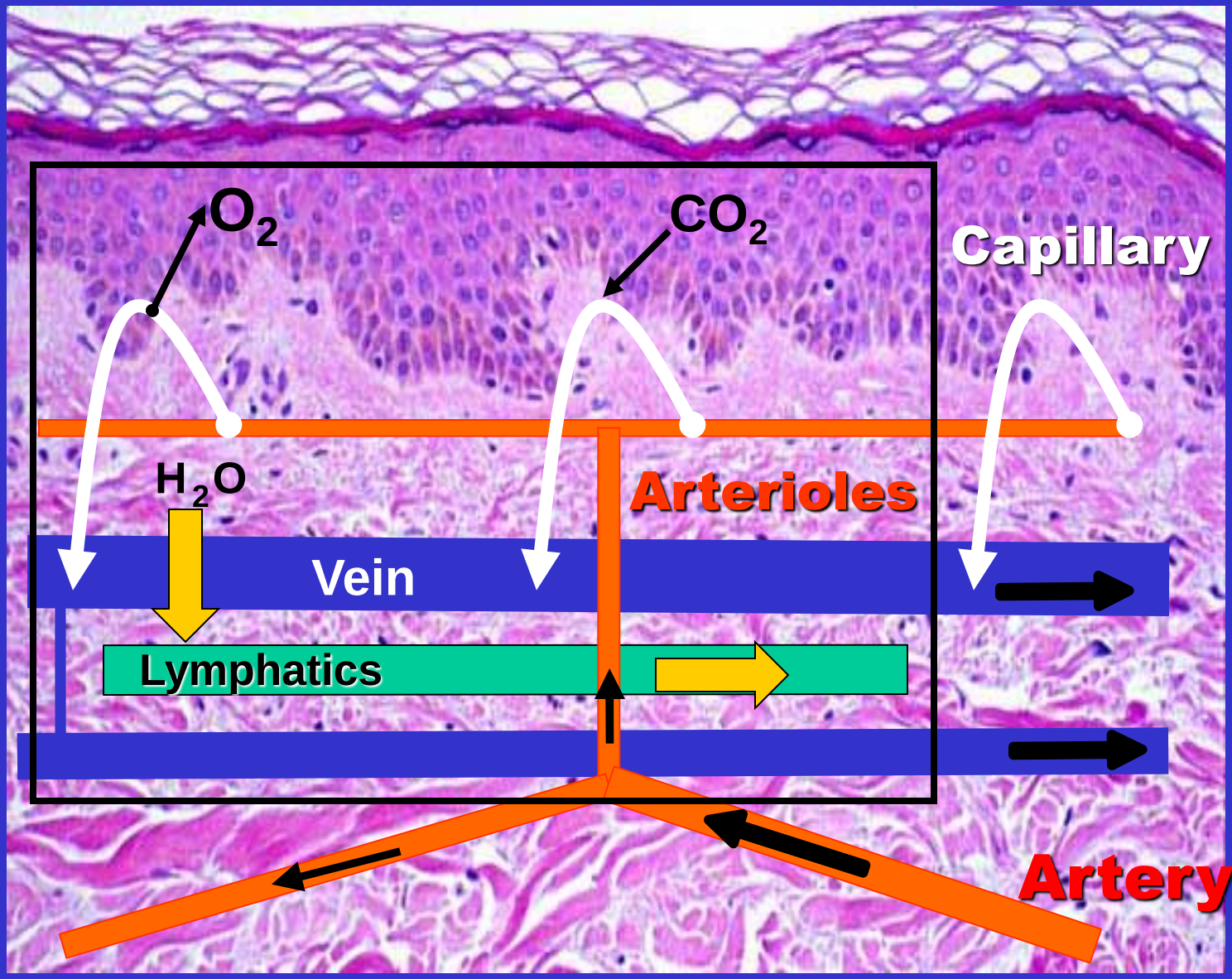
Relationship to Wound Healing



Dr. HN Mayrovitz

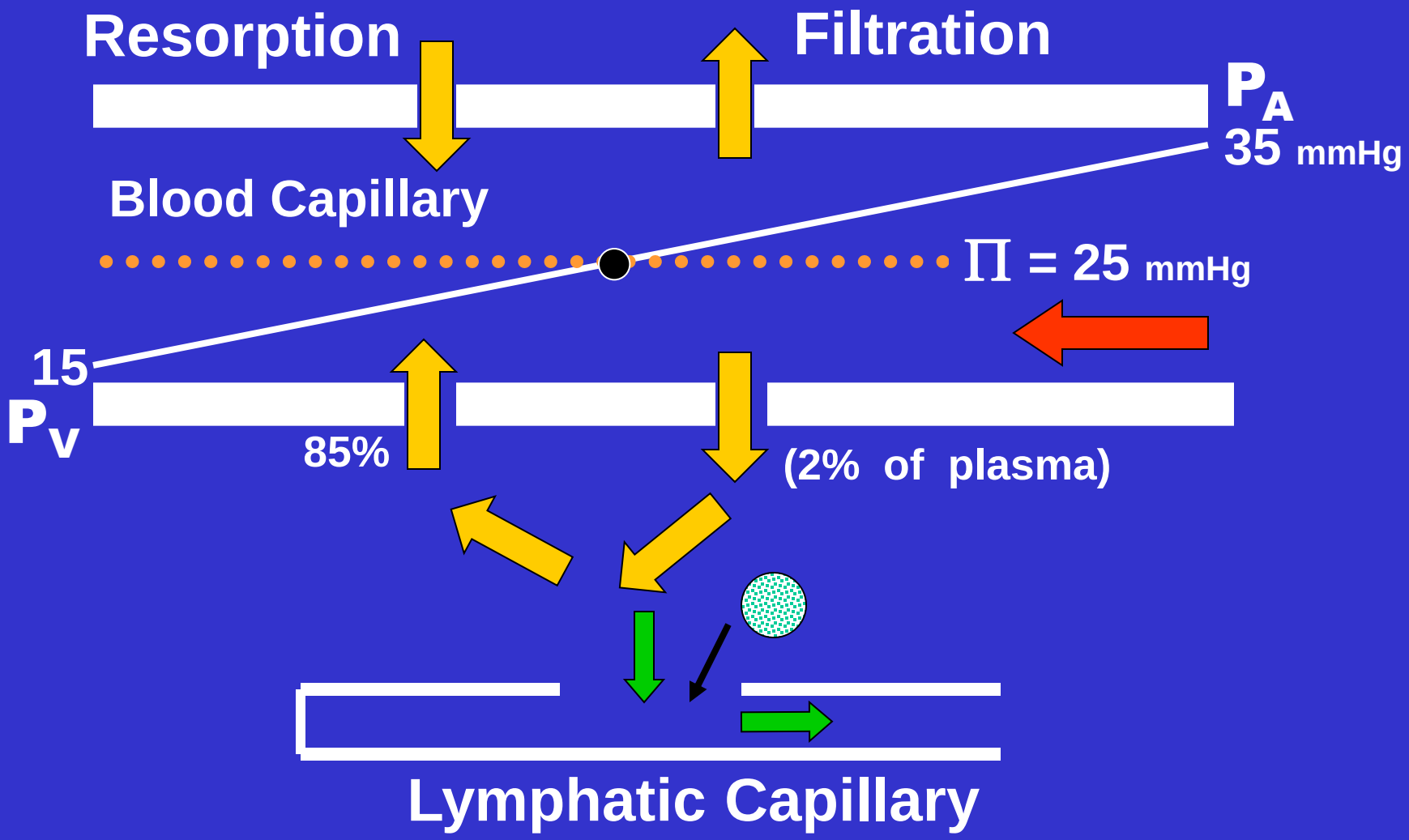
Lymphatic Function

Circulation Schema



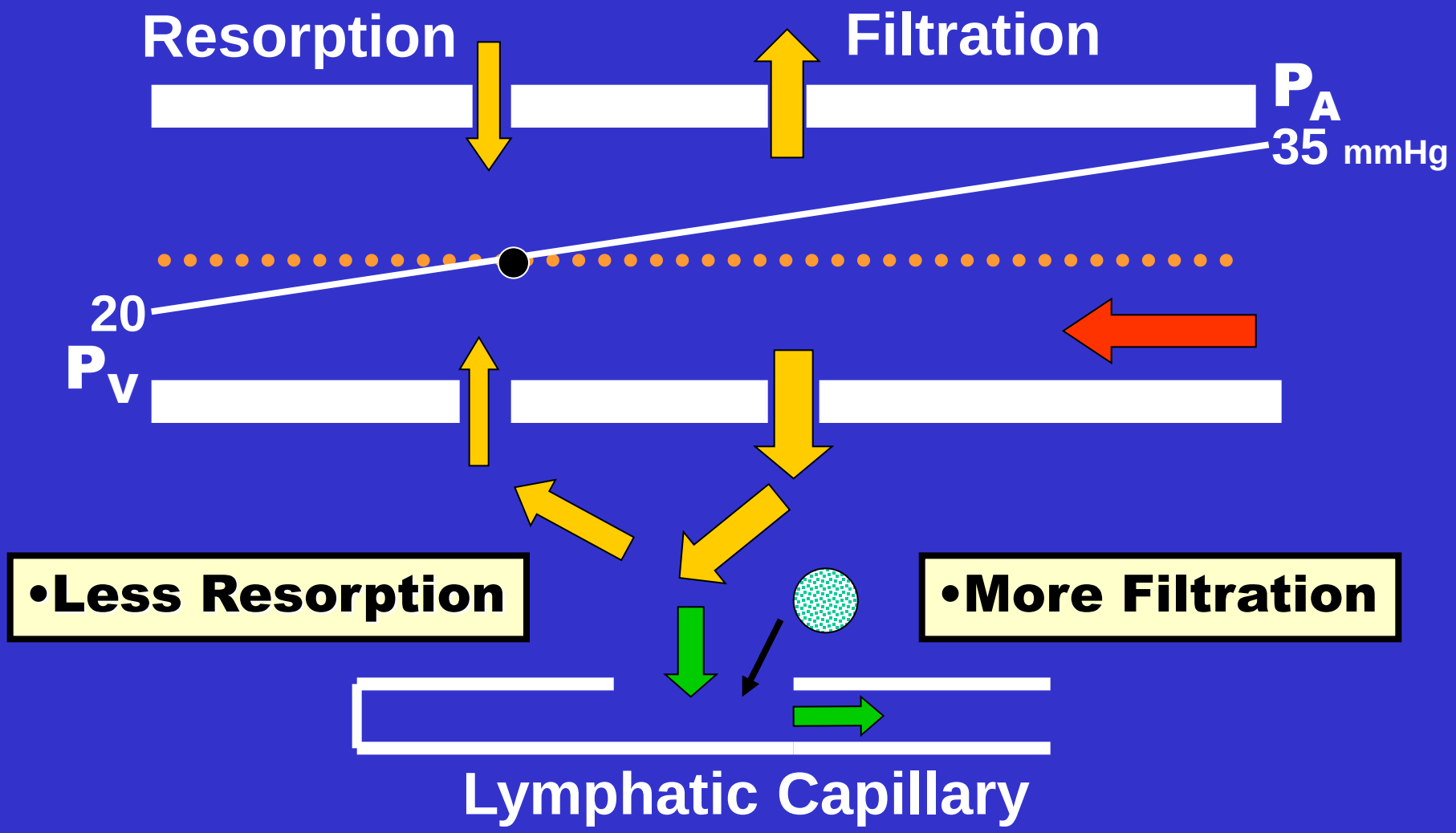
Dr. HN Mayrovitz

Fluid Balance



Dr. HN Mayrovitz

Increased Venous Pressure or Capillary Permeability



Dr. HN Mayrovitz

If Net Filtration Exceeds Lymphatic Transport Capacity

Overload = Edema

+ [Protein]

= Lymphedema

Therapy Options

- **Reduce Filtration**
- **Increase Transport**

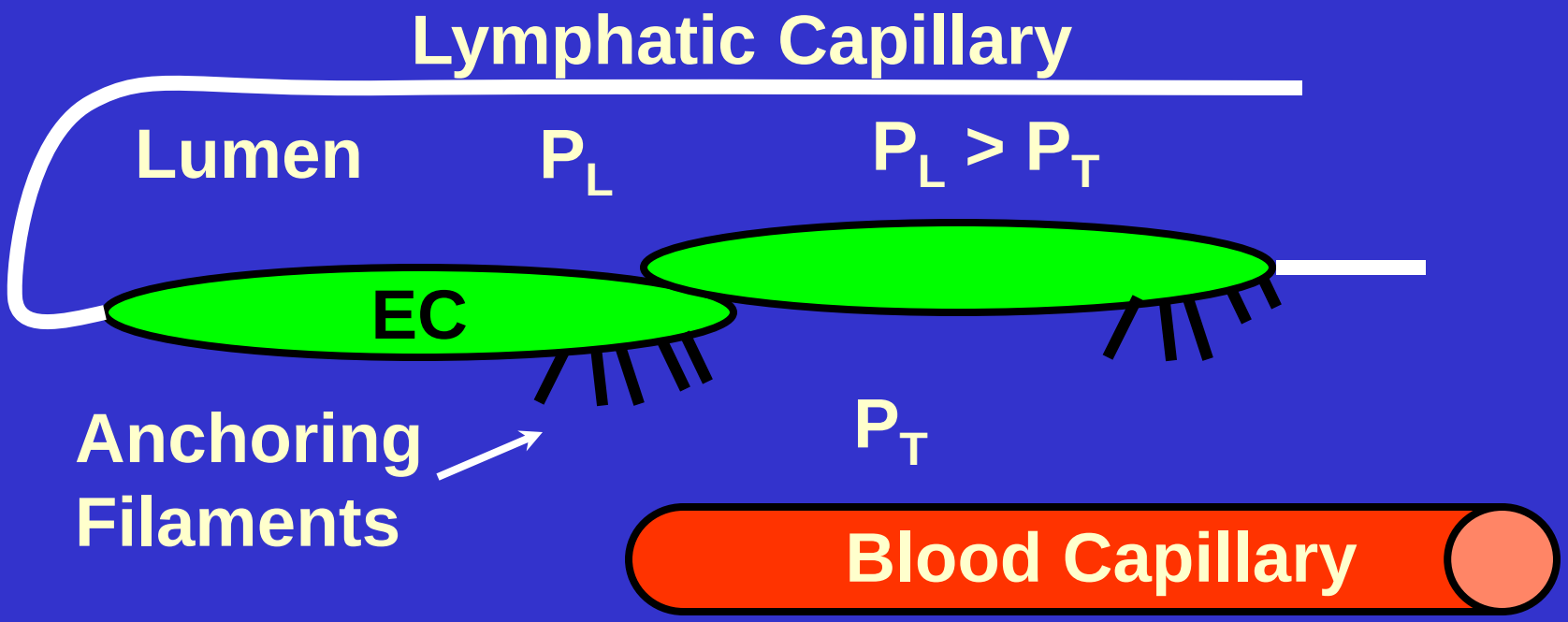
Dr. HN Mayrovitz

Normal Lymph Transport

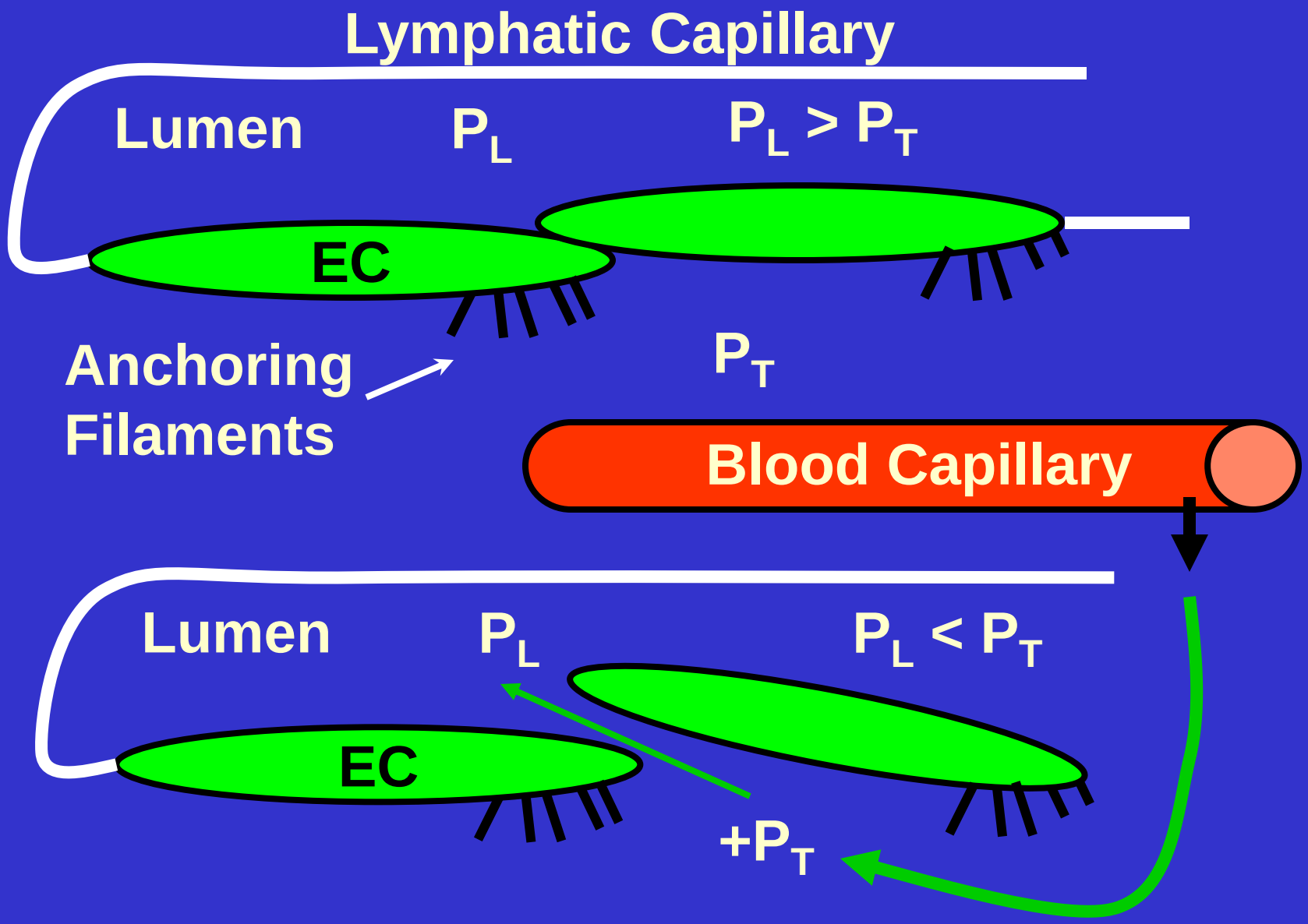
- Lymphangion Contraction
- Muscle Pump
- Arterial Pulsations
- Body Movements
- Respiration

Dr. HN Mayrovitz

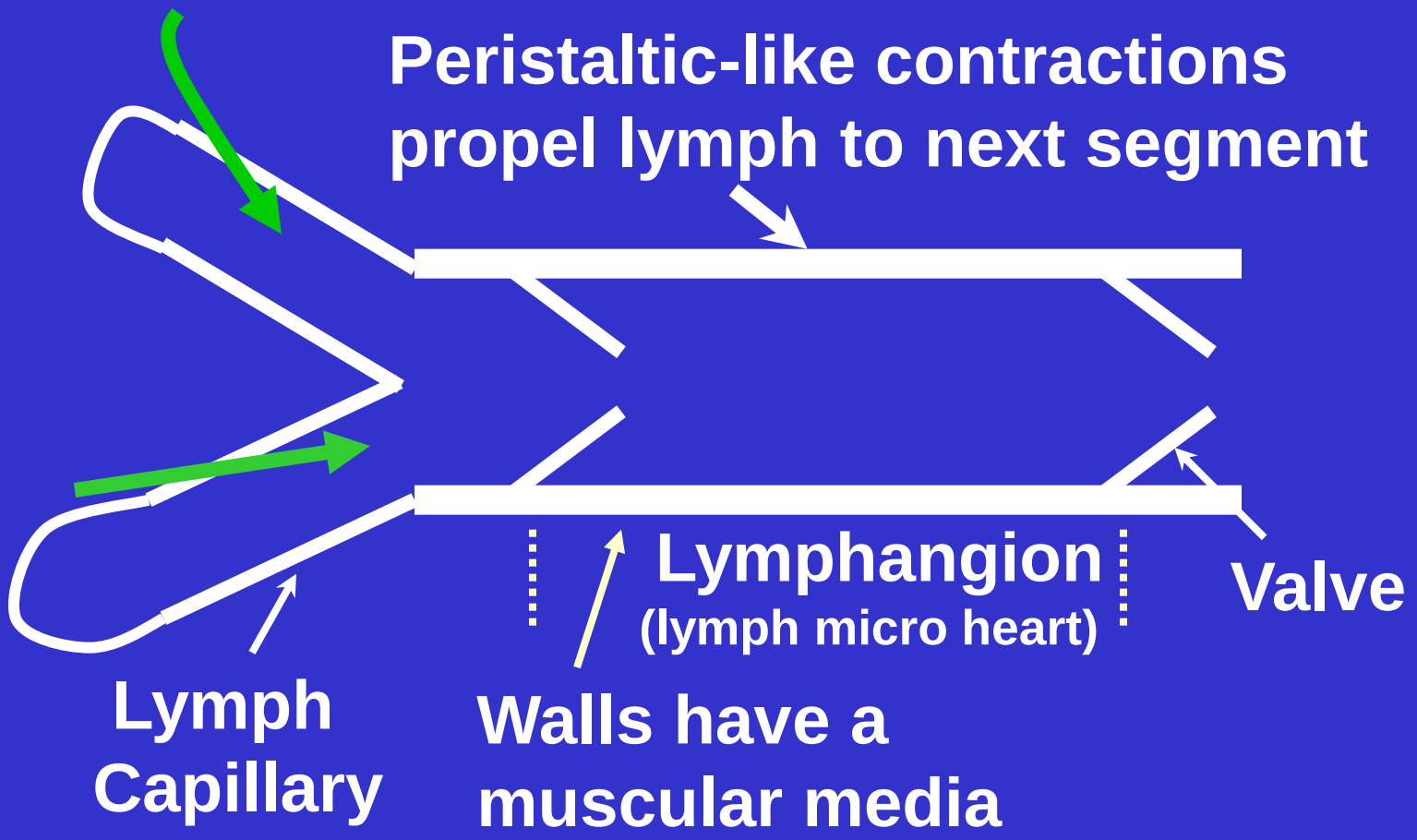
Lymphatic Capillaries



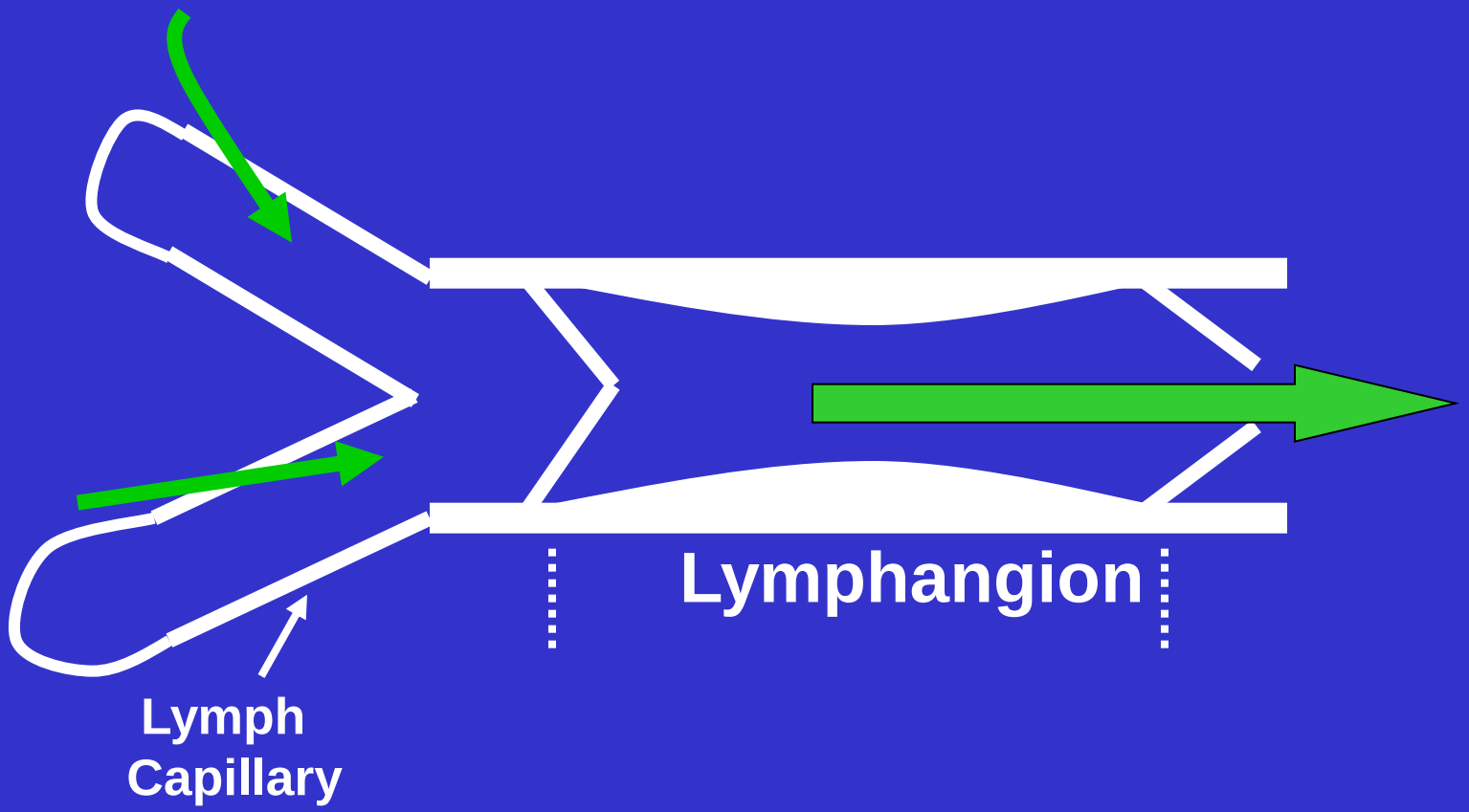
Lymphatic Capillaries



Lymphatic ‘Hearts’



Lymphatic ‘Hearts’

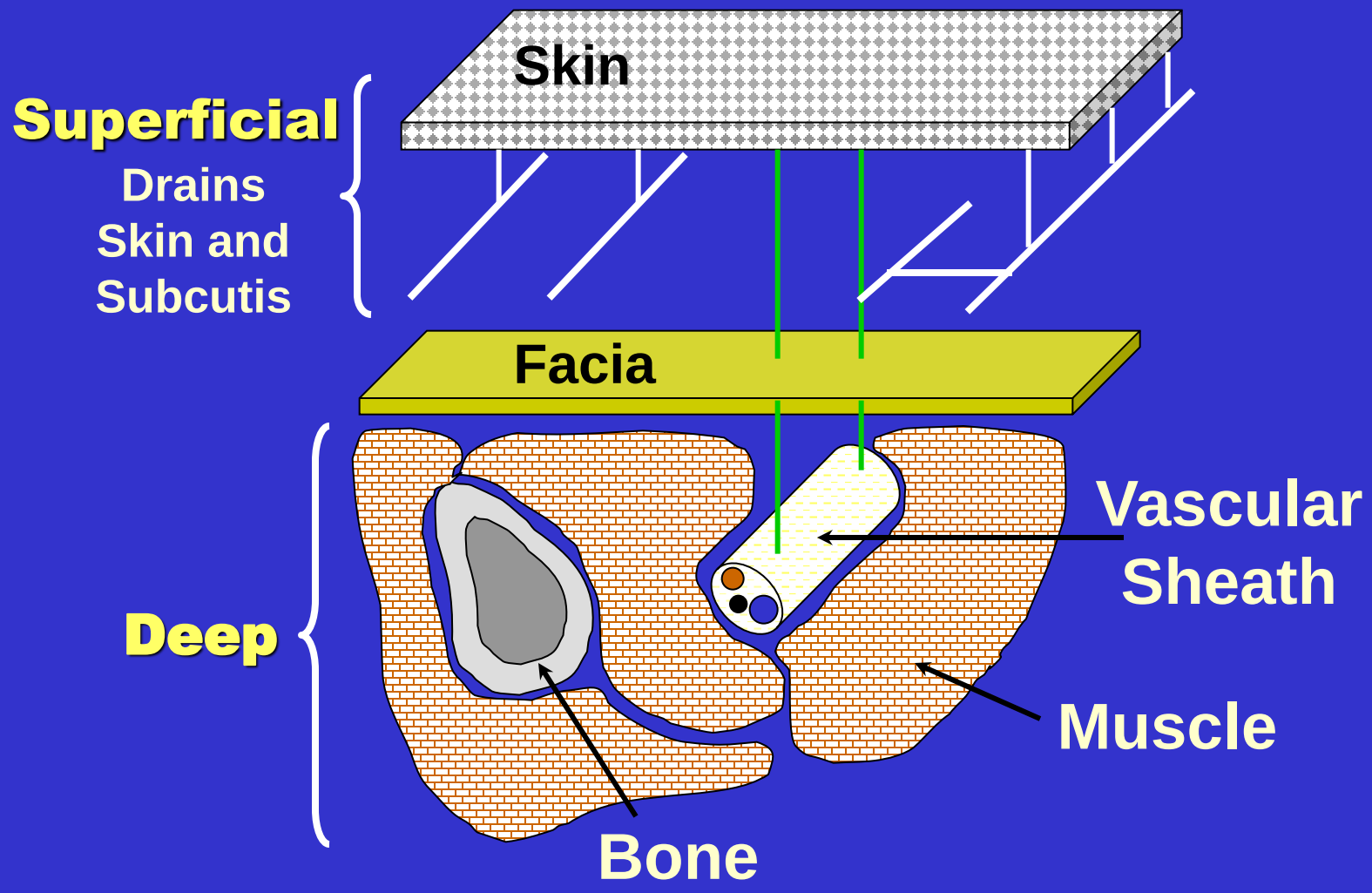


Contraction force and frequency are preload and afterload dependent - analogous to heart

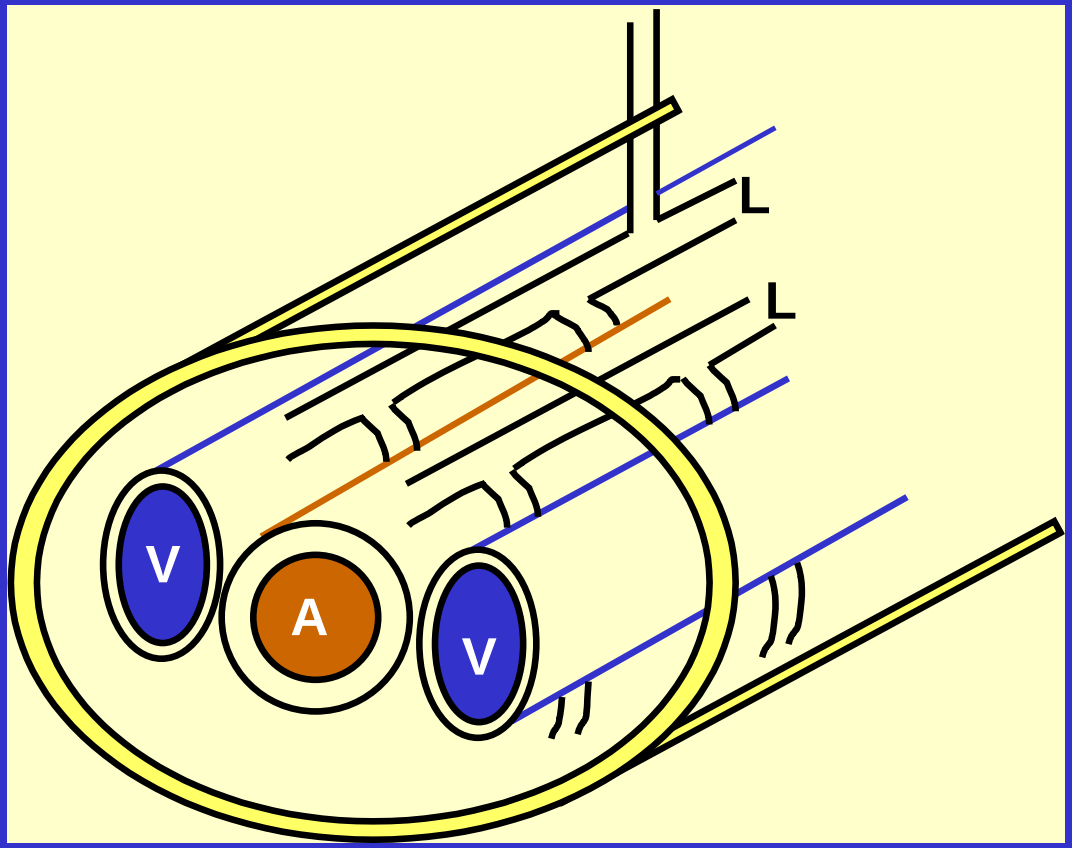
Dr. HN Mayrovitz

Compression Therapy Considerations

Arrangement



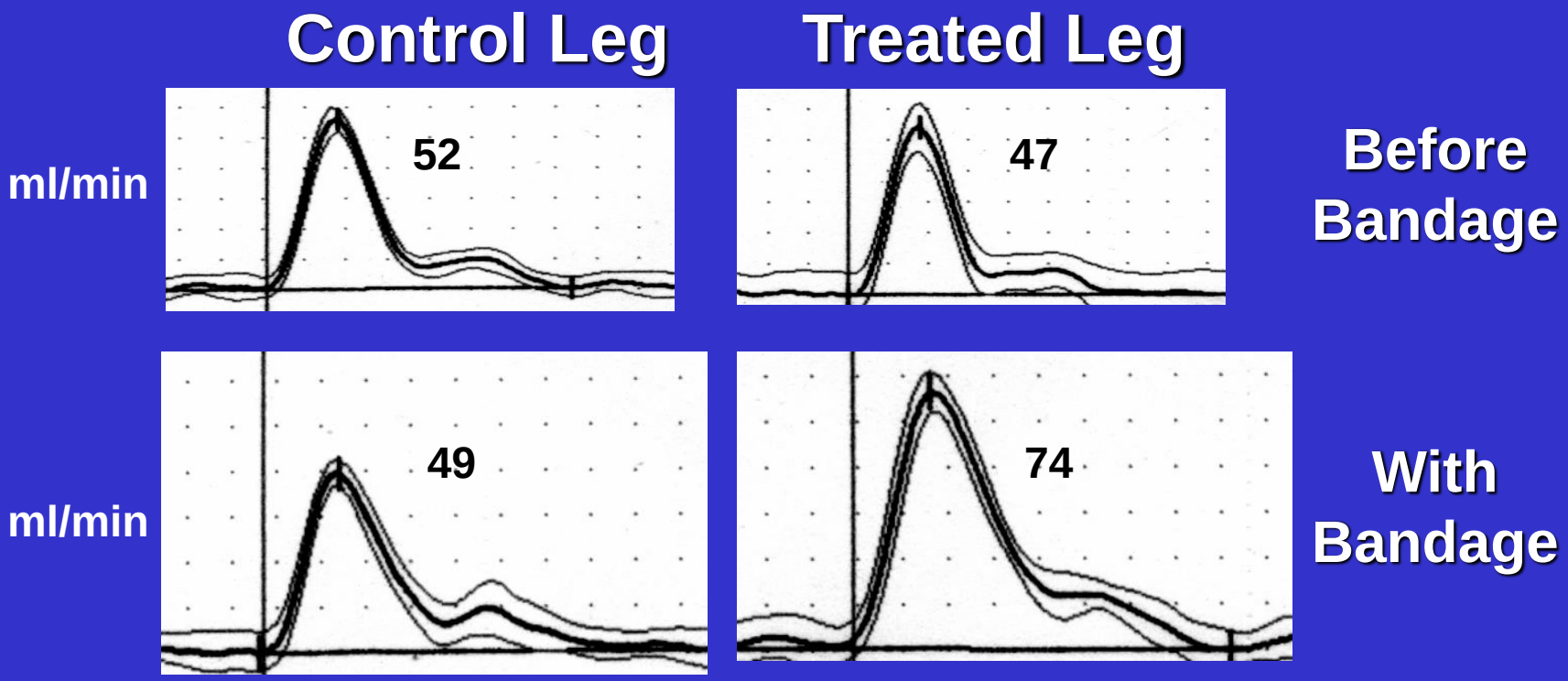
Vascular Sheath



Arterial Pulsations Mechanically Augment Lymph Transport

Dr. HN Mayrovitz

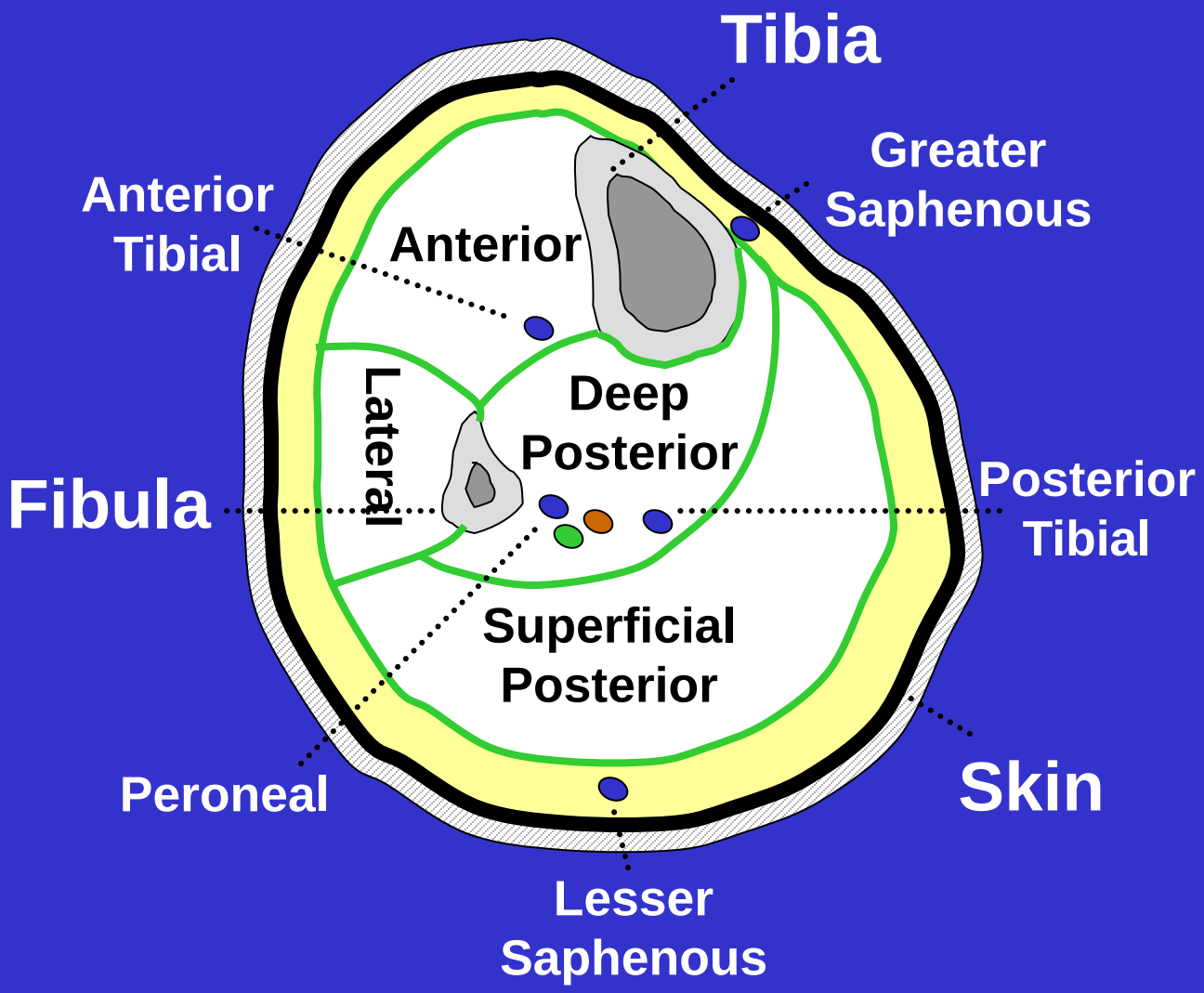
Arterial Flow Pulses



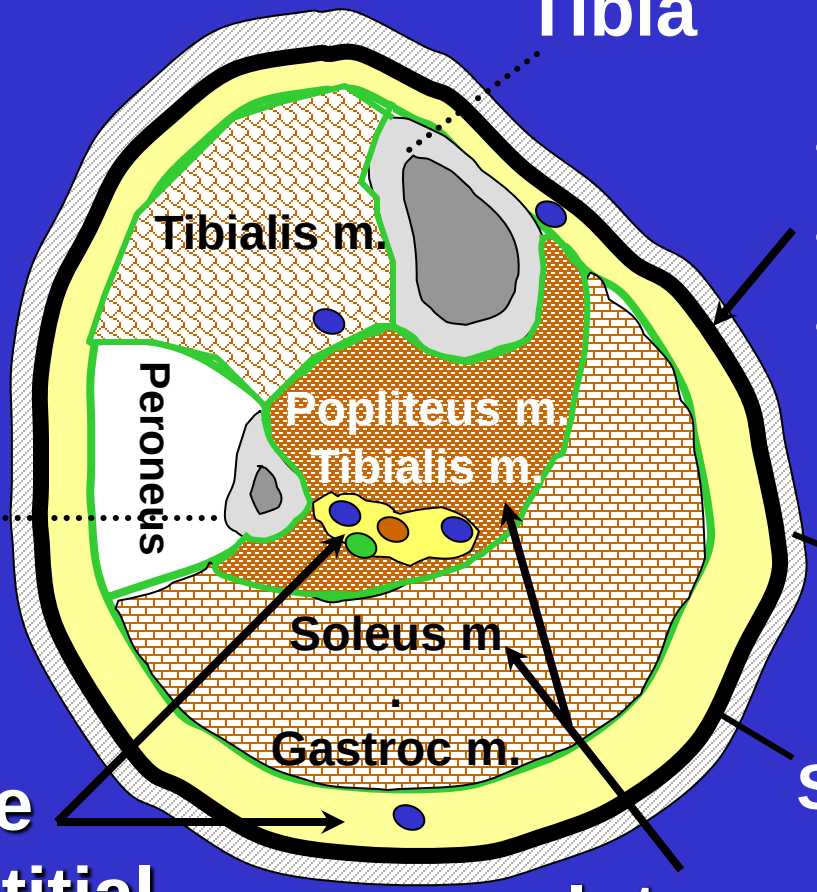
Below Knee Blood Flow Determined by Nuclear Magnetic Resonance

Dr. HN Mayrovitz

Compartments



Pressure Definitions



Fibula

- Sub-bandage
- Surface
- Contact

Compression Bandage or Device

Skin

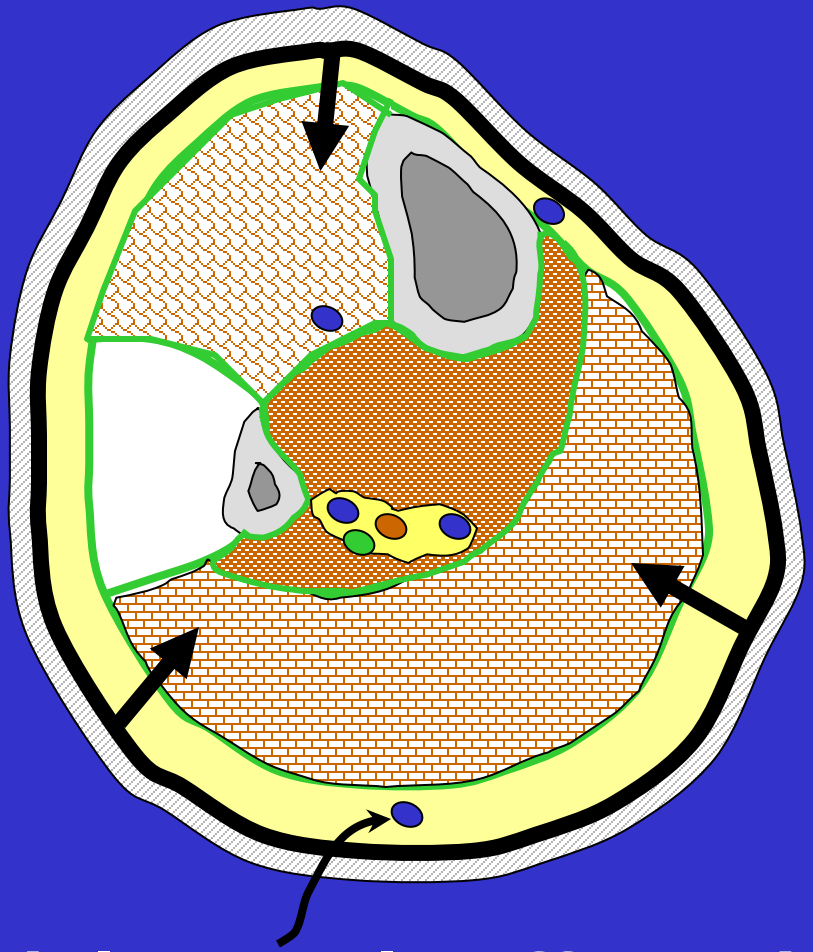
- Tissue
- Interstitial

- Intramuscular

Dr. HN Mayrovitz

Resting (Static) Pressure

Relaxed Muscles



Laplace's Law

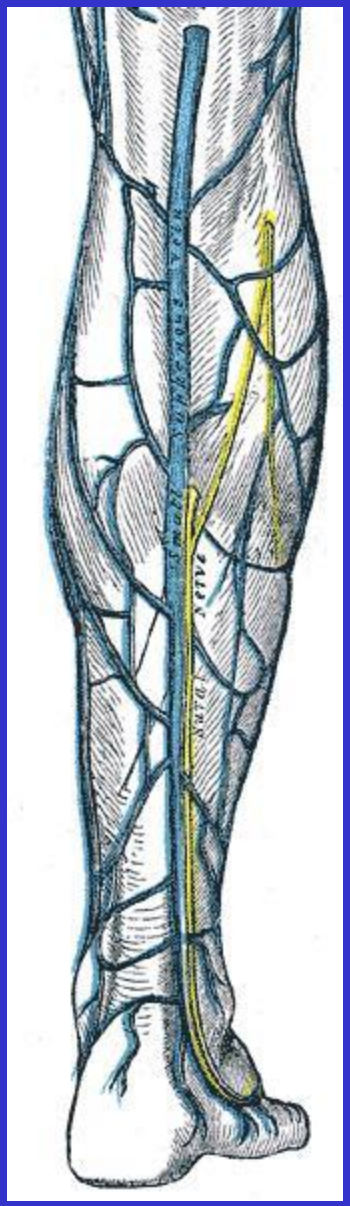
$$P \sim \frac{T}{R}$$

Superficial vessels effected the most

Dr. HN Mayrovitz

Pressure Gradient Concept

$$P \sim \frac{T}{R}$$



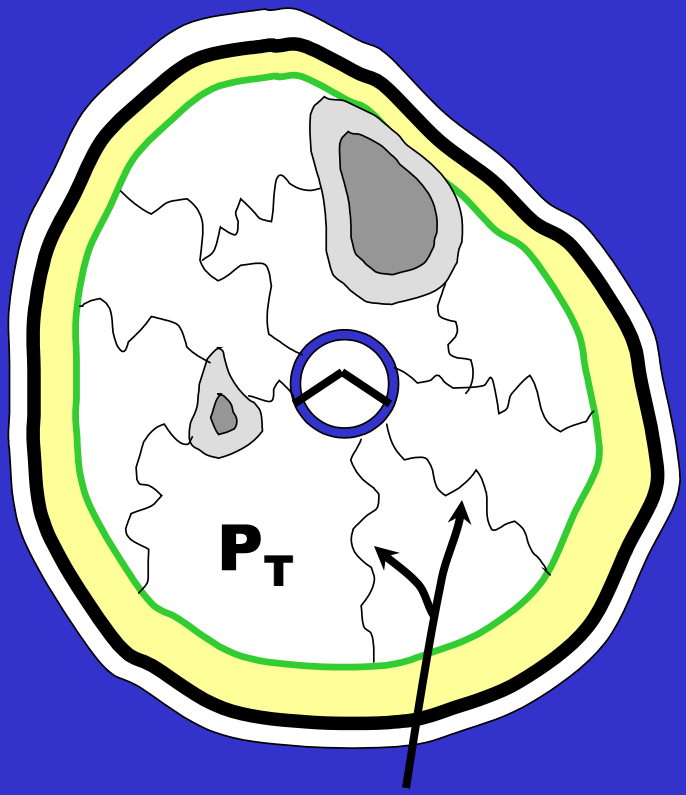
Constant tension
compression applied

Increasing R
Decreasing P

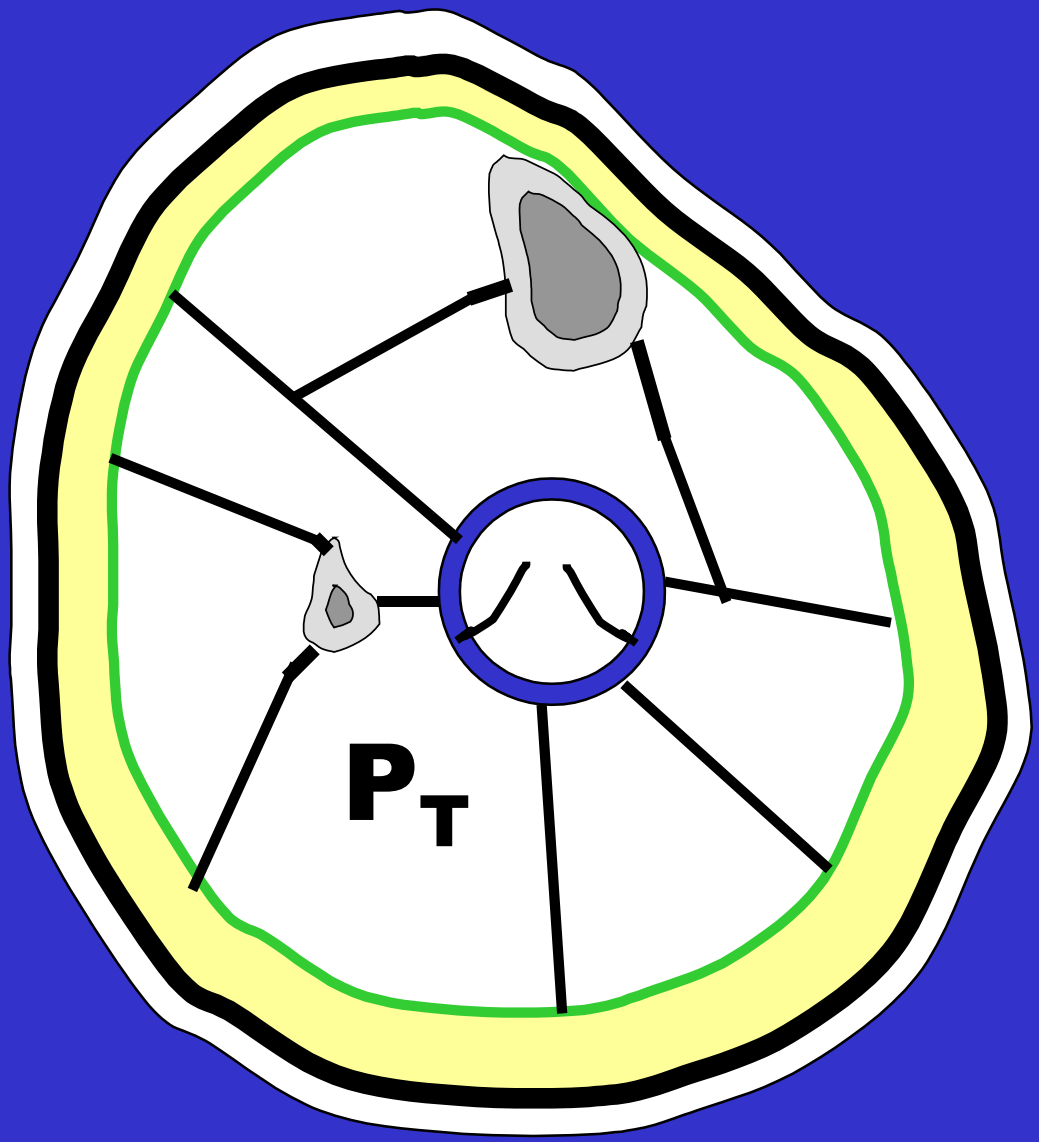
Dr. HN Mayrovitz

Edema and Tissue Pressure

Normal



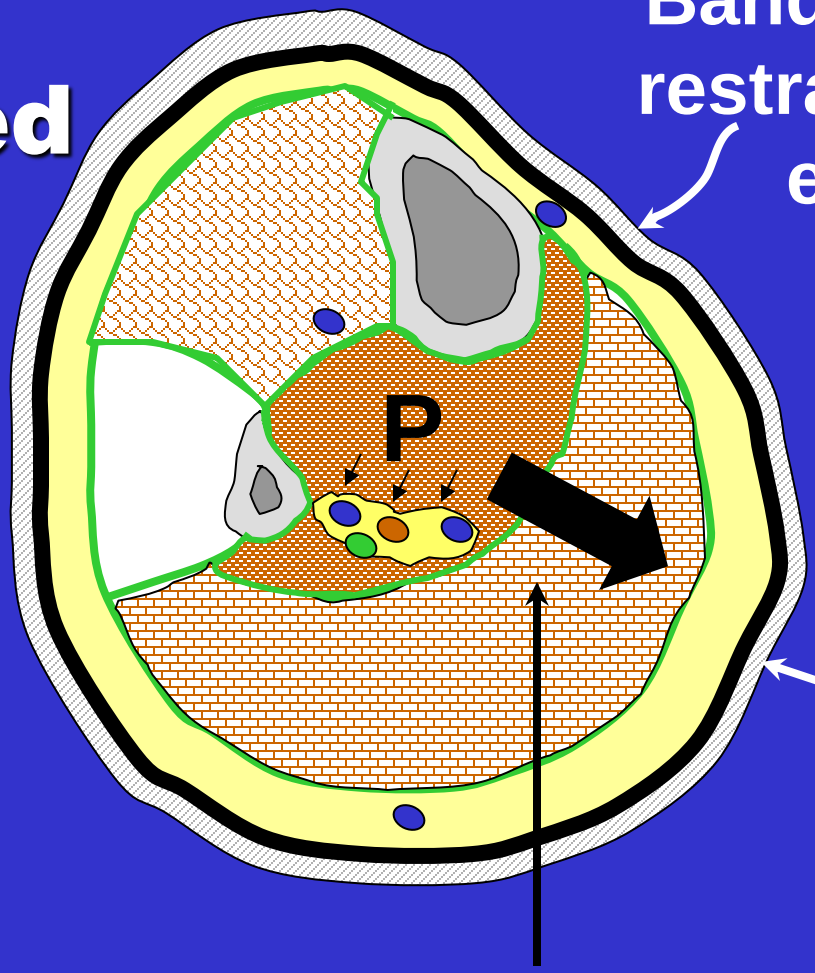
Loose Fibrous Trabeculae



Working (Dynamic) Pressure

Contracted Muscles

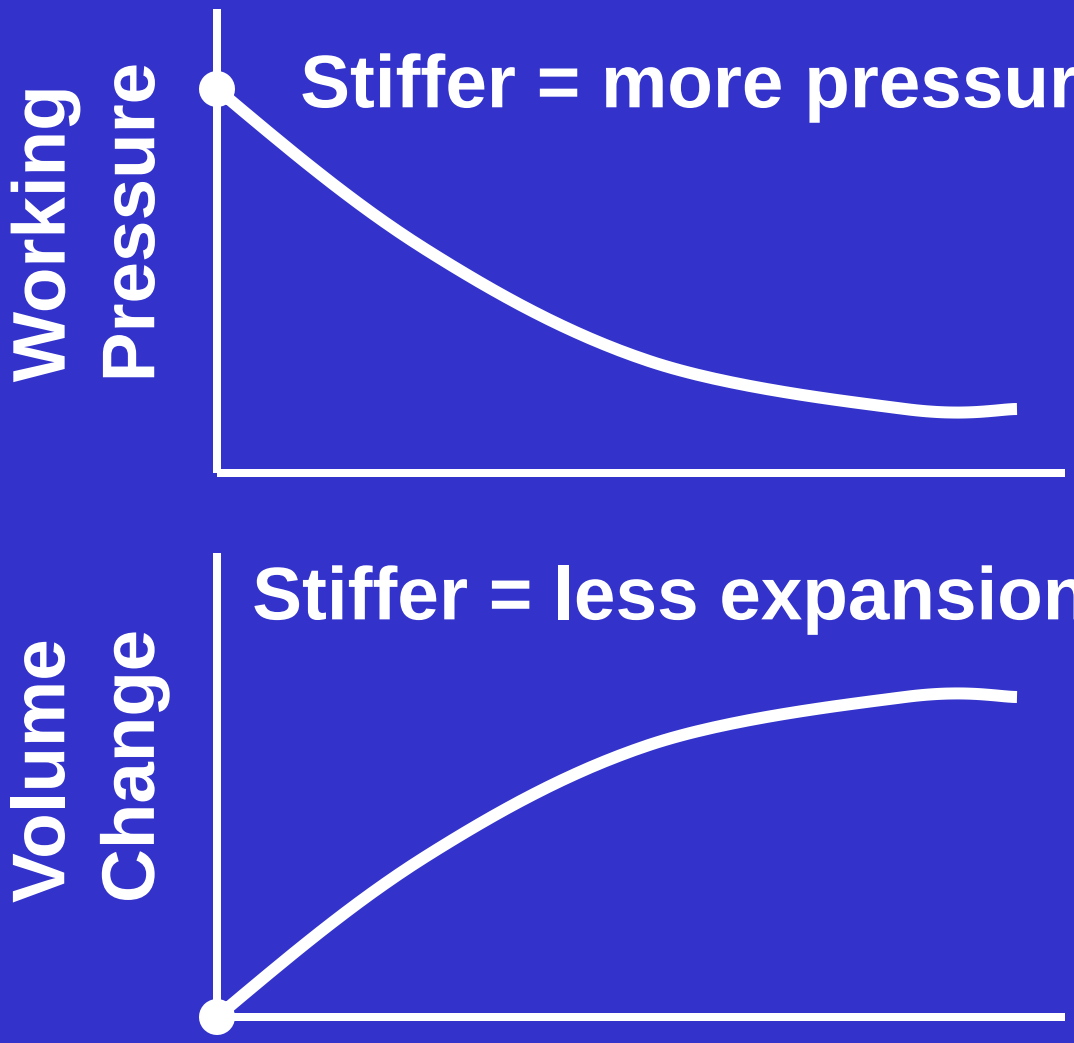
Bandage acts as a restraint to muscle expansion

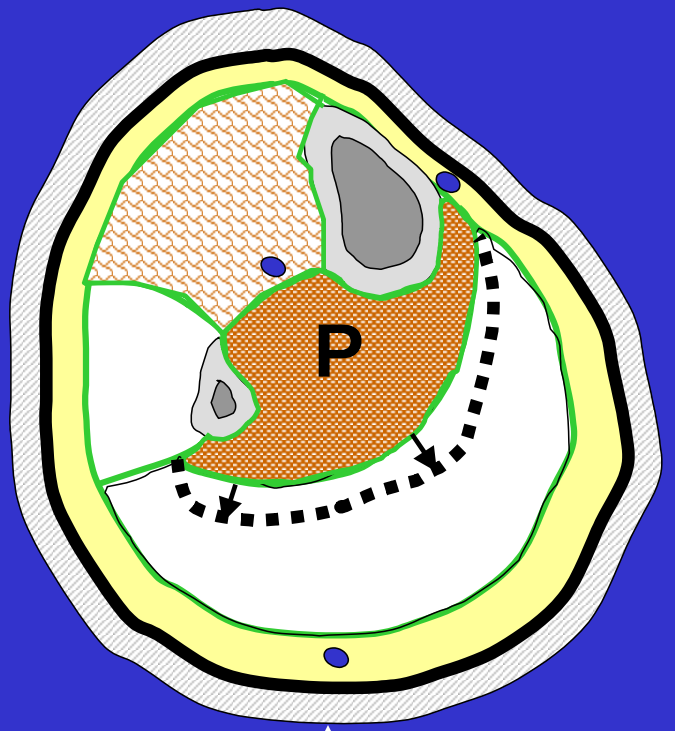


P ~ Contraction Force x ‘Rigidity’

Dr. HN Mayrovitz

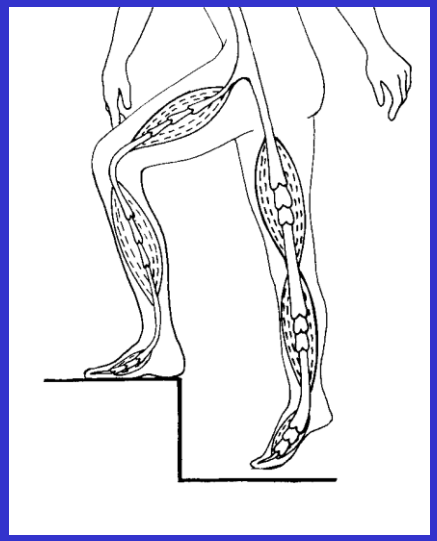
Bandage Features Affect Pressure





Dr. HN Mayrovitz

Range of Dynamic Pressures



Form fitted steel pipe

'short stretch'

'long stretch'

No external compression

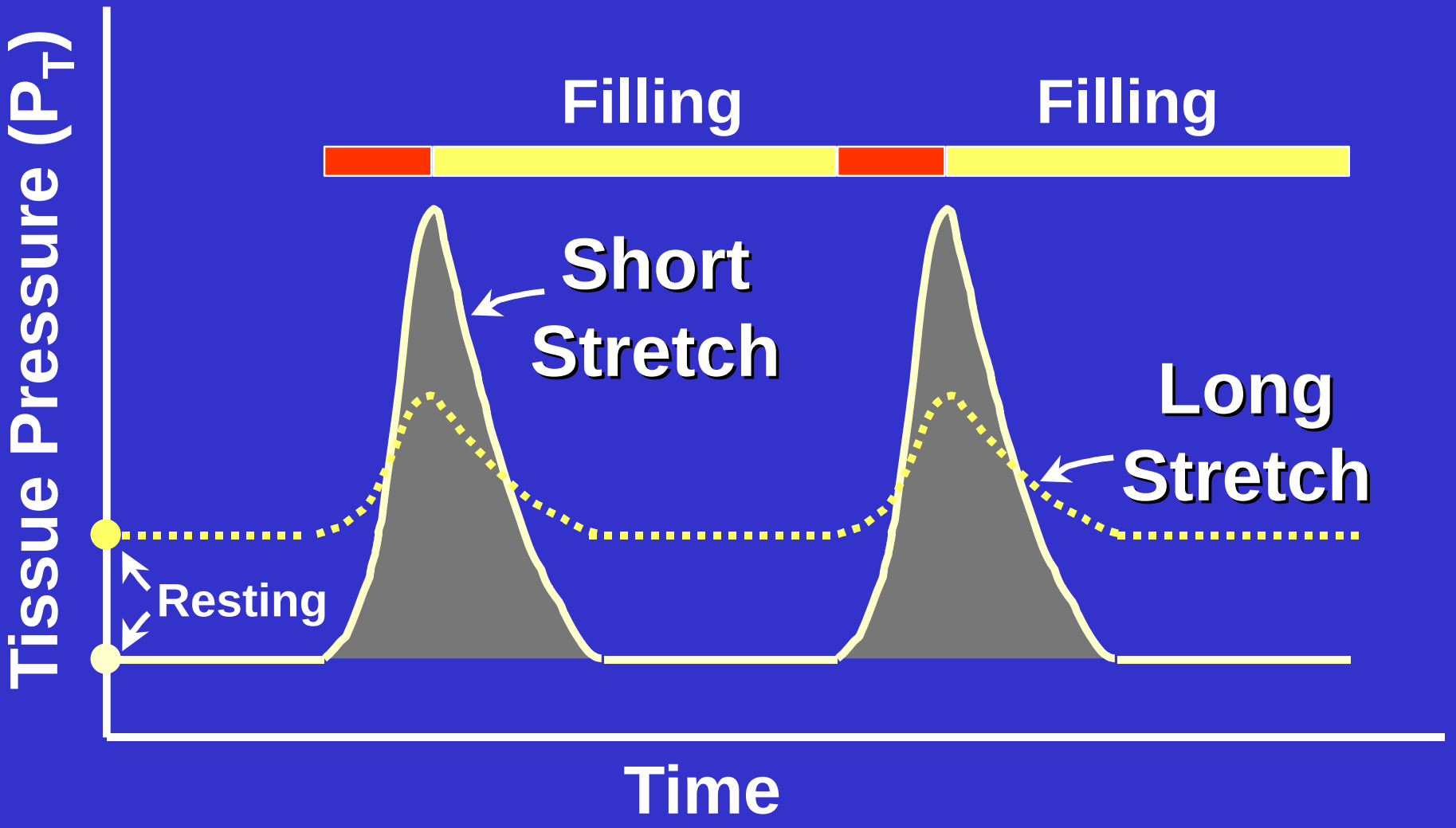
Dynamic Pressure (ΔP)

0

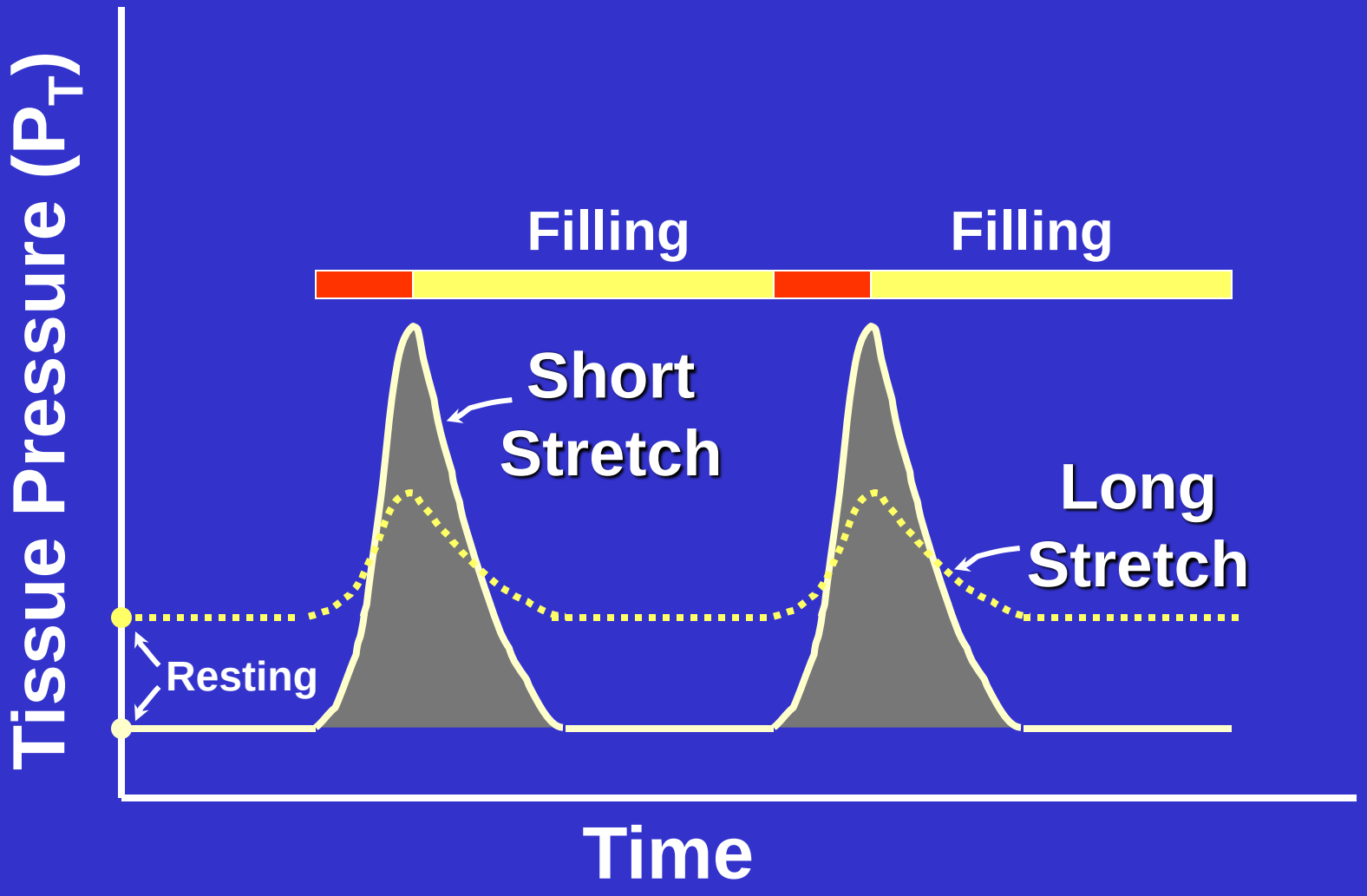
Bandage "Stretchibility"

Dr. HN Mayrovitz

Working vs. Resting Pressures
Role of Compression Material



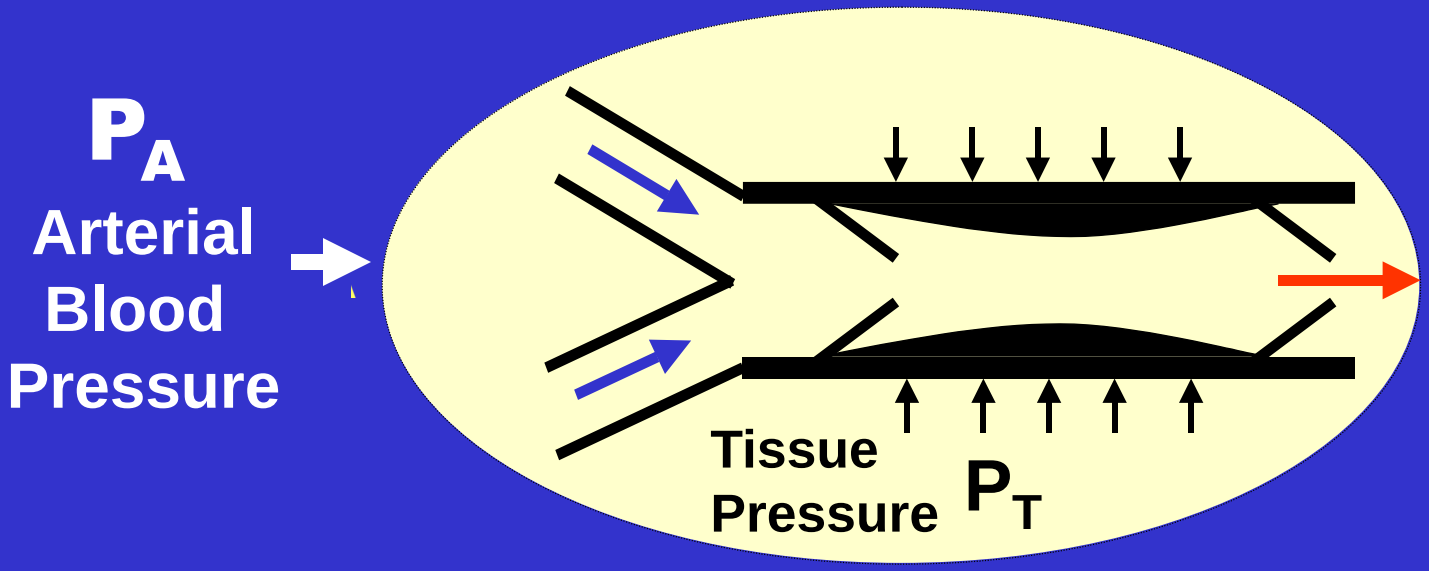
Working vs. Resting Pressures
Role of Compression Material



Dr. HN Mayrovitz

Overall Impact of Compression

Depends on both working and resting pressures

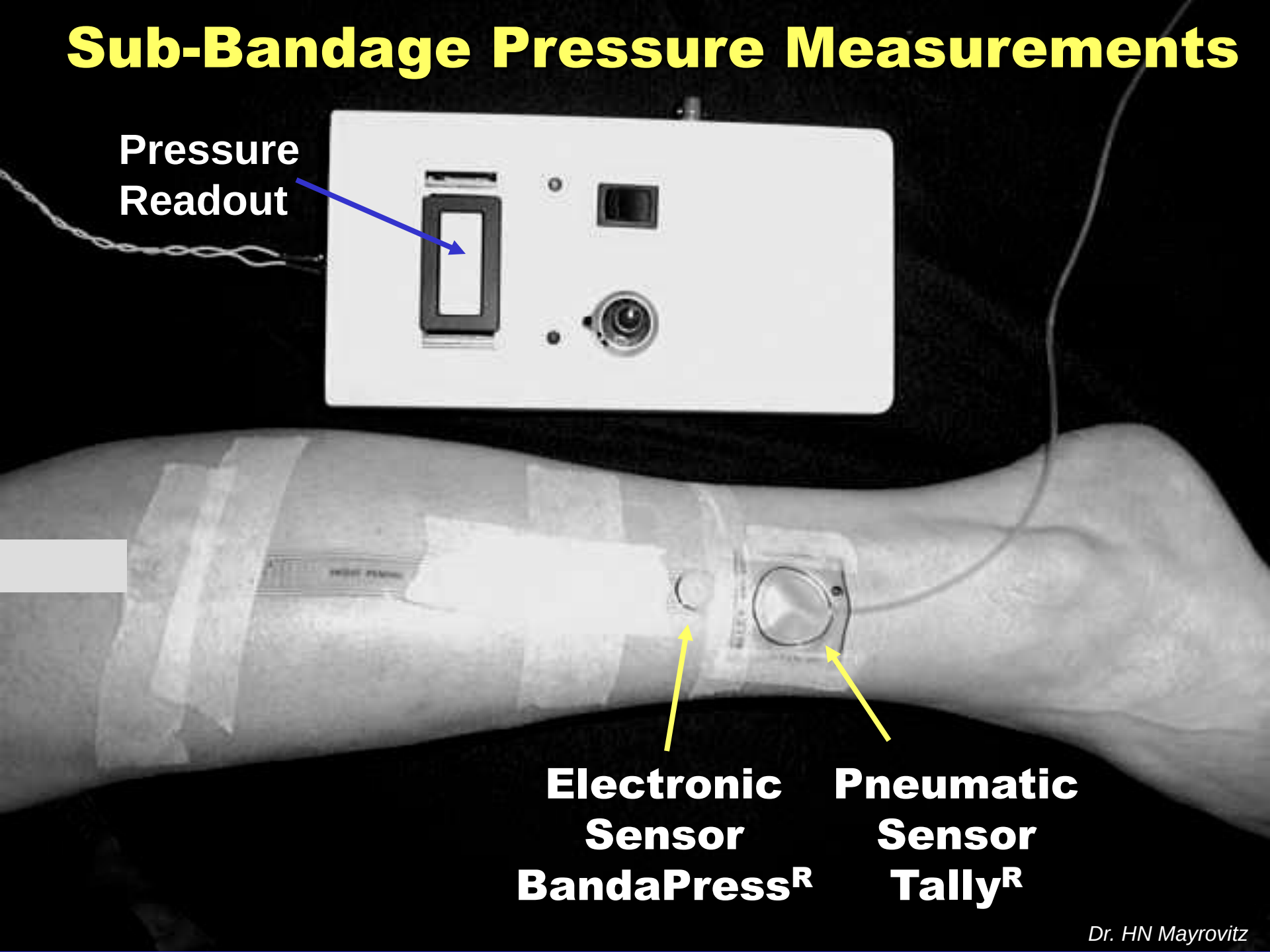


- **Filling**: Inflow ~ $P_A - P_T$
- **Emptying**: Outflow ~ $\Delta V \sim \Delta P_T$
- **Most Efficient**: Low resting P_T and High ΔP_T

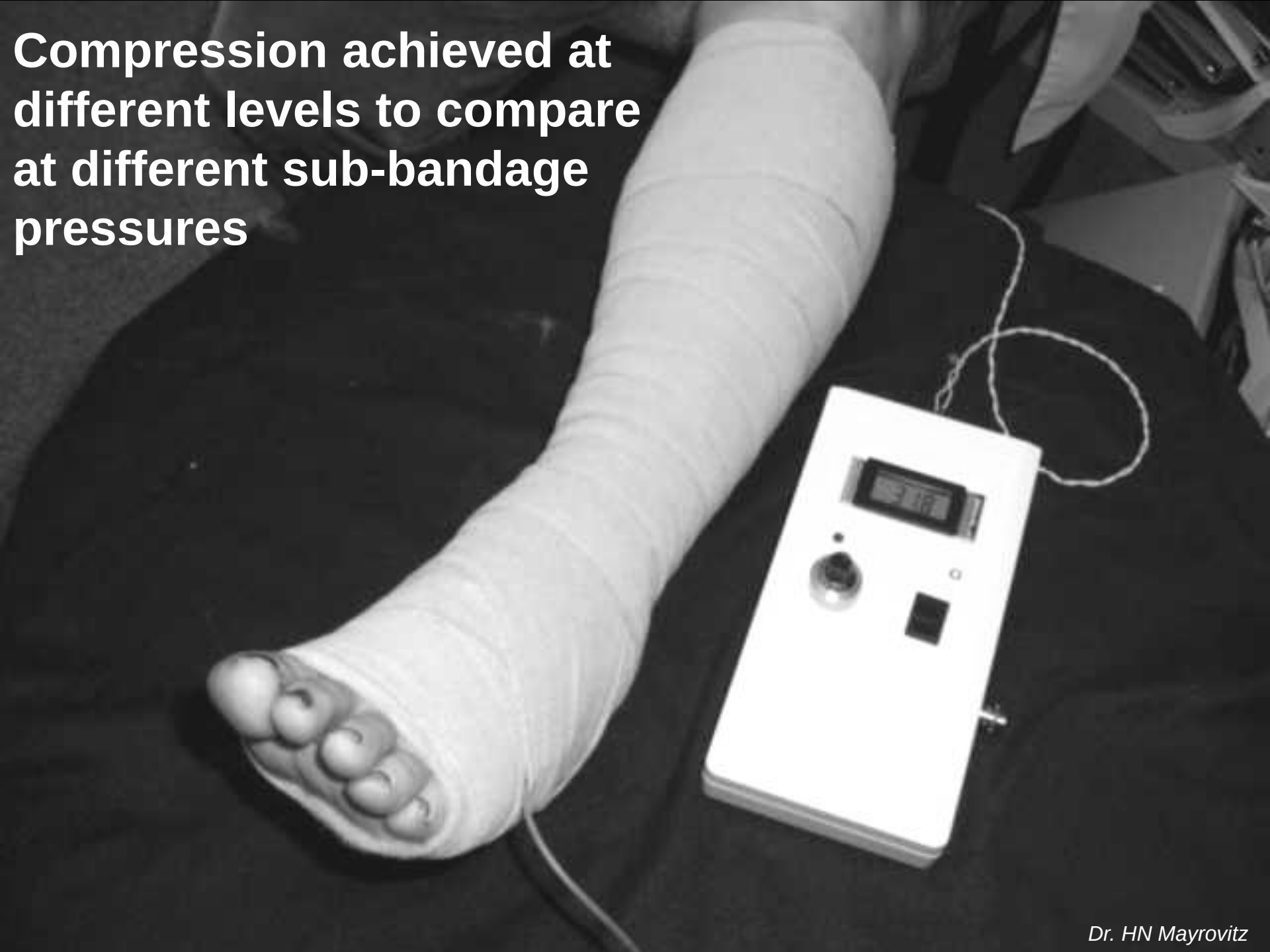
Dr. HN Mayrovitz

Examples

Sub-Bandage Pressure Measurements

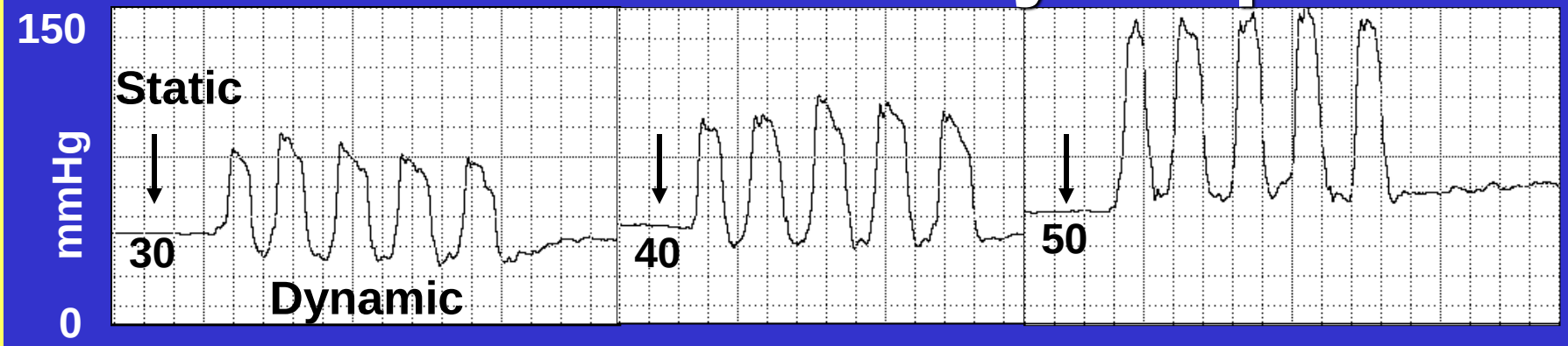


Dr. HN Mayrovitz


Compression achieved at different levels to compare at different sub-bandage pressures
Dr. HN Mayrovitz

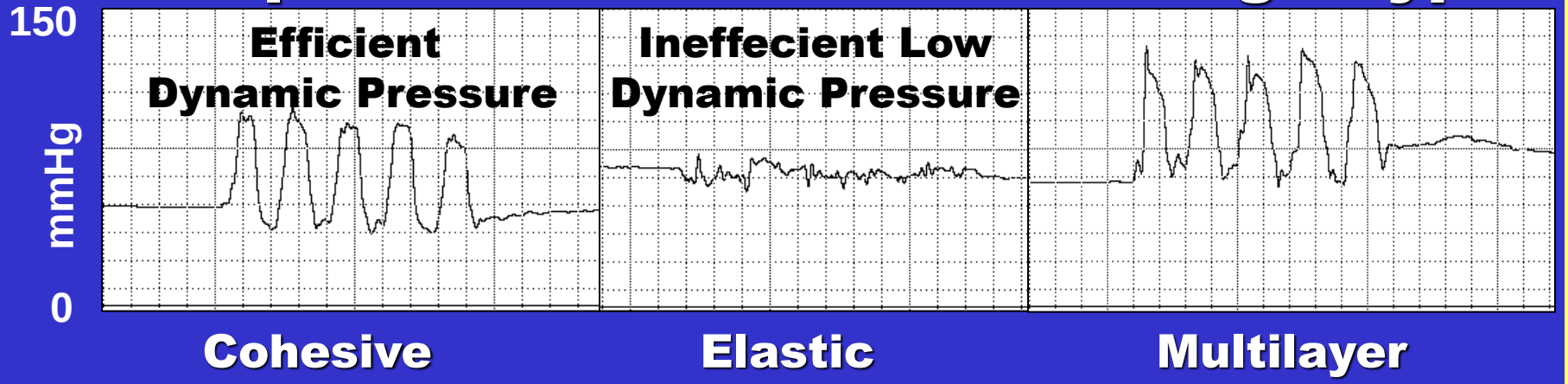
Dynamic (Working) Pressures

Static Pressures Set by Compression



Dynamic pressures via calf muscle contraction

Comparsions of Different Bandage Types



Dr. HN Mayrovitz

Multiple Choice Questions

1. According to Laplace's law, if a limb is bandaged with constant tension, then the contact pressure experienced by the limb will be:

a) greater where the limb is widest
b) greater where the limb is narrowest*
c) equal at all sites since the tension is constant
d) least over areas of bony prominence such as the malleoli

2. A short-stretch bandage, as compared to a long-stretch:

a) results in a greater resting pressure
b) affects the deep vessels more than the superficial vessels
c) results in a greater working pressure*
d) has a greater effect on underlying blood vessels at rest

3. A short-stretch bandadge provides more efficient venous and lymphatic filling and emptying because it produces:
a) greater working pressure and greater resting pressure
b) reduced working pressure and reduced resting pressure
c) greater working pressure and reduced resting pressure*
d) reduced working pressure and greater resting pressure

4. Which tends to produce local tissue edema?
a) an increase in venous pressure*
b) an increase in blood capillary resorption
c) a decrease in blood capillary filtration
d) a high protein content in blood capillaries

5. Which aids the process of lymphatic transport?
a) an increase in venous pressure
b) an increase in arterial pulses*
c) relaxation of the muscles in walls of lymphangions
d) relaxation of the muscles of the calf

References

1. Mayrovitz HN and Sims N. Compression Therapy. In: Wound Healing: Science and Practice. (*in press, 2004*) ed., R. Kirsner & A. Falabella
2. Mayrovitz HN , Larsen PB. Effects of compression bandaging on leg pulsastile blood flow. *Clinical Physiology* 1997;17:105-17
3. Mayrovitz HN . Compression-Induced pulsatile blood flow changes in human legs. *Clinical Physiology, 1997;*18:117-24.
4. Mayrovitz HN, Delgado M., Smith J. Compression bandanging effects lower extremity peripheral and sub-bandange skin blood perfusion.*Wounds* 1997;9:146-52.


Thanks for your Attention