Training and the Musculoskeletal System

Pages 267-270 and 431-439

ADAPTATIONS

Total Strength Gains

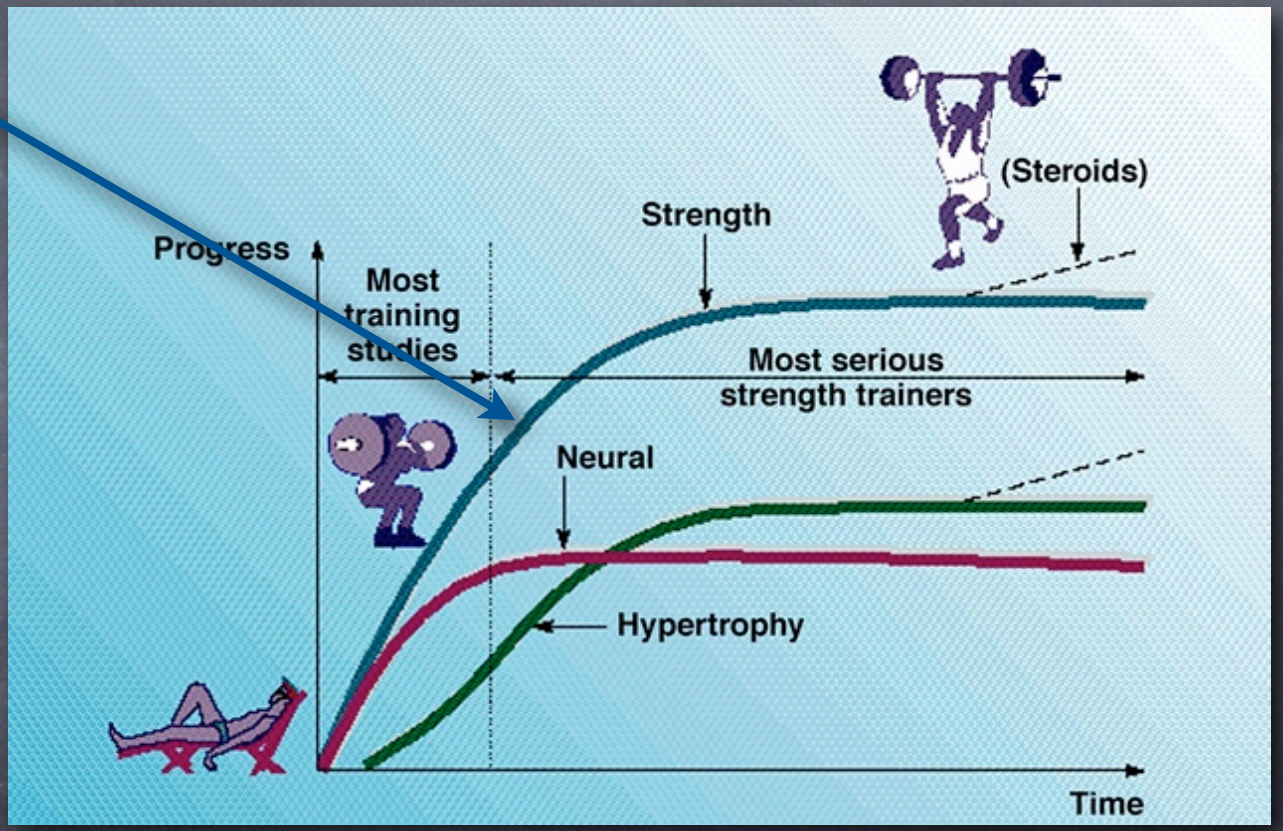
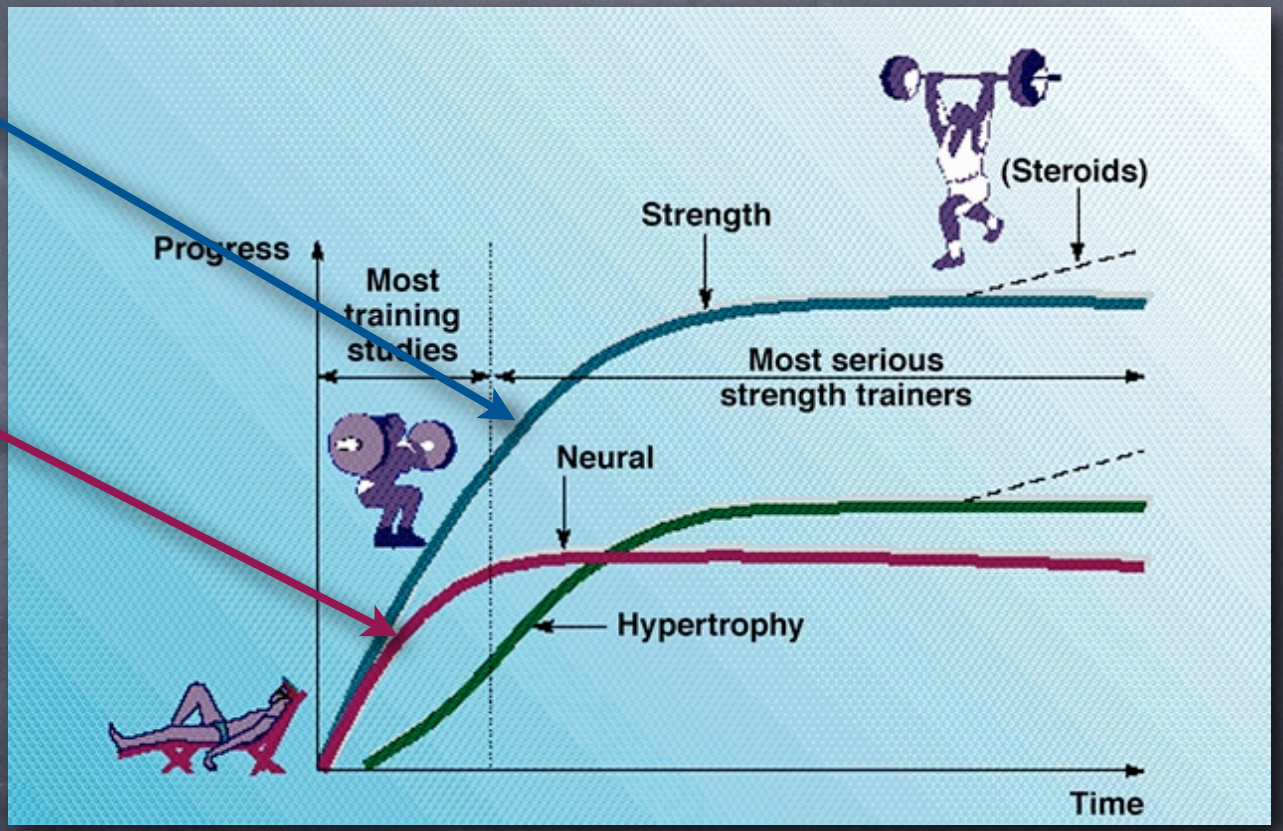


Figure 13.17

ADAPTATIONS

Total Strength Gains

1. Neural factors with "carry over" or "transfer"



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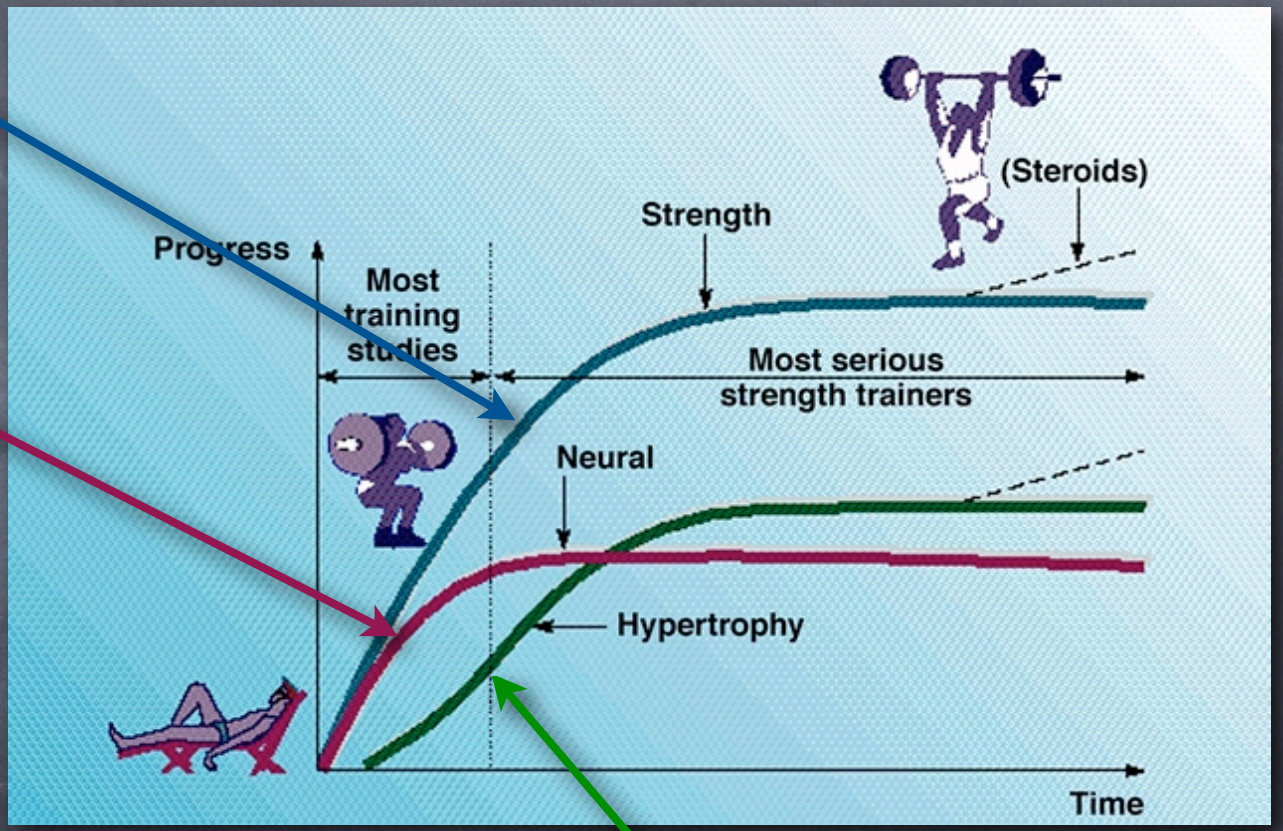
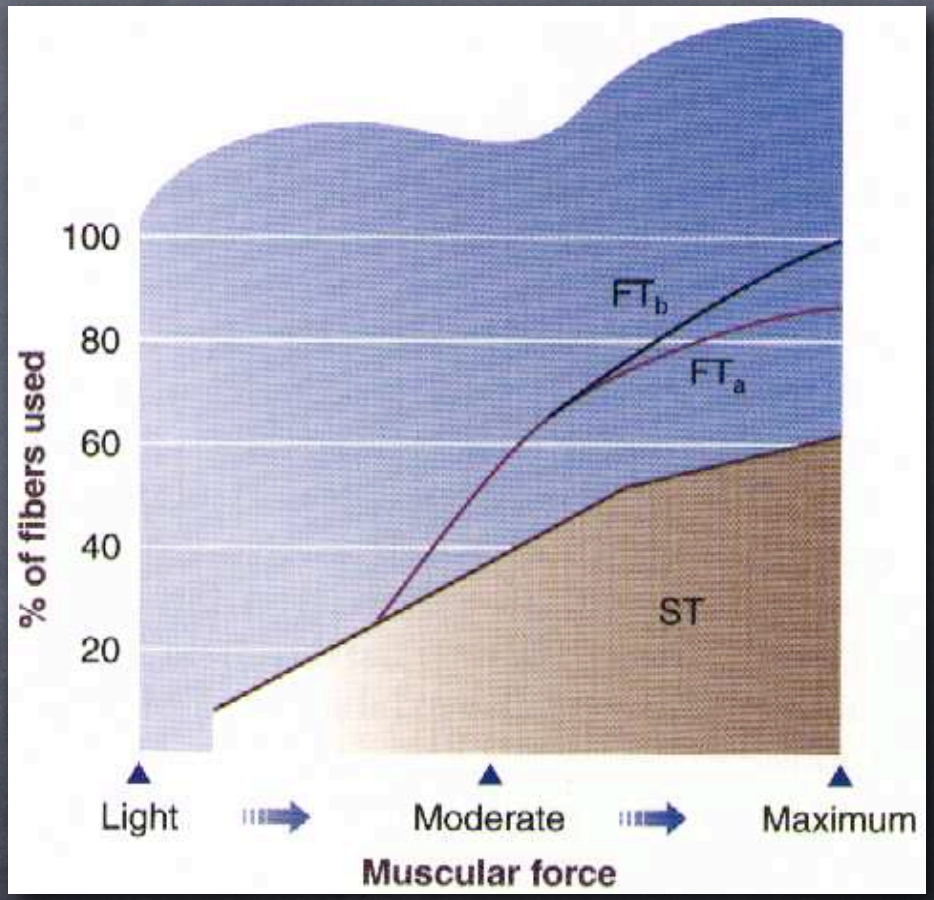


Figure 13.17

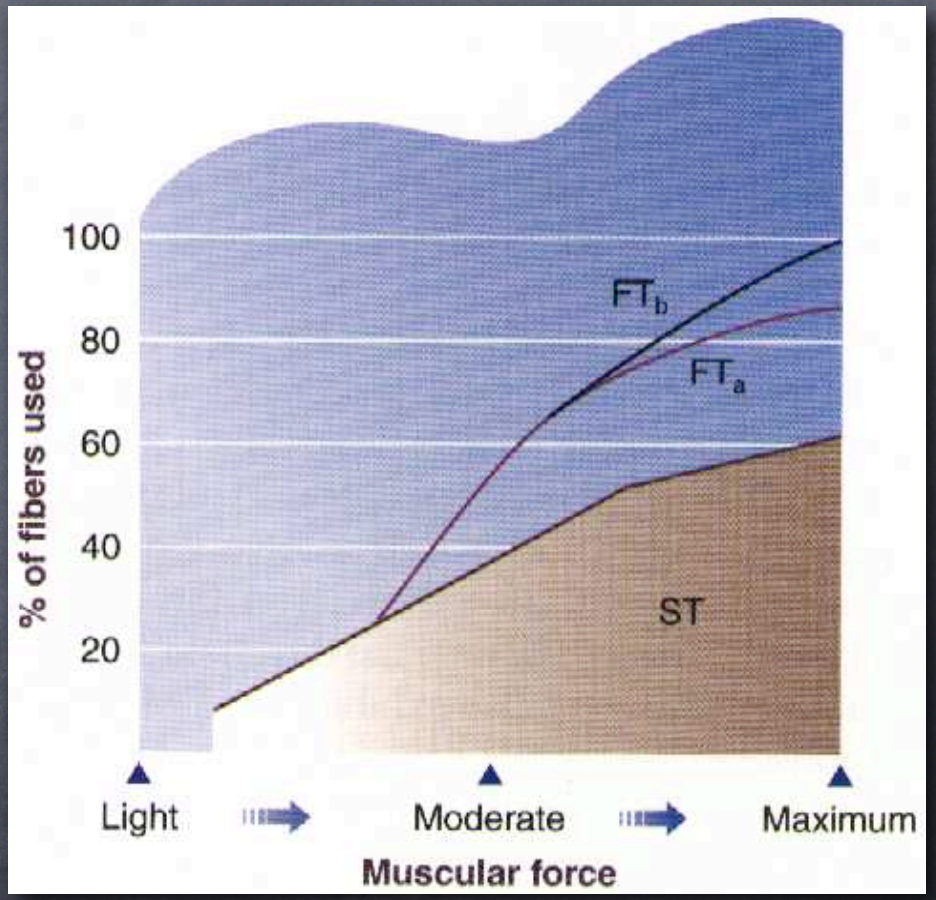
2. Muscular factors

1. Neural Adaptations



1. Neural Adaptations

1. Recruitment of **additional MU** (IIb or Fast Twitch B)



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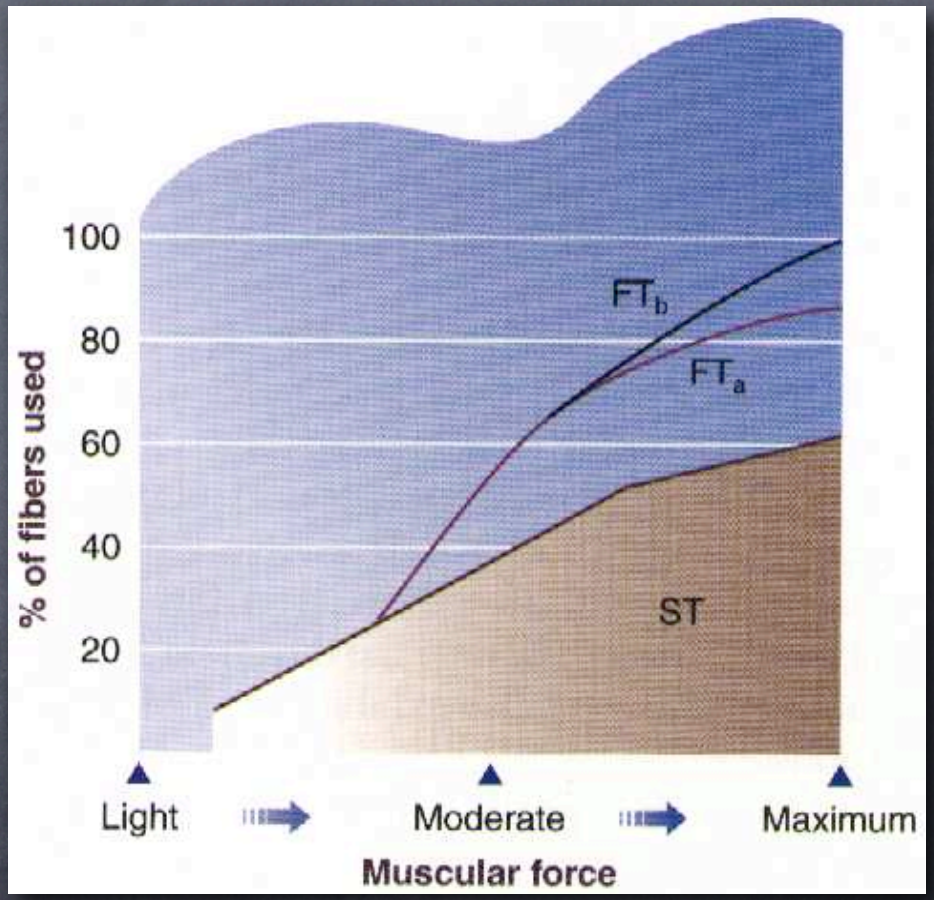
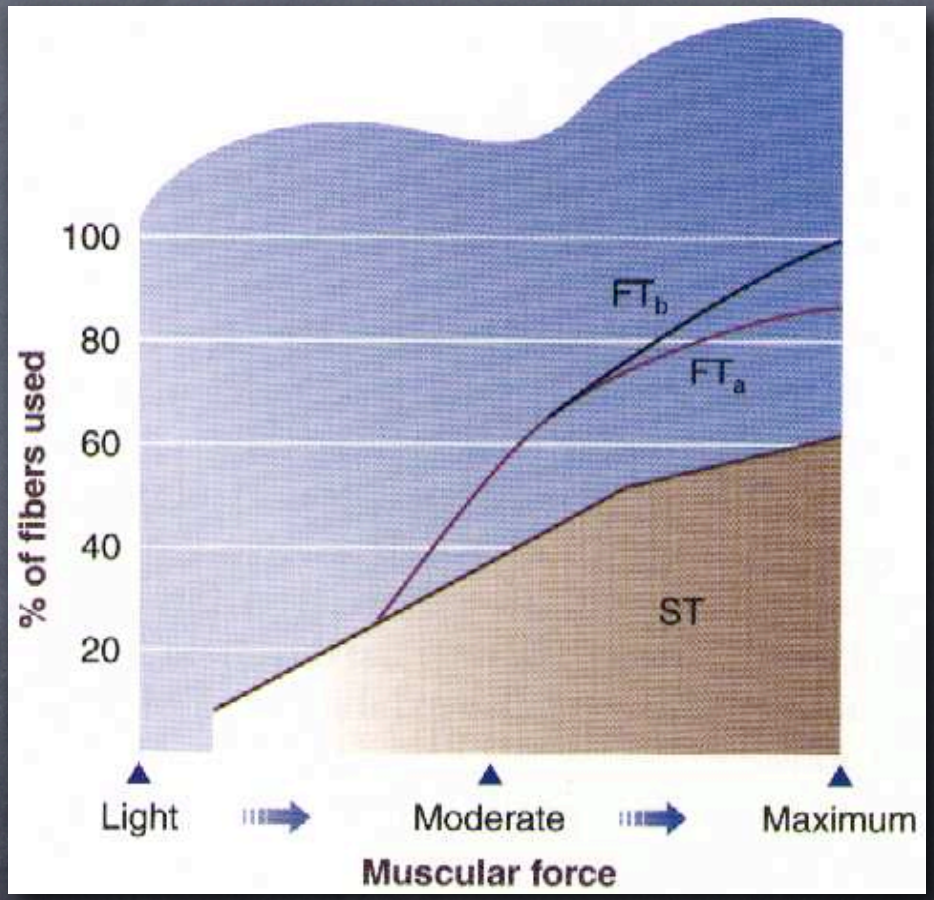
2. Enhance **synchronization** of MU firing

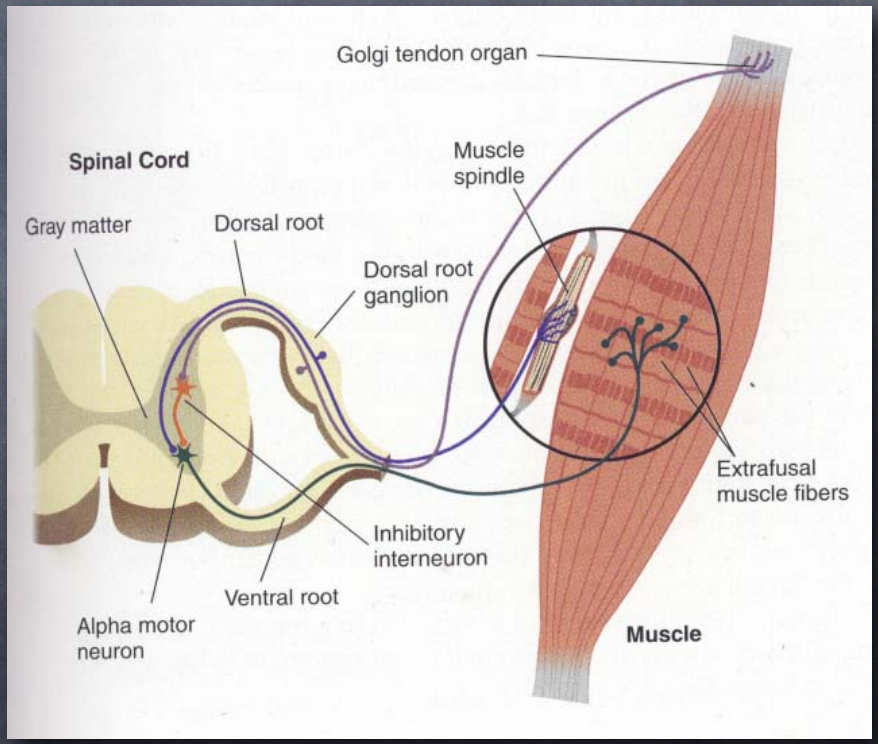


1. Neural Adaptations

1. Recruitment of **additional MU** (IIb or Fast Twitch B)
2. Enhance **synchronization** of MU firing
3. **Neural dis-inhibition** (ignoring GTO)

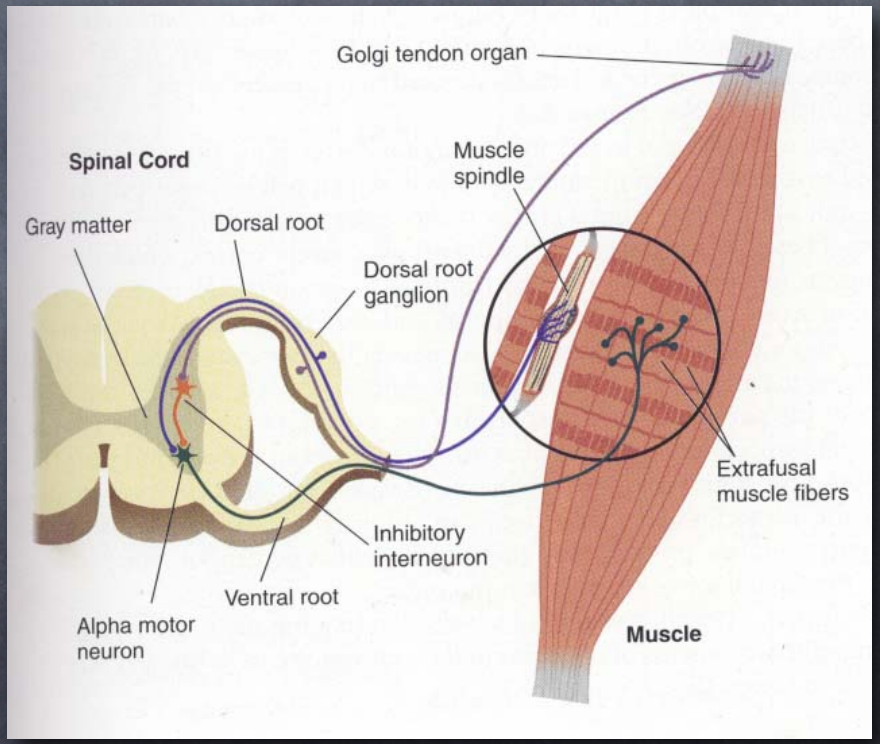


Neural dis-inhibition



Neural dis-inhibition

Golgi tendon organs inhibit muscle contraction



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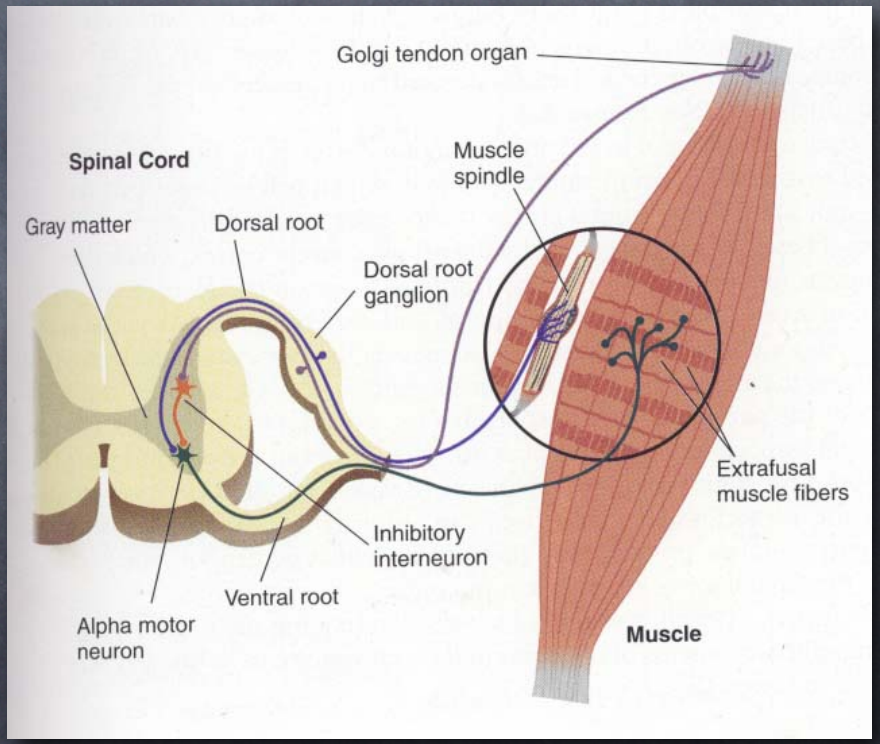
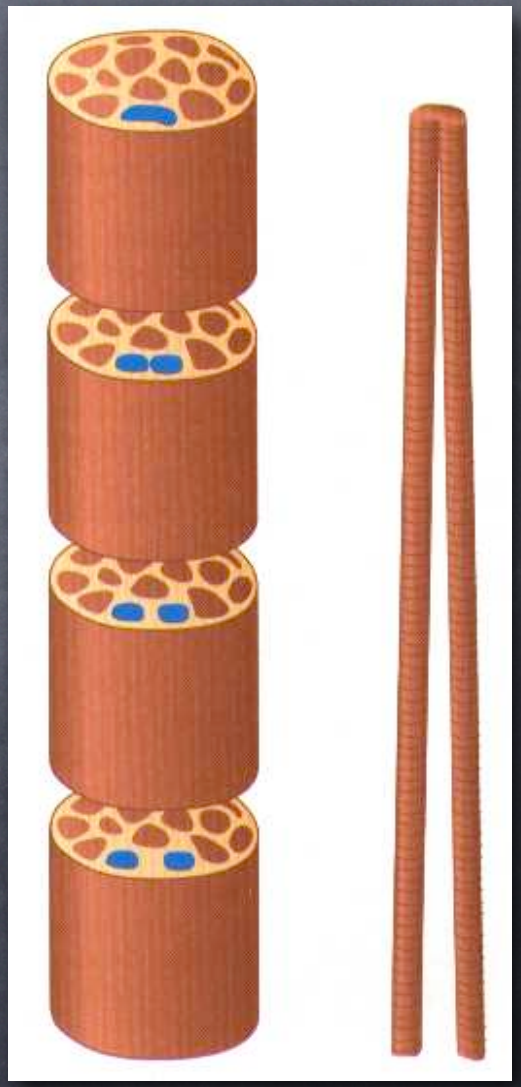
Training effects



2. Muscle Adaptations

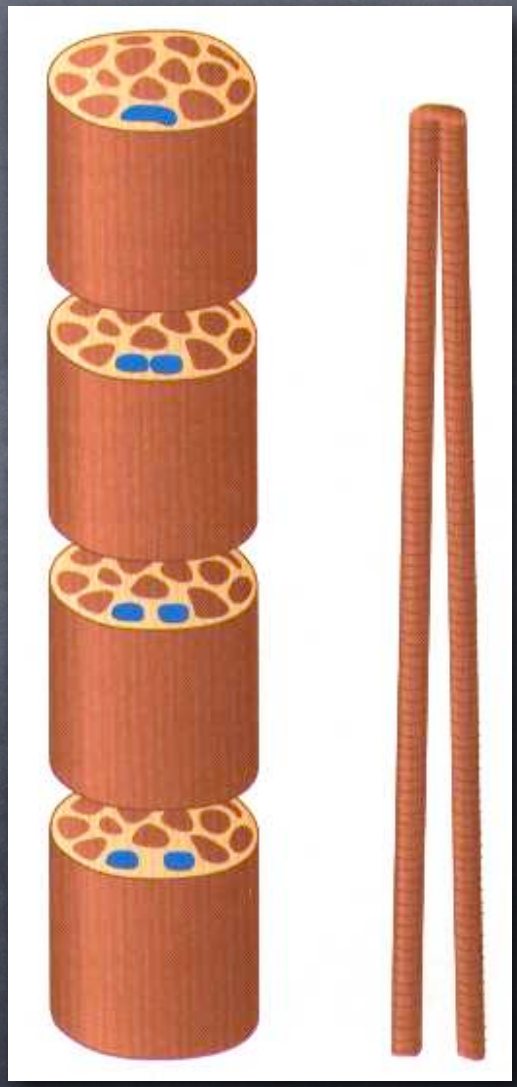
- Whole Muscle hypertrophy
-

Hypertrophy v Hyperplasia



Hypertrophy v Hyperplasia

- WHOLE MUSCLE HYPERTROPHY
  1. Fiber Hypertrophy
  2. Fiber Hyperplasia →
  - 95-100% of whole muscle hypertrophy due to fiber hypertrophy



Whole Muscle Hypertrophy

- Fiber hypertrophy and hyperplascia
  - Increase in protein (actin and myosin)
- Increase in water
- Increase in connective tissue

FYI

Milo of Crotona

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Milo of Crotona, Greek athlete, lived about the end of the 6th century B.C. He was six times crowned at the Olympic Games and six times at the Pythian for wrestling, and was famous throughout the civilized world for his feats of strength - such as carrying an ox on his shoulders through the stadium at Olympia. In his native city he was much honored, and he commanded the army which defeated the people of Sybaris in 511.

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The traditional account of his death is often used to point a moral: he found a tree which some woodcutters had partially split with a wedge, and attempted to rend it asunder; but the wedge fell out and the tree closed on his hand, imprisoning him until wolves came and devoured him. His name became proverbial for personal strength.

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Encyclopaedia Britannica

American College of Sports Medicine, 2002

FYI

SUMMARY

American College of Sports Medicine Position Stand on Progression Models in Resistance Training for Healthy Adults. *Med. Sci. Sports Exerc.* Vol. 34, No. 2, 2002, pp. 364–380. In order to stimulate further adaptation toward a specific training goal(s), progression in the type of resistance training protocol used is necessary. The optimal characteristics of strength-specific programs include the use of both concentric and eccentric muscle actions and the performance of both single- and multiple-joint exercises. It is also recommended that the strength program sequence exercises to optimize the quality of the exercise intensity (large before small muscle group exercises, multiple-joint exercises before single-joint exercises, and higher intensity before lower intensity exercises). For initial resistances, it is recommended that loads corresponding to 8–12 repetition maximum (RM) be used in novice training. For intermediate to advanced training, it is recommended that individuals use a wider loading range, from 1–12 RM in a periodized fashion, with eventual emphasis on heavy loading (1–6 RM) using at least 3-min rest periods between sets performed at a moderate contraction velocity (1–2 s concentric, 1–2 s eccentric). When training at a specific RM load, it is recommended that 2–10% increase in load be applied when the individual can perform the current workload for one to two repetitions over the desired number. The recommendation for training frequency is 2–3 $d \cdot wk^{-1}$ for novice and intermediate training and 4–5 $d \cdot wk^{-1}$ for advanced training. Similar program designs are recommended for hypertrophy training with respect to exercise selection and frequency. For loading, it is recommended that loads corresponding to 1–12 RM be used in periodized fashion, with emphasis on the 6–12 RM zone using 1- to 2-min rest periods between sets at a moderate velocity. Higher volume, multiple-set programs are recommended for maximizing hypertrophy. Progression in power training entails two general loading strategies: 1) strength training, and 2) use of light loads (30–60% of 1 RM) performed at a fast contraction velocity with 2–3 min of rest between sets for multiple sets per exercise. It is also recommended that emphasis be placed on multiple-joint exercises, especially those involving the total body. For local muscular endurance training, it is recommended that light to moderate loads (40–60% of 1 RM) be performed for high repetitions (> 15) using short rest periods (< 90 s). In the interpretation of this position stand, as with prior ones, the recommendations should be viewed in context of the individual's target goals, physical capacity, and training status.

4. Resistance Training Programs

4. Resistance Training Program Design

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- Intensity
  - resistance
  - force

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- Intensity
  - resistance
  - force
- Volume
  - reps
  - sets

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- Intensity
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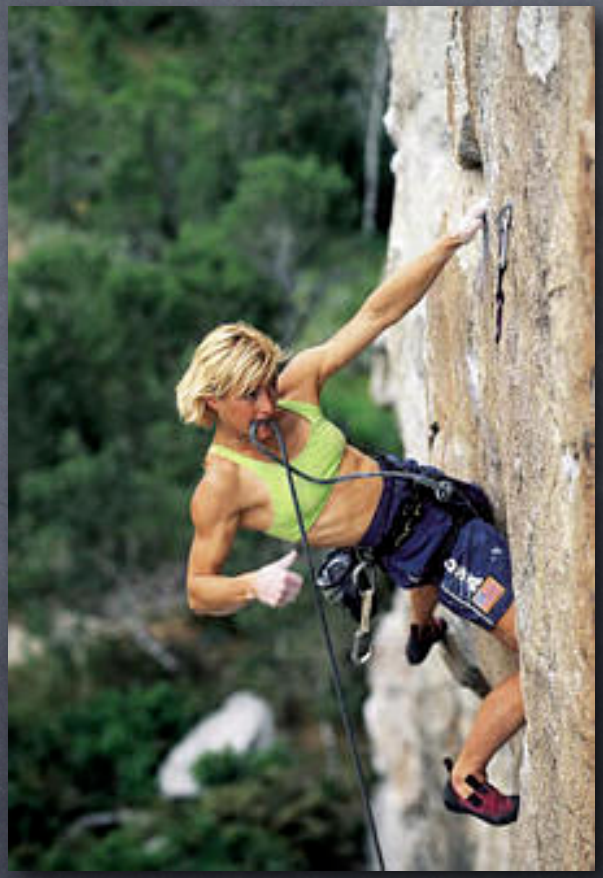

Resistance Training Programs

- Untrained/Novice
  - Faster gains
  - Any "program" effective
    - As little as 1 set at 67-80% (8-12 reps)

Resistance Training Programs

- Moderate to Highly Trained Individuals
  - Strength
  - Power
  - Hypertrophy
  - Endurance

Strength Program

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- Repetitions: few (≤ 6)

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- Why the longer time period between sets?

Power Program

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- Emphasis: speed
  - increases neural stimulation
  - minimizes the slowing effects of strength

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- Plyometric exercises (next...)

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Power Program - Plyometrics

Power Program - Plyometrics

Power Skipping

Repeated Tuck Jumps

Repeated Long Jumps

Diagonal Obstacle Jump

Alternate Leg Bounding

Squat Jump

Single Leg Hops

Plyometric Loading

Plyometric Loading

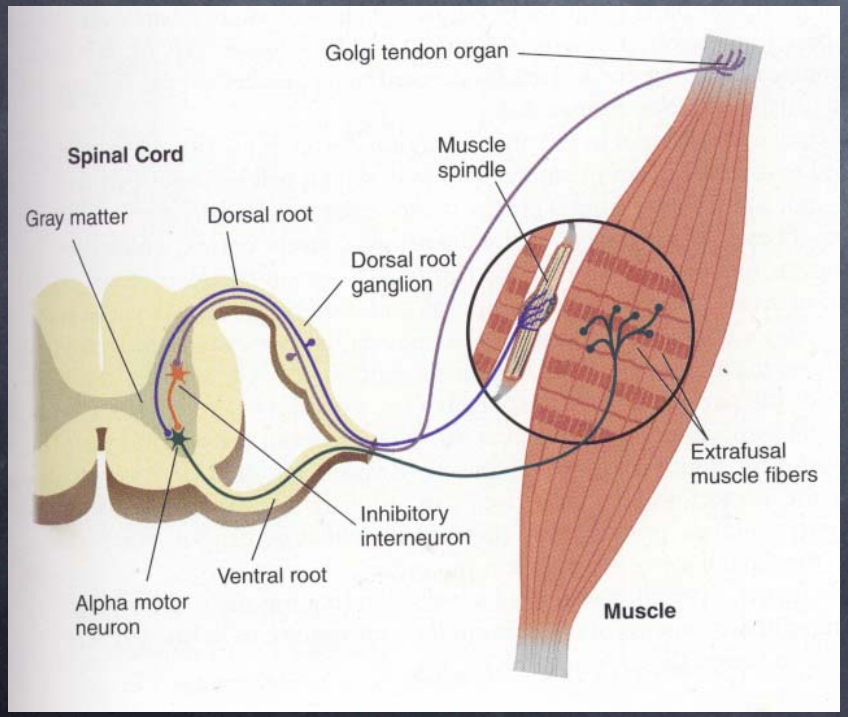
- What is it?

Plyometric Loading

- What is it?
- What's the physiology behind it?
  - **Elastic energy:** more powerful muscle contraction
  - **Stretch-shortening cycle:** greater fiber recruitment (next slide...)

Plyometric Physiology

Muscle Spindles



Plyometric Physiology

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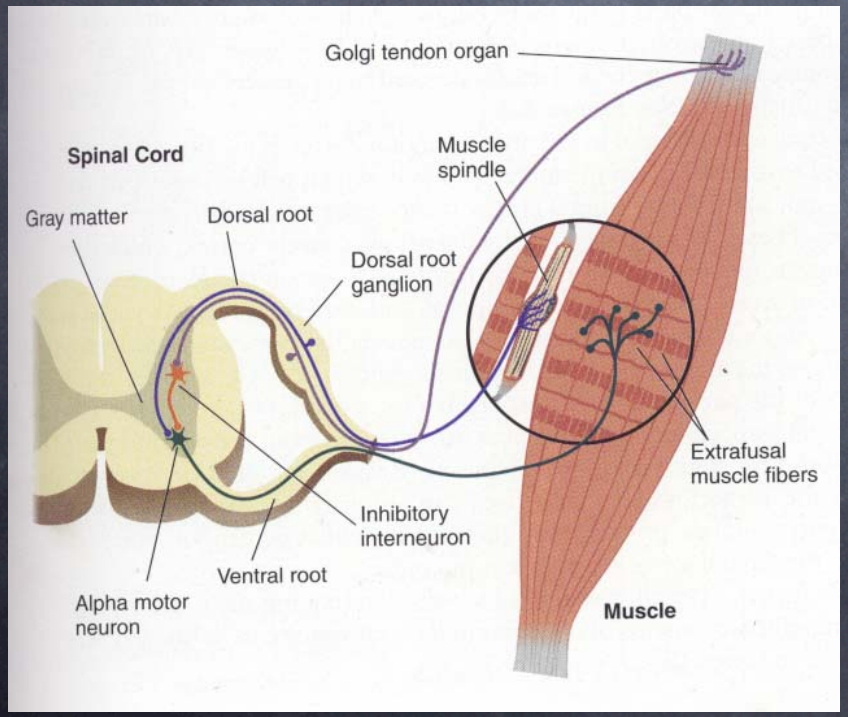
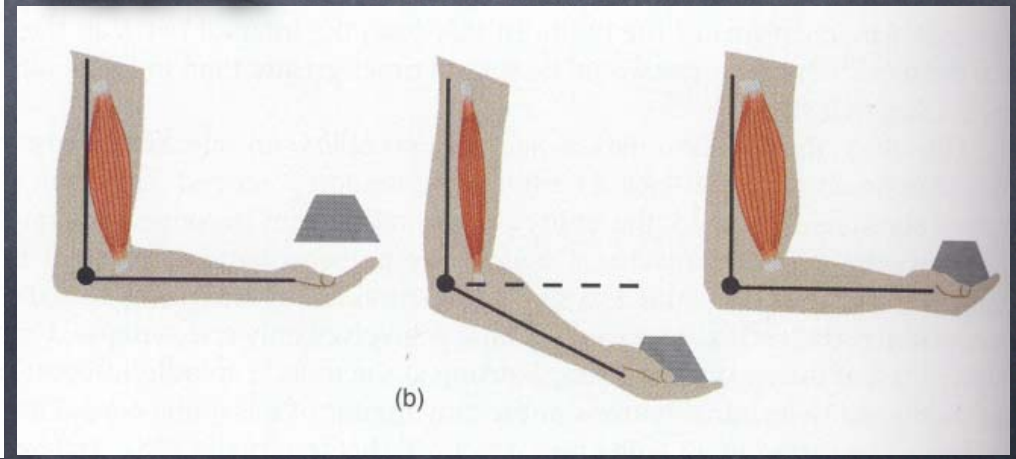
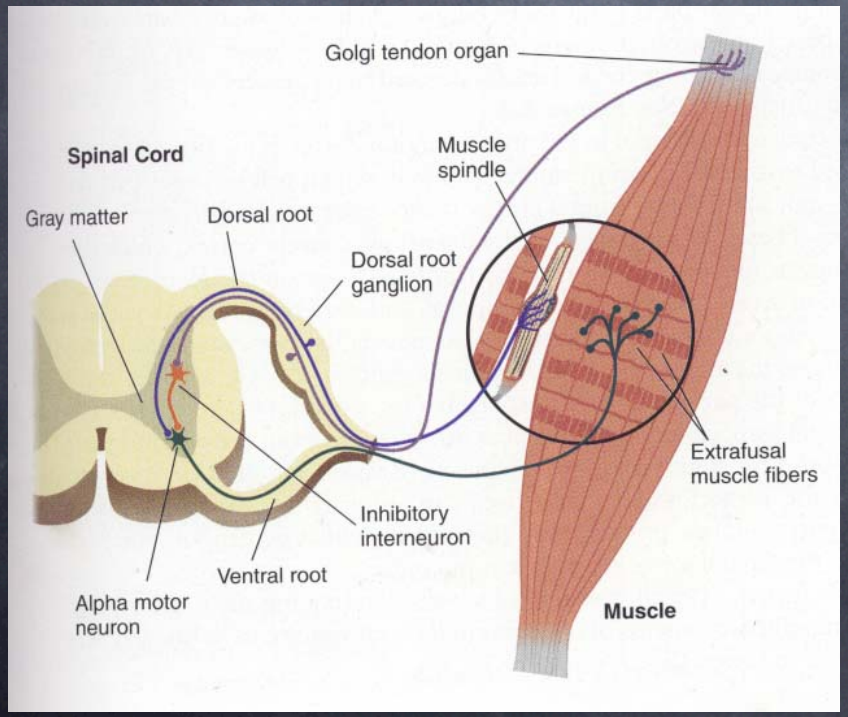


Neutral

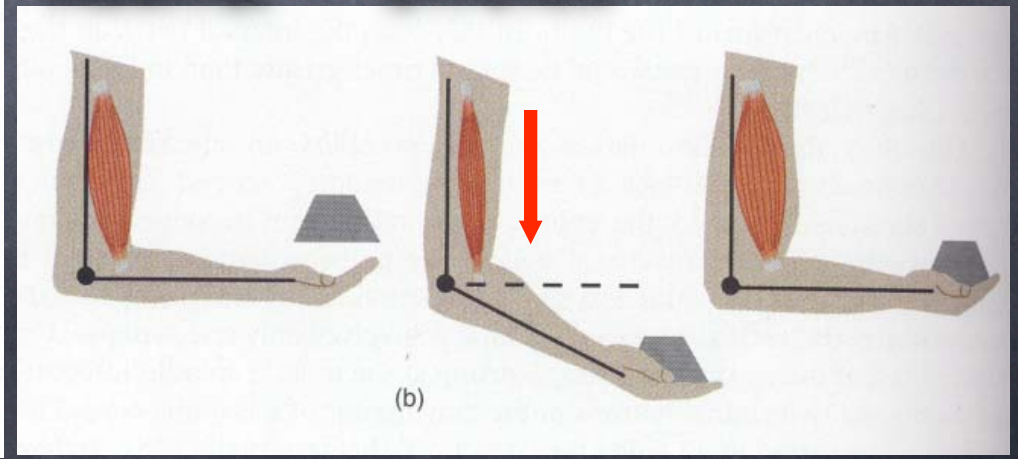


Plyometric Physiology

Muscle Spindles



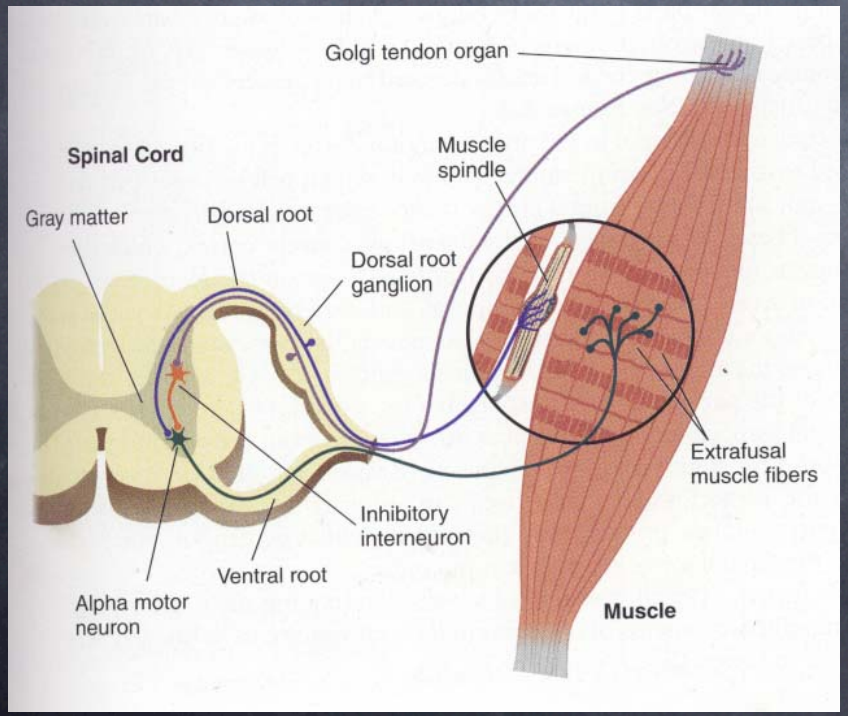
Neutral Stretch

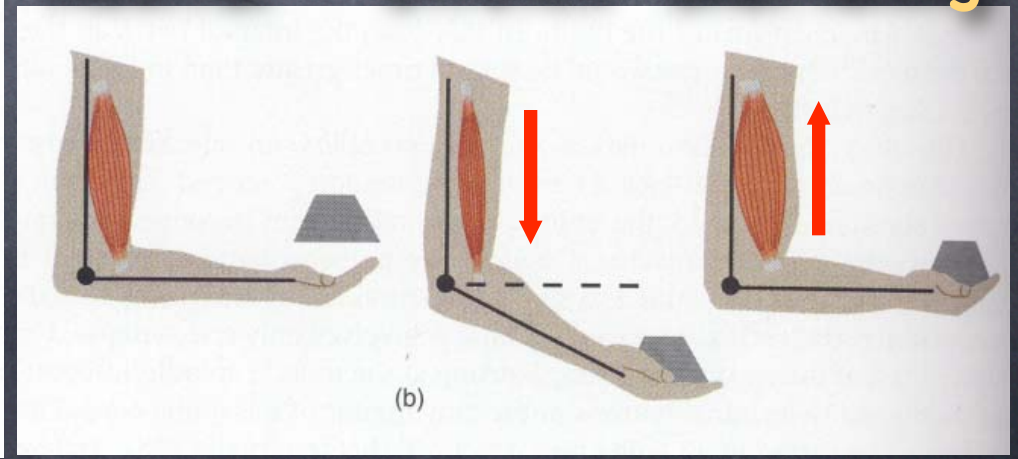


Plyometric Physiology

Stretch-Shortening Cycle

Muscle Spindles





Hypertrophy Program

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- Greater volume and number of exercises
  - Volume = reps x sets

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- Less rest (less than 90 sec.)
  - Why less rest?

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Endurance Program

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- Repetitions: high ≥12
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- Moderate rest depending on number of reps (30 sec to 3 min)

Endurance Program

- What is muscle endurance?
- Resistance: low ≤67%
- Repetitions: high ≥12
- Sets: 2-3

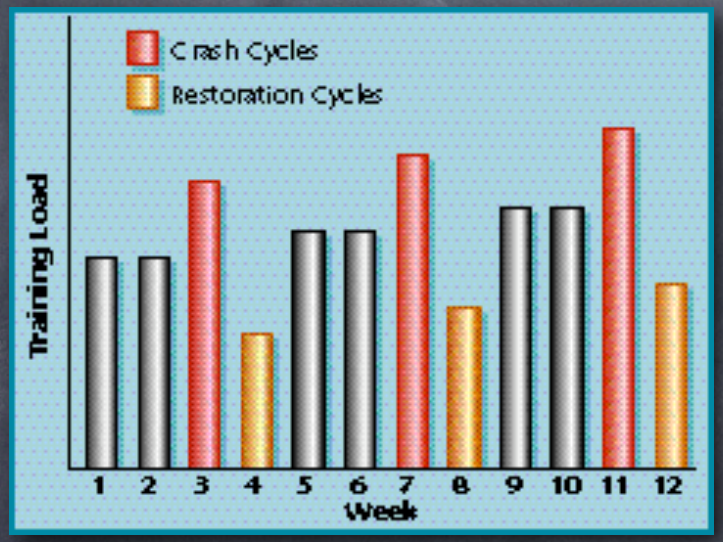
- Moderate rest depending on number of reps (30 sec to 3 min)
- Reasons: toning (?), core training, injury prevention, etc

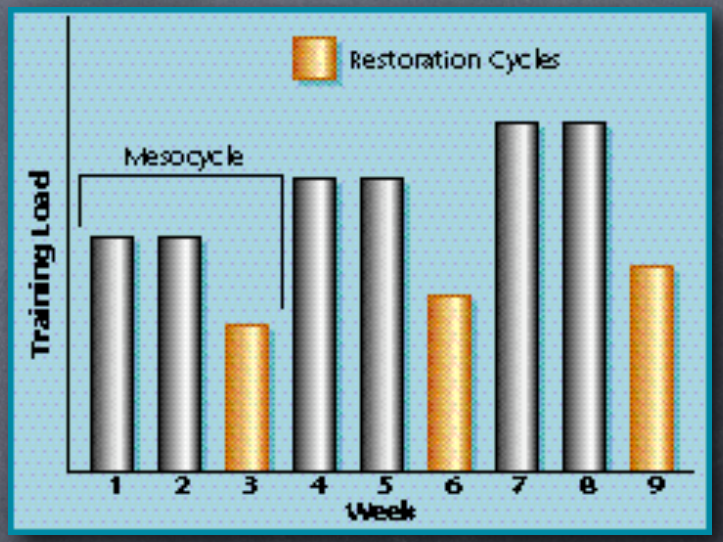
Resistance Programs

	Strength	Power	Hypertrophy	Endurance
Resistance	≥85%	75-85%	67-85%	≤67%
Reps	≤6	3-5	6-12	≥12
Sets	2-6	3-5	3-6	2-3
Rest	2-5 min	2-5 min	0.5-1.0 min	≤0.5 min

Know the physiology

Periodization





Periodization

Example

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Example

1. Hypertrophy
   - 2-3 months with microcycles or day to day variations

Periodization

Example

1. Hypertrophy
   - 2-3 months with microcycles or day to day variations
2. Endurance
   - 2-3 weeks

Periodization

Example

1. Hypertrophy
   - 2-3 months with microcycles or day to day variations
2. Endurance
   - 2-3 weeks
3. Strength
   - 2-3 months with microcycles or day to day variations

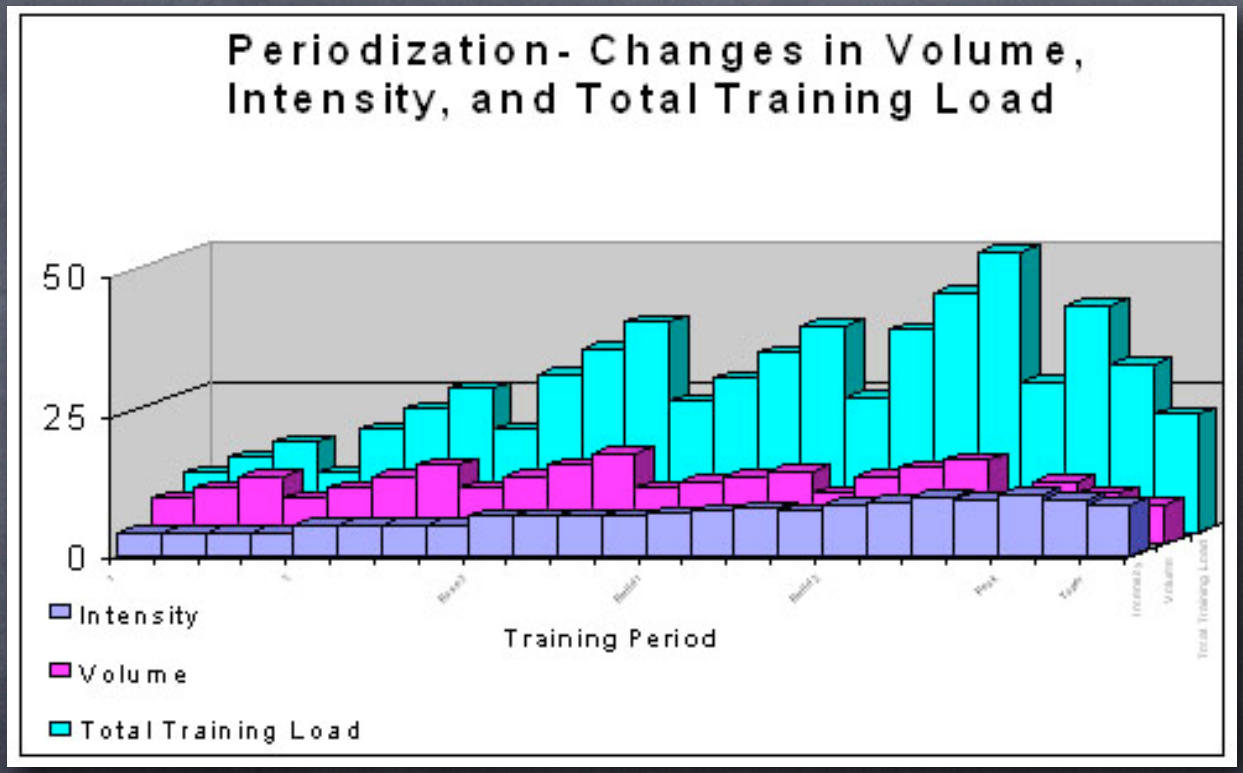
Periodization

Example

1. Hypertrophy
   - 2-3 months with microcycles or day to day variations
2. Endurance
   - 2-3 weeks
3. Strength
   - 2-3 months with microcycles or day to day variations
4. Power
   - 1-2 Weeks

Periodization

Periodization



Myth Busters

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- Muscle size (hypertrophy) does not necessarily lead to inflexibility

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- Endurance programs (high reps) are not effective for weight loss

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- Muscle size (hypertrophy) does not necessarily lead to inflexibility
- Endurance programs (high reps) are not effective for weight loss
- Muscle tissue has only a slightly higher "metabolism" than fat tissue

5. Muscle Action

5. Muscle Action

- Isometric

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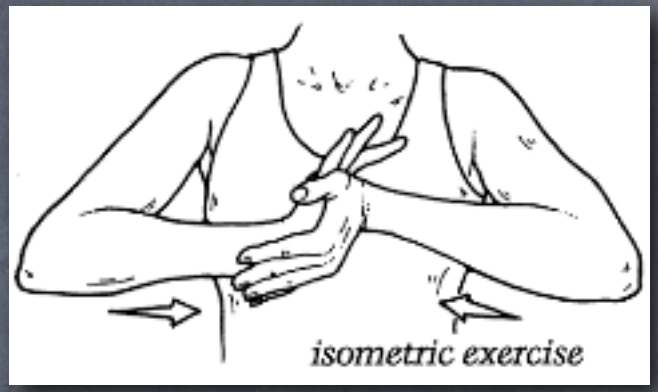
- Isometric
- Isotonic or Dynamic

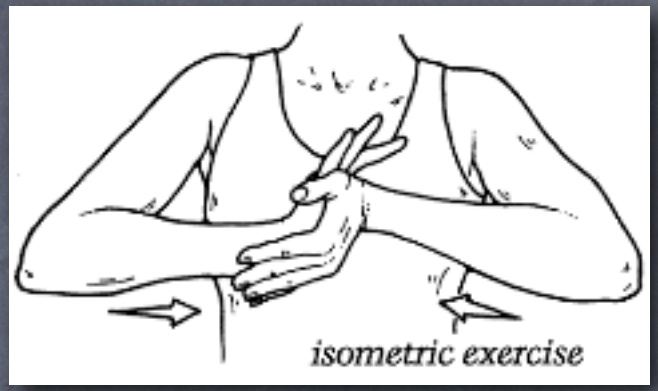
5. Muscle Action

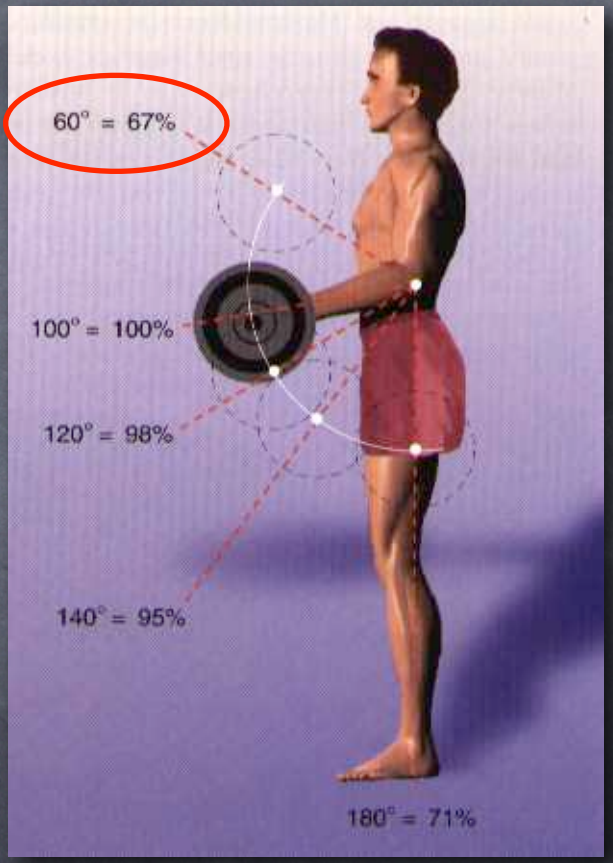
- Isometric
- Isotonic or Dynamic
- Isokinetic

Isometric Training



Isometric Training





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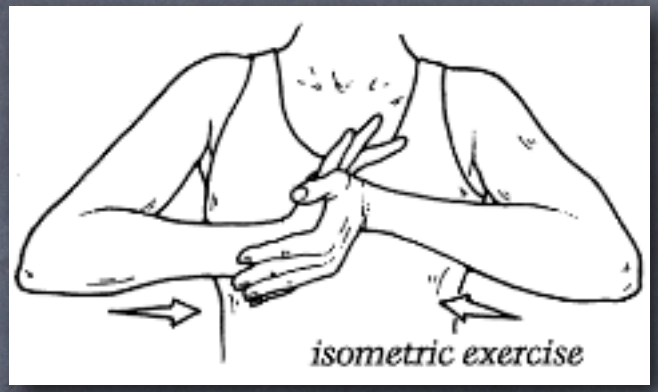
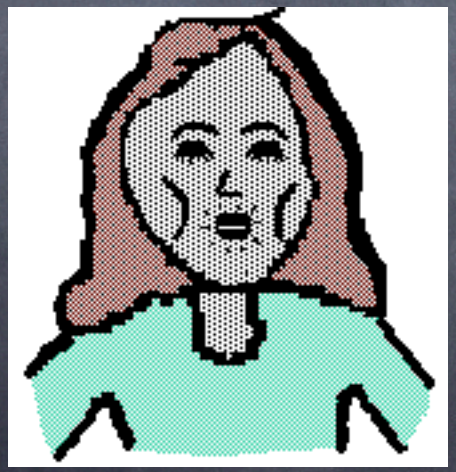
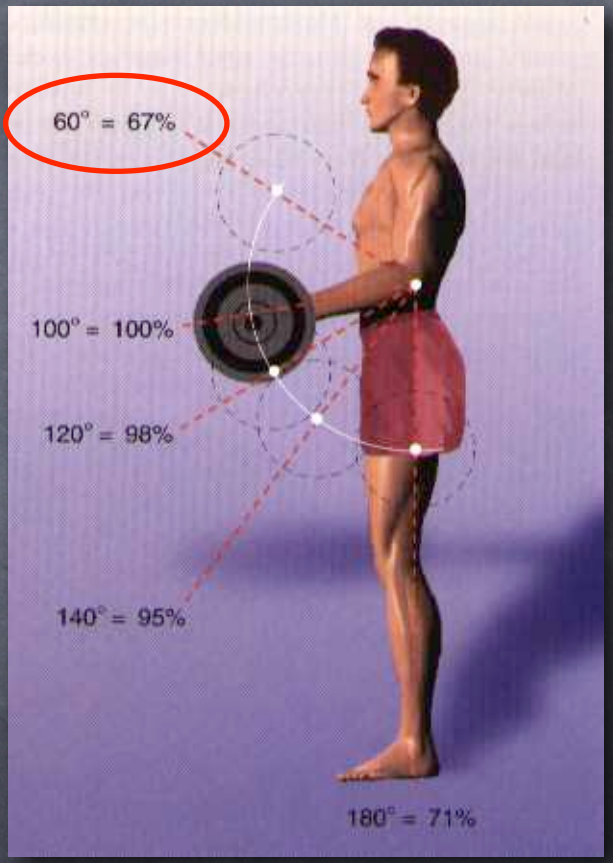






Isotonic Training

Isotonic Training

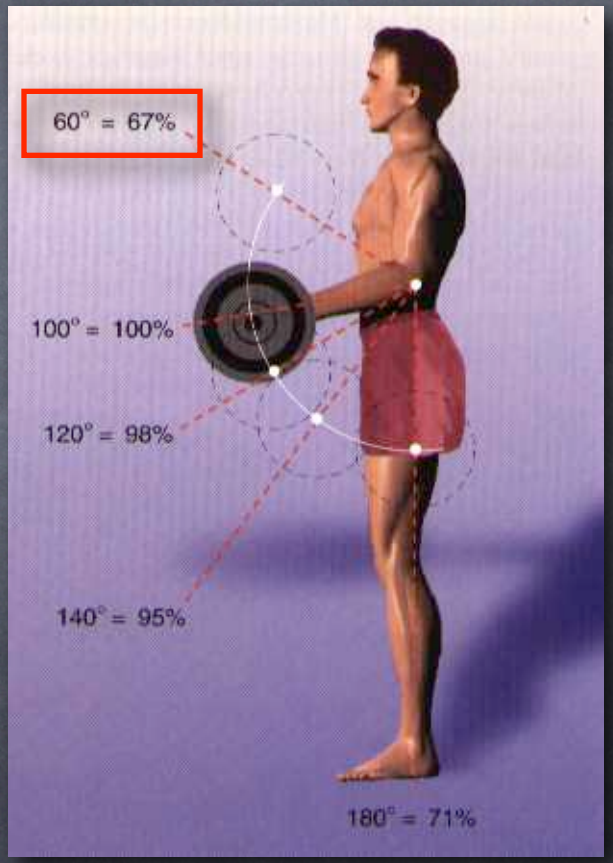
- Concentric and eccentric muscle contractions

Isotonic Training

- Concentric and eccentric muscle contractions
- Examples of isotonic exercises

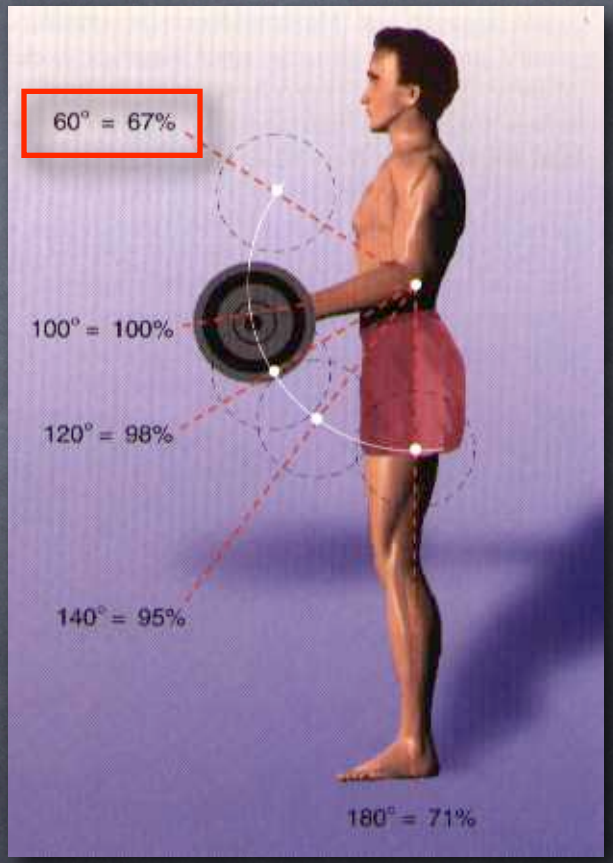
1. **Free Weights**
2. **Machines**

Free Weights



Free Weights

- What are the physiological advantages?



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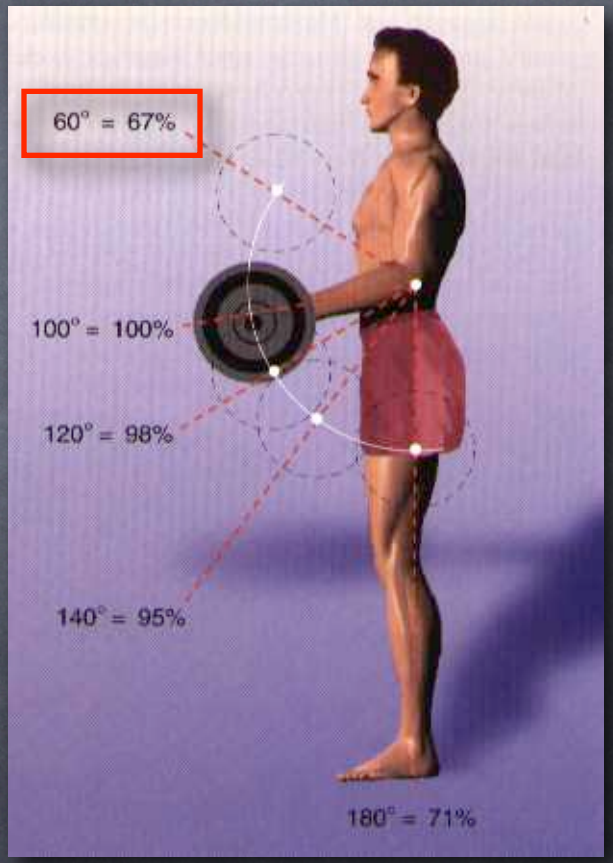
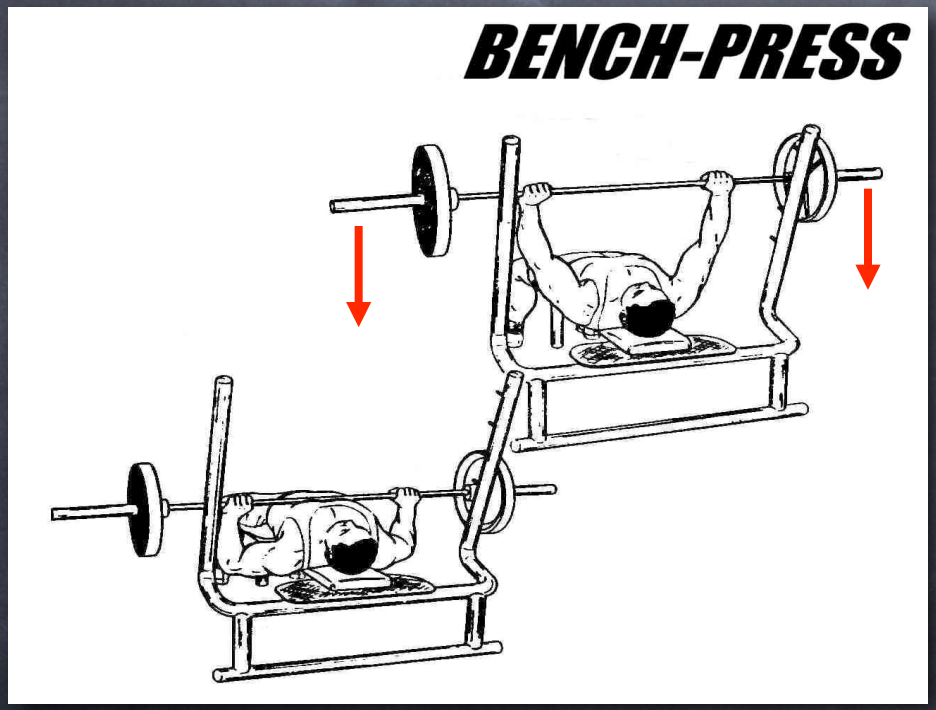
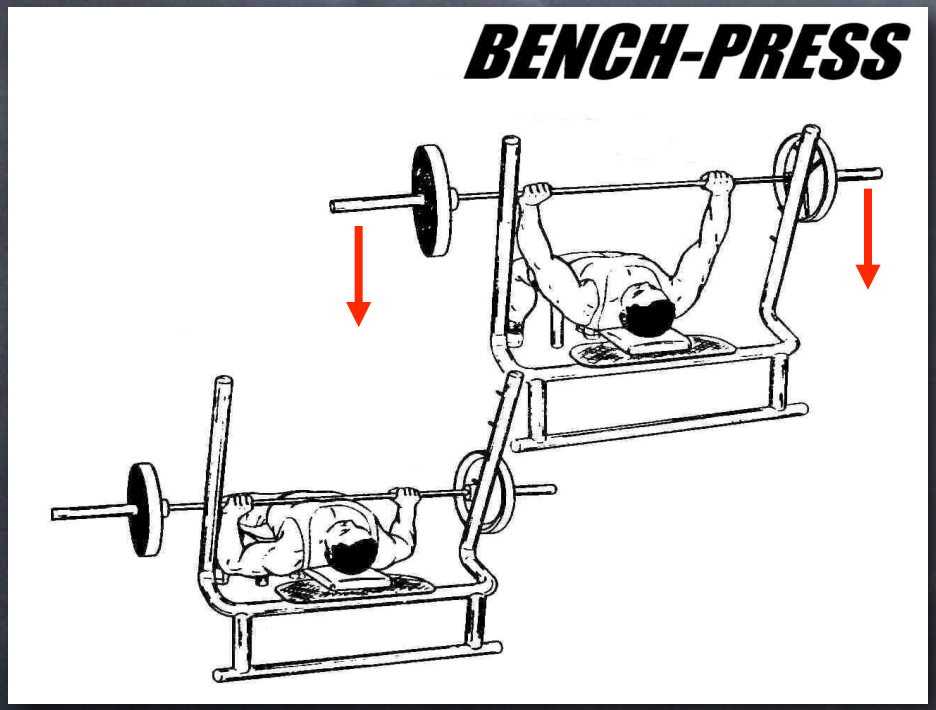


Eccentric Loading



Increase in length
of pectoralis major
as the weight is lowered

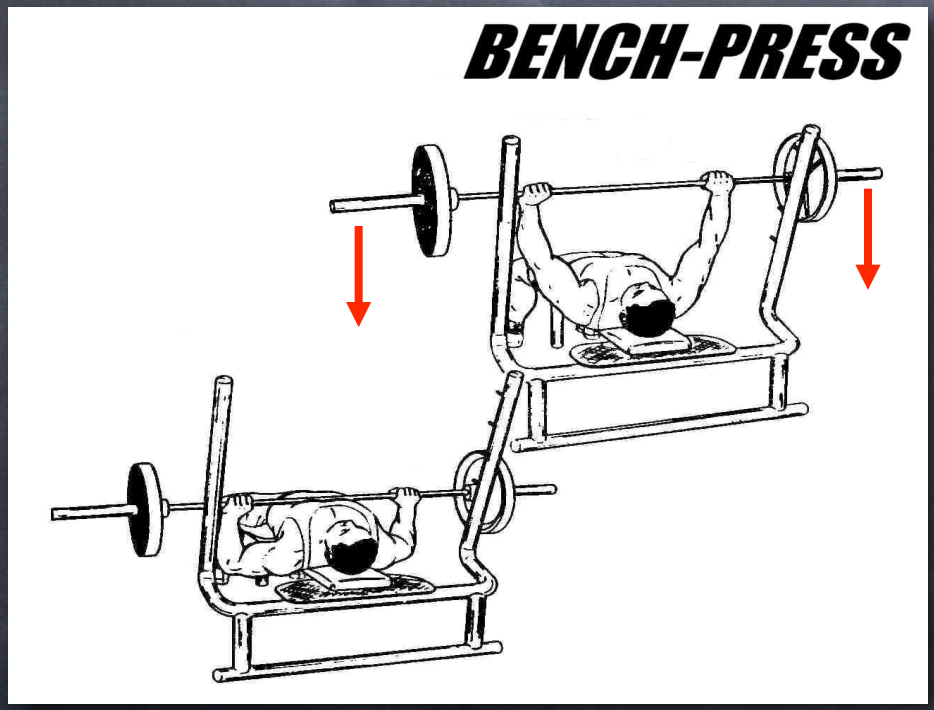
Eccentric Loading



Increase in length of pectoralis major as the weight is lowered

120% of 1RM is used as an upper limit

Eccentric Loading

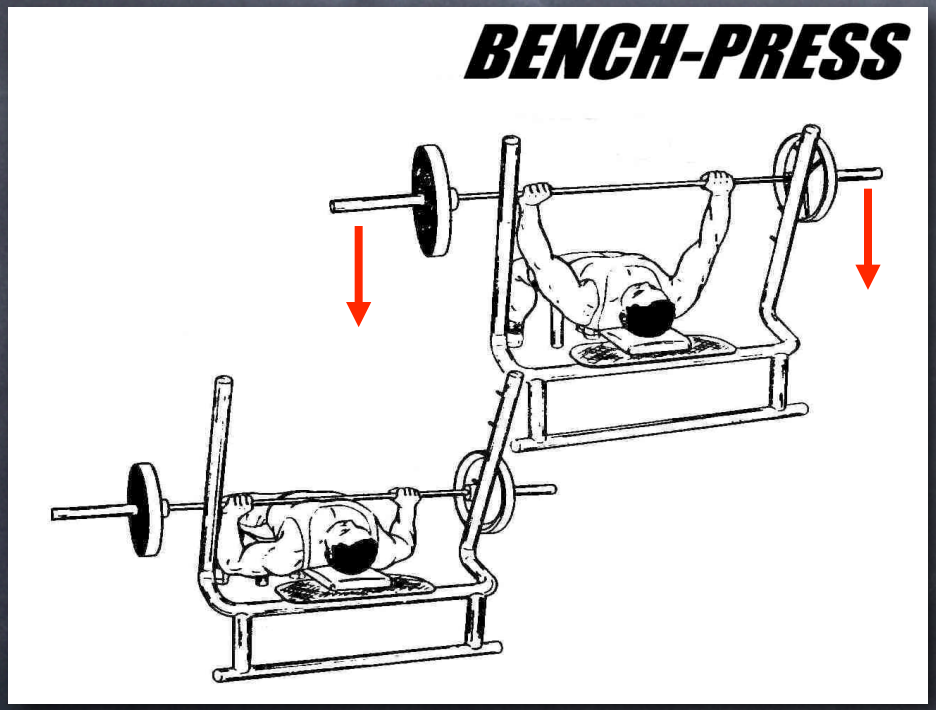


Increase in length of pectoralis major as the weight is lowered

120% of 1RM is used as an upper limit

What are the physiological benefits?

Eccentric Loading



Increase in length of pectoralis major as the weight is lowered

120% of 1RM is used as an upper limit

What are the physiological benefits?

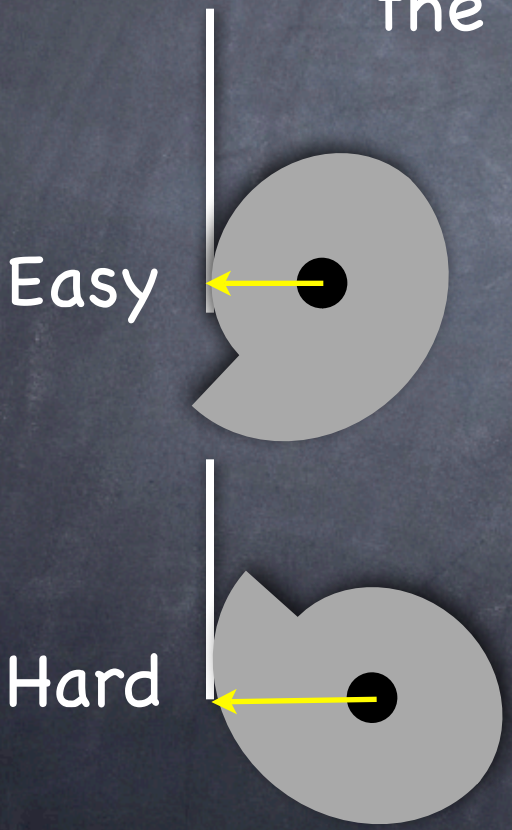
What are the physiological risks?

Machines

- What are the physiological advantages?
- What are the physiological disadvantages?

Variable Resistance

Note the shape of the cam



Variable Resistance

- What are the physiological advantages?
- What are the physiological disadvantages?

Isokinetic

Isokinetic

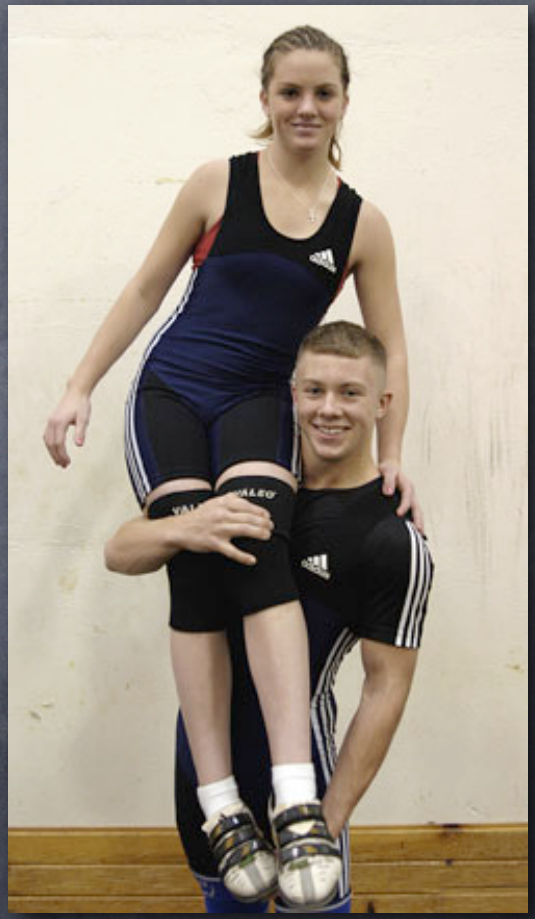
- **Accommodating resistance** keeps the speed of contraction constant

Comparison

Program	Equipment	Advant.	Disadvant.
Isometric	Various types	Weak points	R.O.M., Valsalva
Isotonic	Free Weights	Synergist Muscles	Weak points
	Machine (Universal)	Emphasize	Synergist Muscles
Variable Resistance	Machine (Nautilus)	Full ROM	Synergist Muscles
Isokentic	Machine (Cybex)	Rehab	Non-specifc

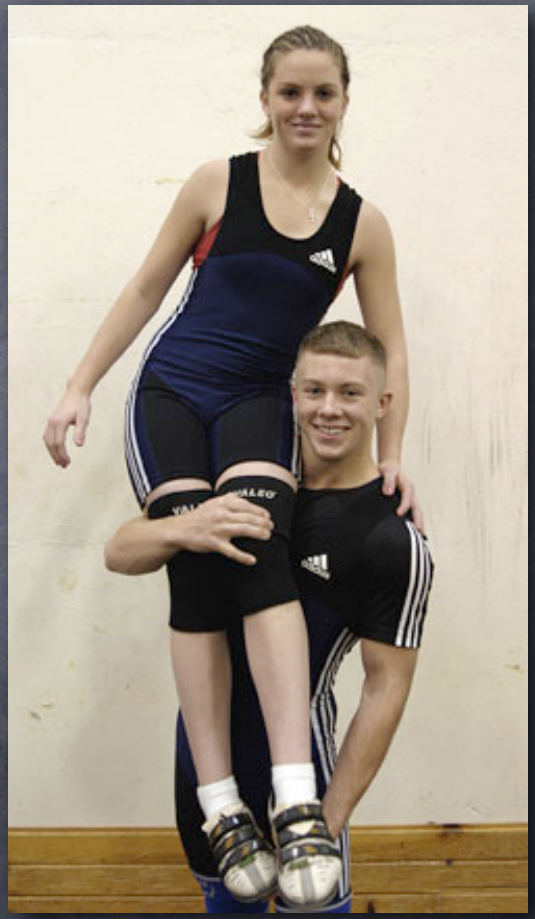
Table 21.3

6. Gender Differences



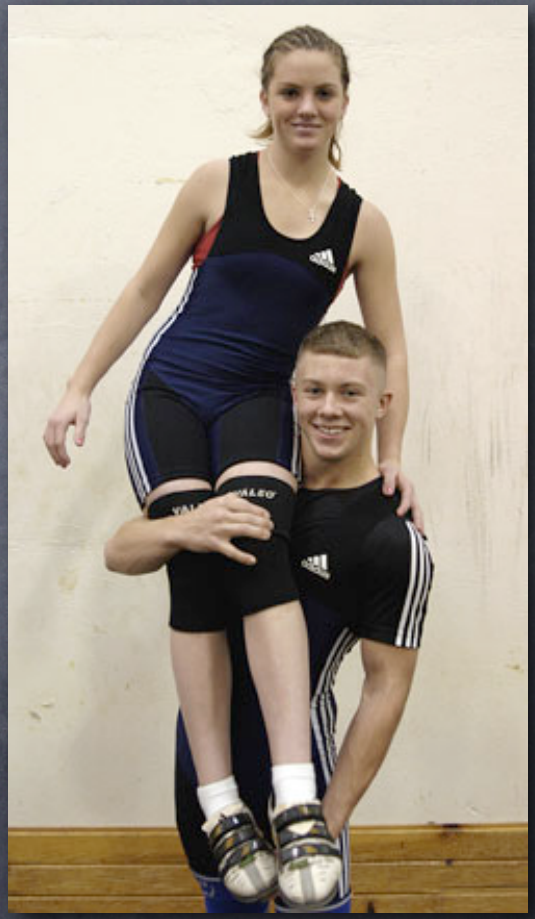
6. Gender Differences

- Why are men generally stronger than women?

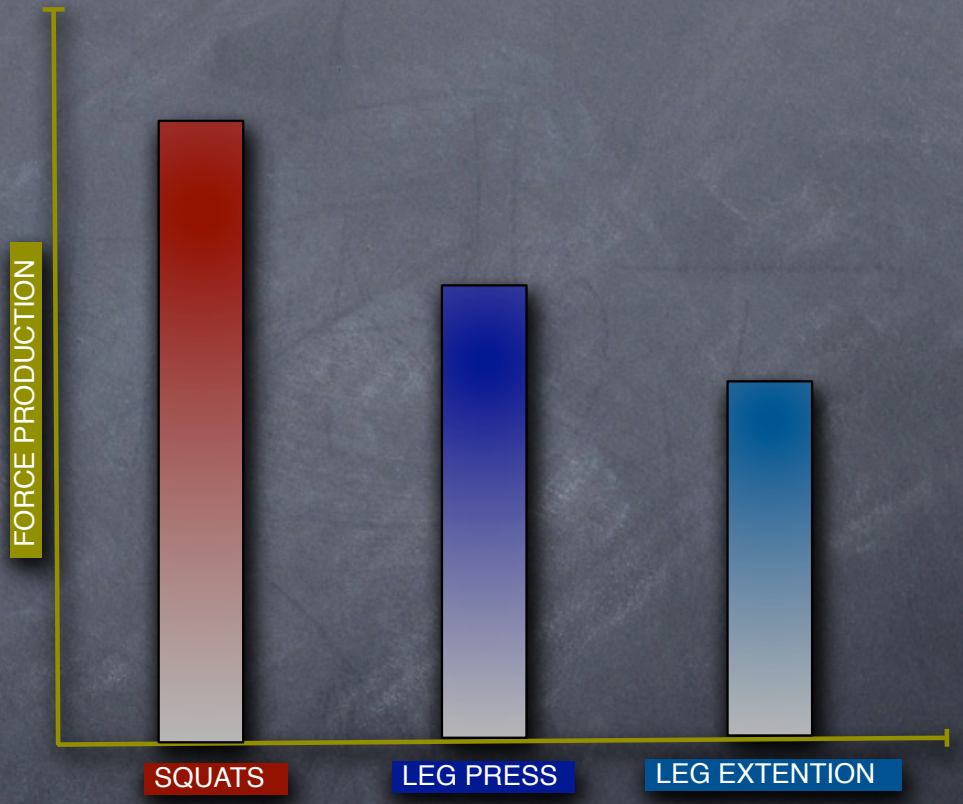


6. Gender Differences

- Why are men generally stronger than women?
- Pound for pound of muscle mass, are men stronger than women?



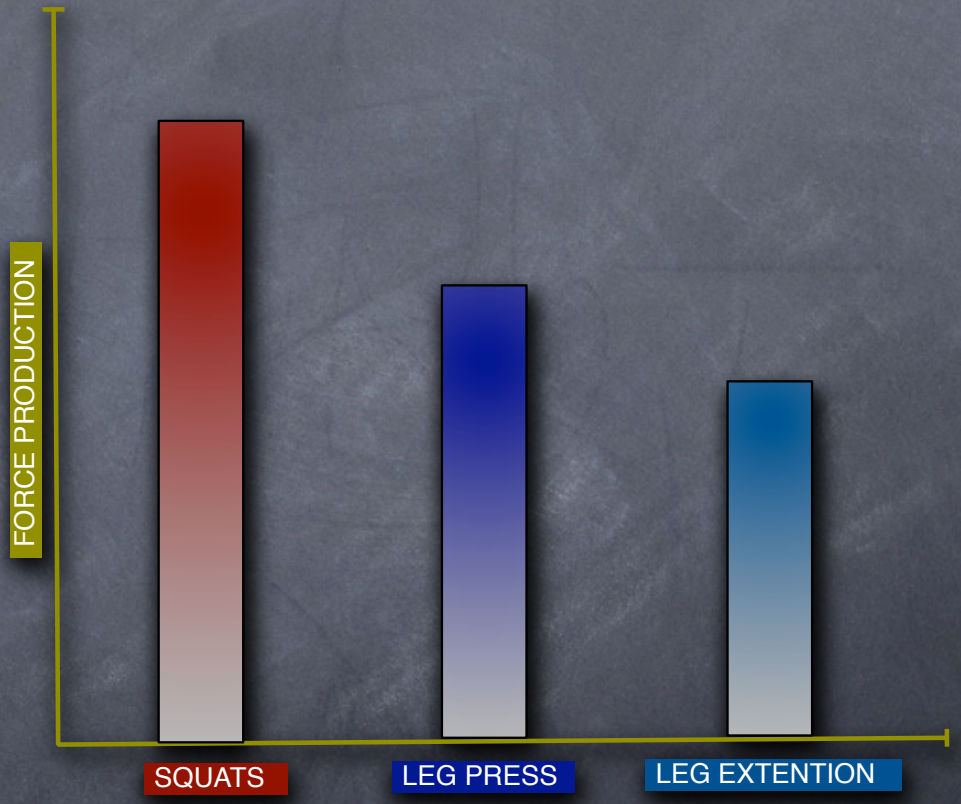
7. Muscle Group Specificity



Percent improvement in strength from training with squat exercise only

7. Muscle Group Specificity

Type of exercise matters even in the same muscle groups



Percent improvement in strength from training with squat exercise only

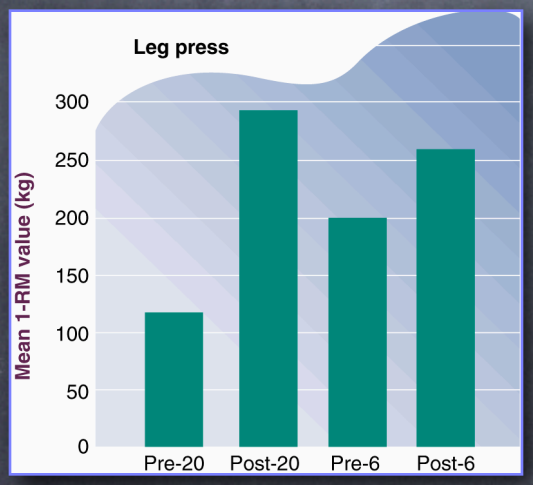
8. Reversibility

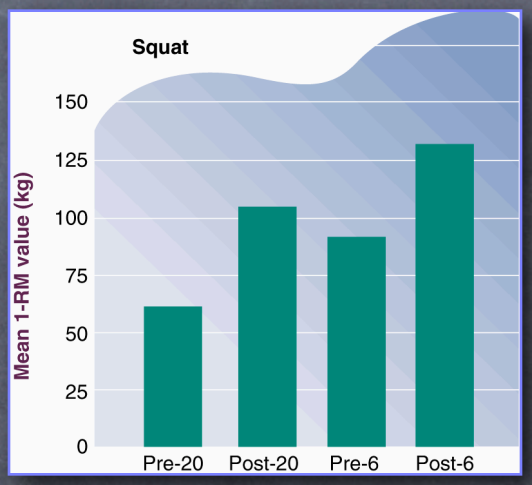
Return of strength after periods of inactivity

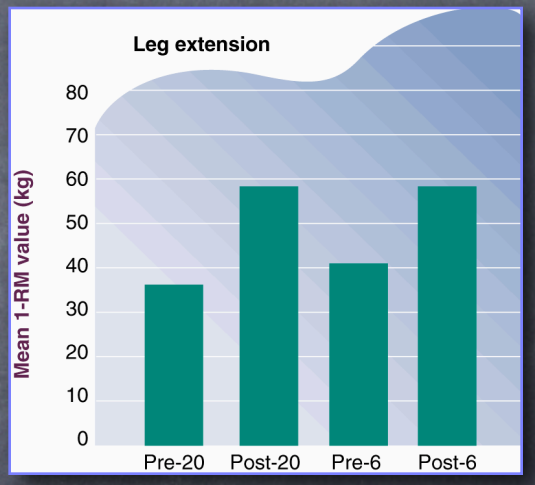
Why is strength re-gained faster than the initial gains?

8. Reversibility

Return of strength after periods of inactivity







Why is strength re-gained faster than the initial gains?

Flexibility

Pages 318, 436, 439

Flexibility

Pages 318, 436, 439

Streching/Flexibility

Streching/Flexibility

Frequency = 3-7 days a week

Streching/Flexibility

Frequency = 3-7 days a week

Intensity = tightness

Streching/Flexibility

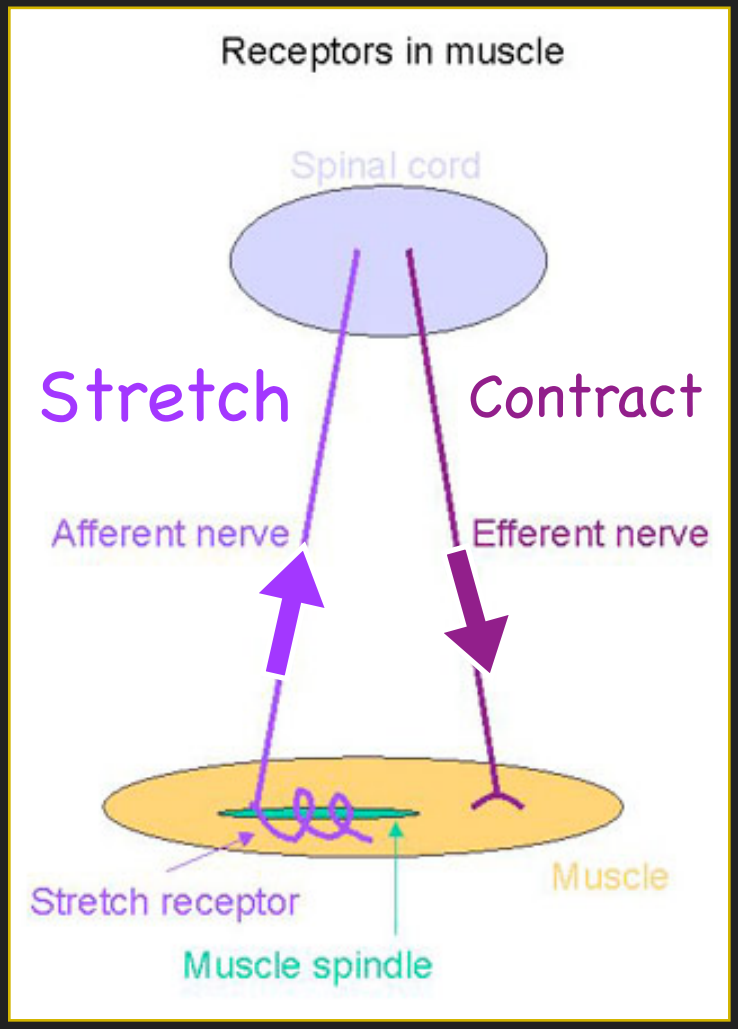
Frequency = 3-7 days a week

Intensity = tightness

Time = 15-60 sec., 1-3 sets

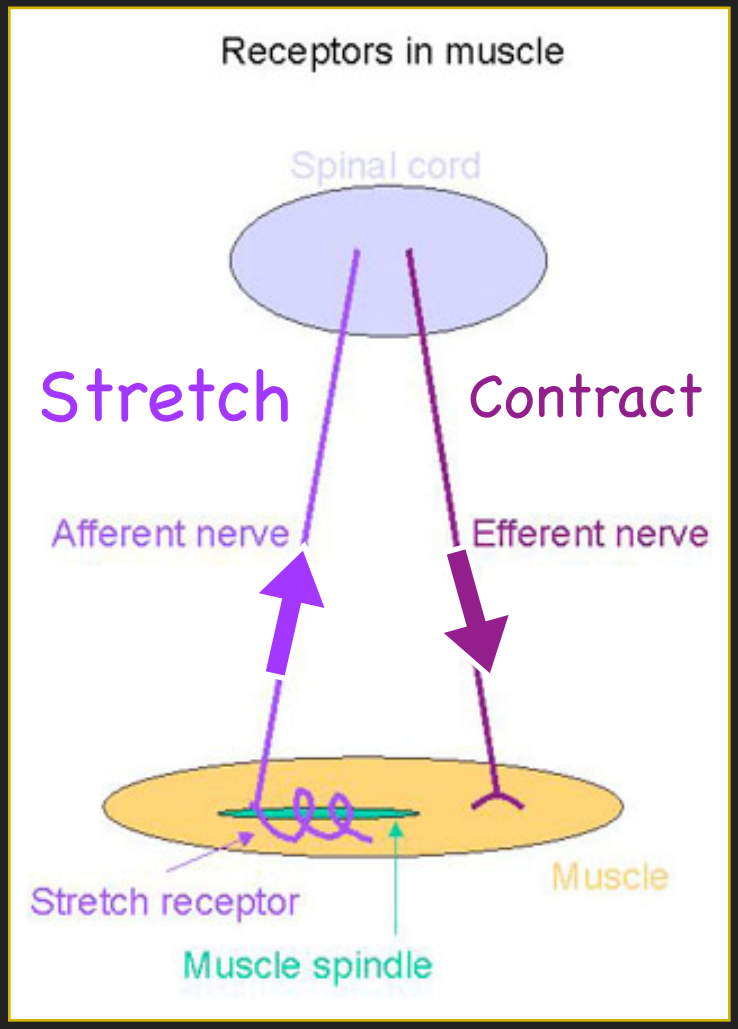
Why more than 15 sec.?

Training for Flexibility



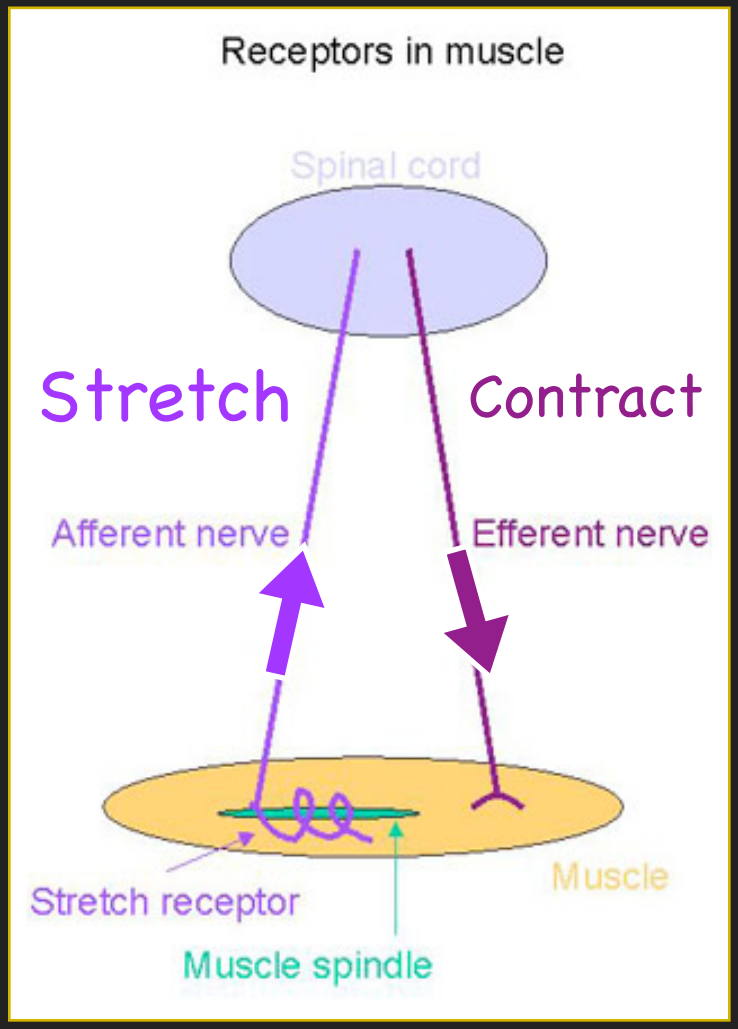
Training for Flexibility

- Static stretching
  - Prevents muscle spindles from shortening the muscle



Training for Flexibility

- Static stretching
  - Prevents muscle spindles from shortening the muscle
- Dynamic stretching
  - May activate muscle spindles which produce muscle shortening



Training for Flexibility

Training for Flexibility

Proprioceptive Neuromuscular Facilitation

Training for Flexibility

Proprioceptive Neuromuscular Facilitation

Contract muscle to stimulate GTO

Training for Flexibility

Proprioceptive Neuromuscular Facilitation

- Contract muscle to stimulate GTO
- GTO cause muscle to relax

Training for Flexibility

Proprioceptive Neuromuscular Facilitation

- Contract muscle to stimulate GTO
- GTO cause muscle to relax
- Stretch relaxed muscle further

Flexibility

- Does stretching increase flexibility?
- Does stretching decrease the risk of injury?

FYI

THE IMPACT OF STRETCHING ON SPORTS INJURY RISK: A SYSTEMATIC REVIEW OF THE LITERATURE

- **THACKER, S. B., J. GILCHRIST, D. F. STROUP, and C. D. KIMSEY, JR.**
- *Med. Sci. Sports Exerc.*, Vol. 36, No. 3, pp. 371-378, 2004.

IMPACT OF STRETCHING ON SPORTS INJURY

FYI

- Little evidence of link between flexibility and injury rate
- Lack of flexibility does not account for many muscles injuries the occur w/i a normal range of motion
- Imbalance in flexibility may increase injury risk
- Stretching may increase performance or it may decrease performance

FYI

IMPACT OF STRETCHING ON SPORTS INJURY

- "There is not sufficient evidence to endorse or discontinue routine stretching before or after exercise to prevent injury among competitive or recreational athletes."
- "Further research, especially well-conducted randomized controlled trials, is urgently needed to determine the proper role of stretching in sports."