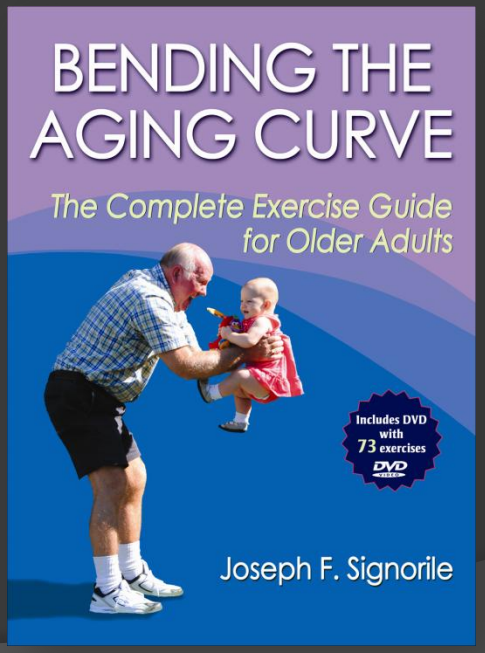
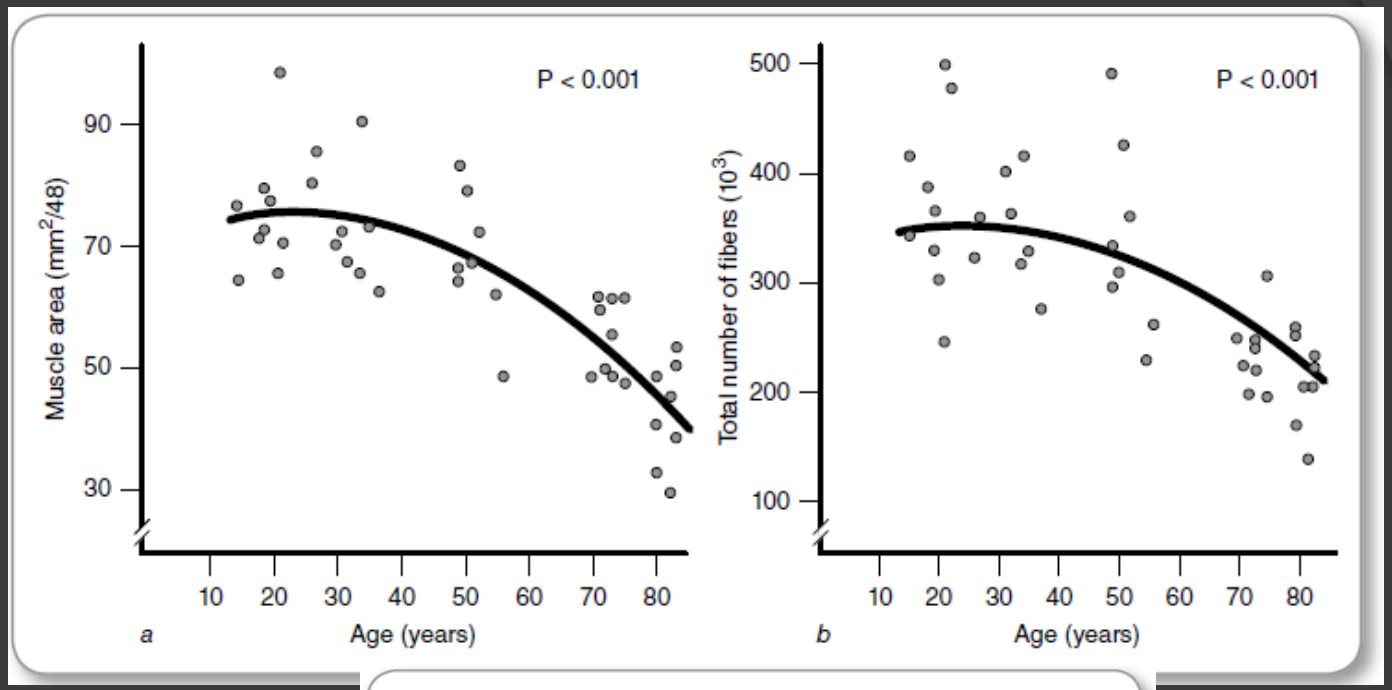
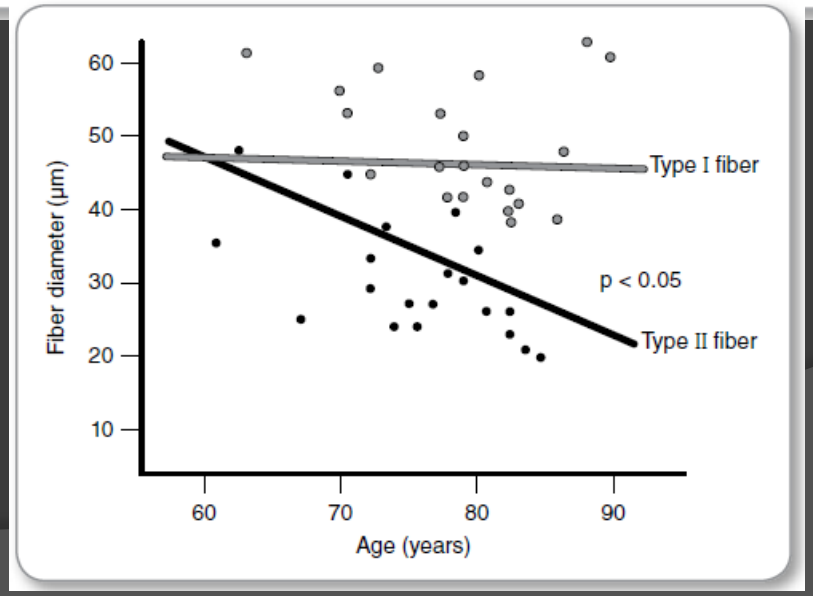
BENDING THE AGING CURVE:
A periodized prescription for improved aging

Joseph Signorile, PhD

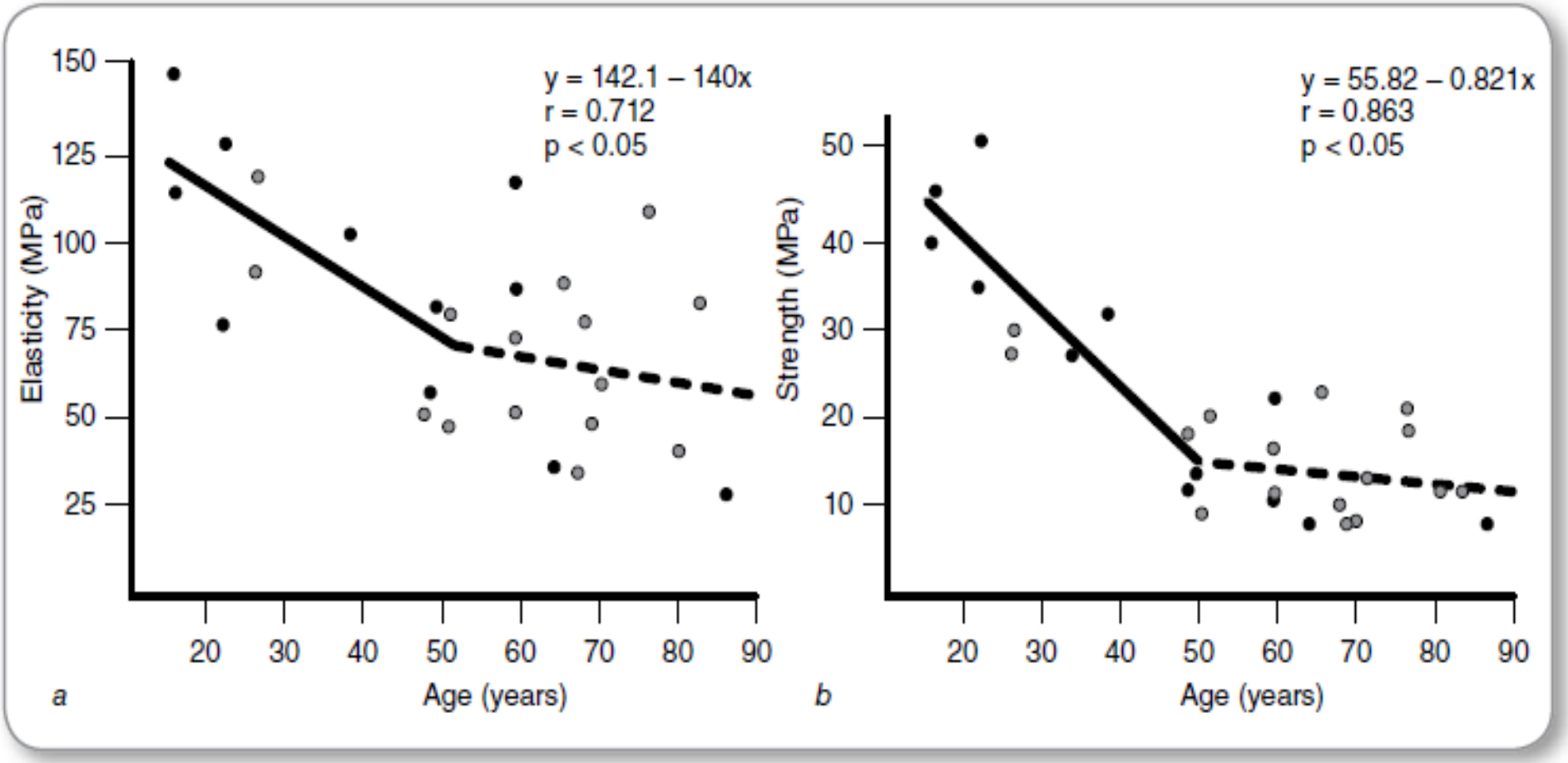


THE NEUROMUSCULAR CURVES

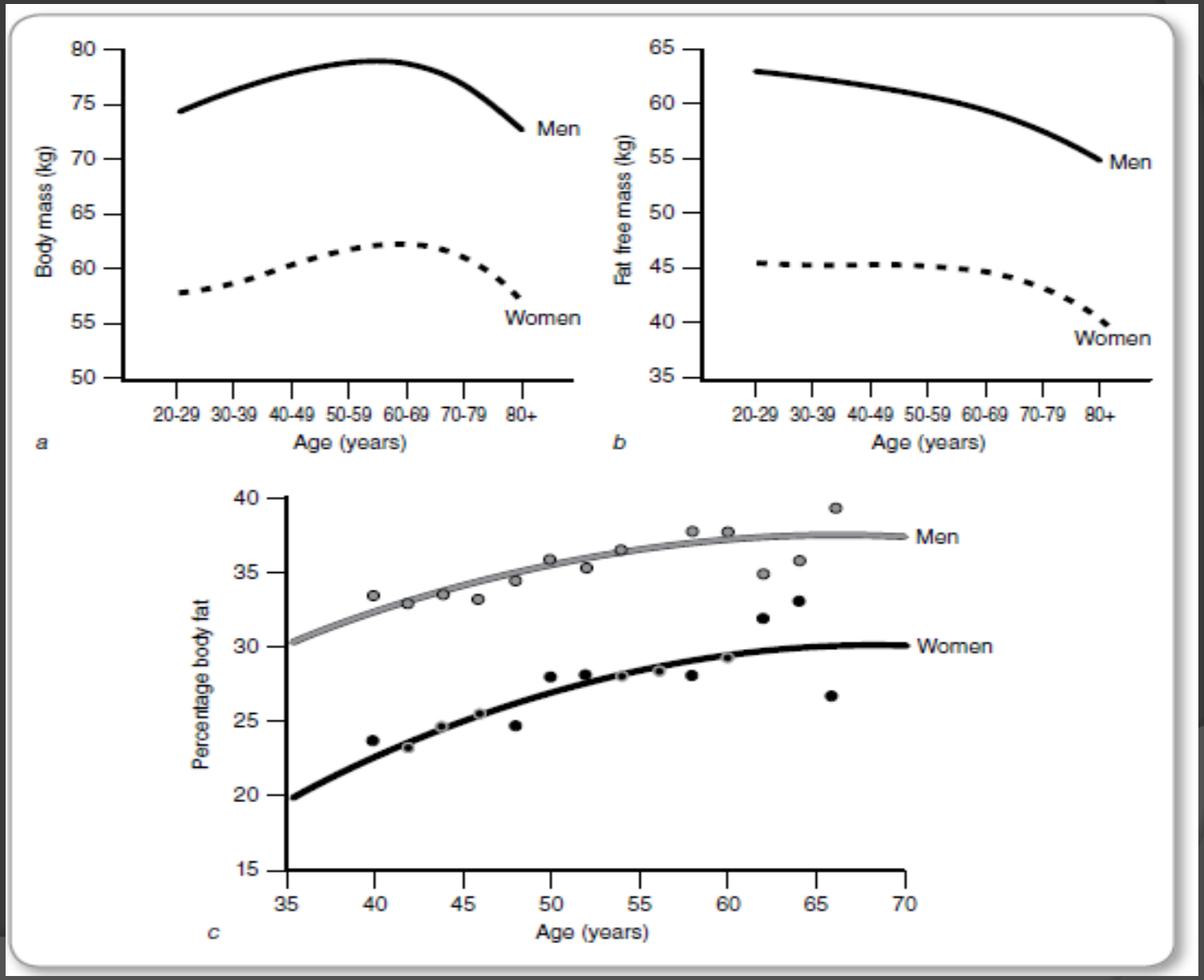




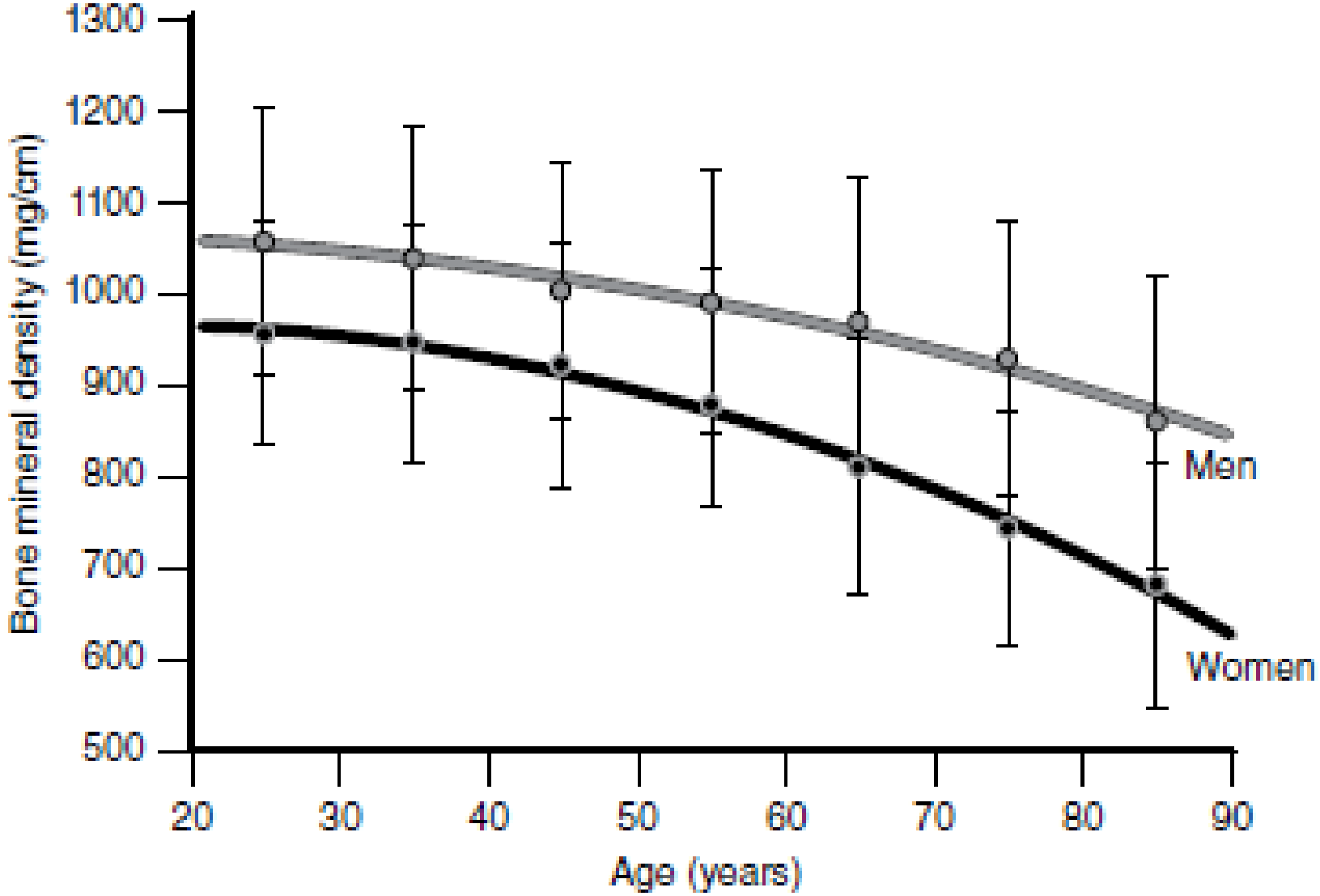
CONNECTIVE TISSUE CURVES



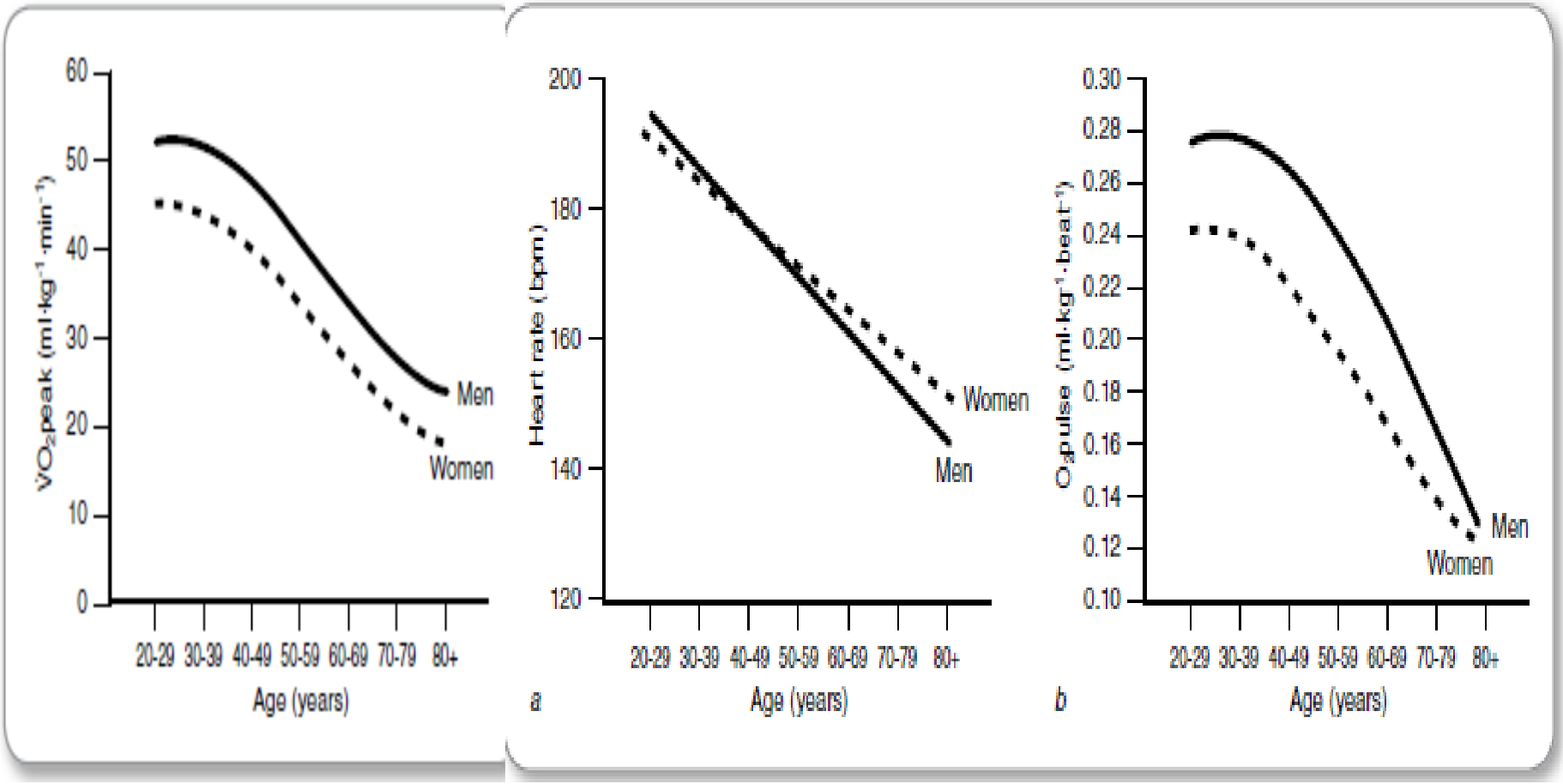
BODY COMPOSITION CURVES



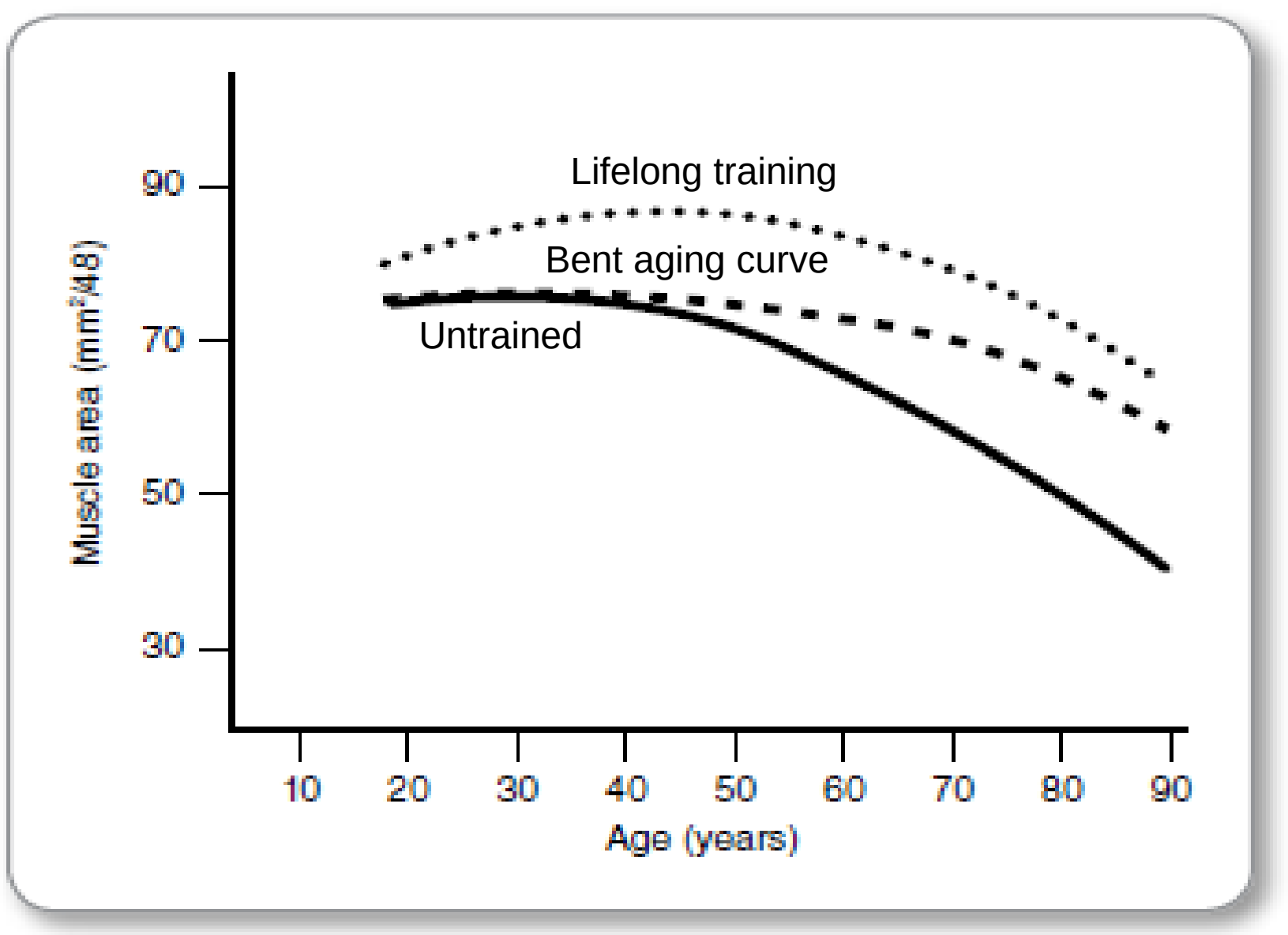
BONE DENSITY CURVES



CARDIOVASCULAR CURVES



BENDING THE AGING CURVE



WHAT IS FRAILTY?

INDEPENDENCE

↓

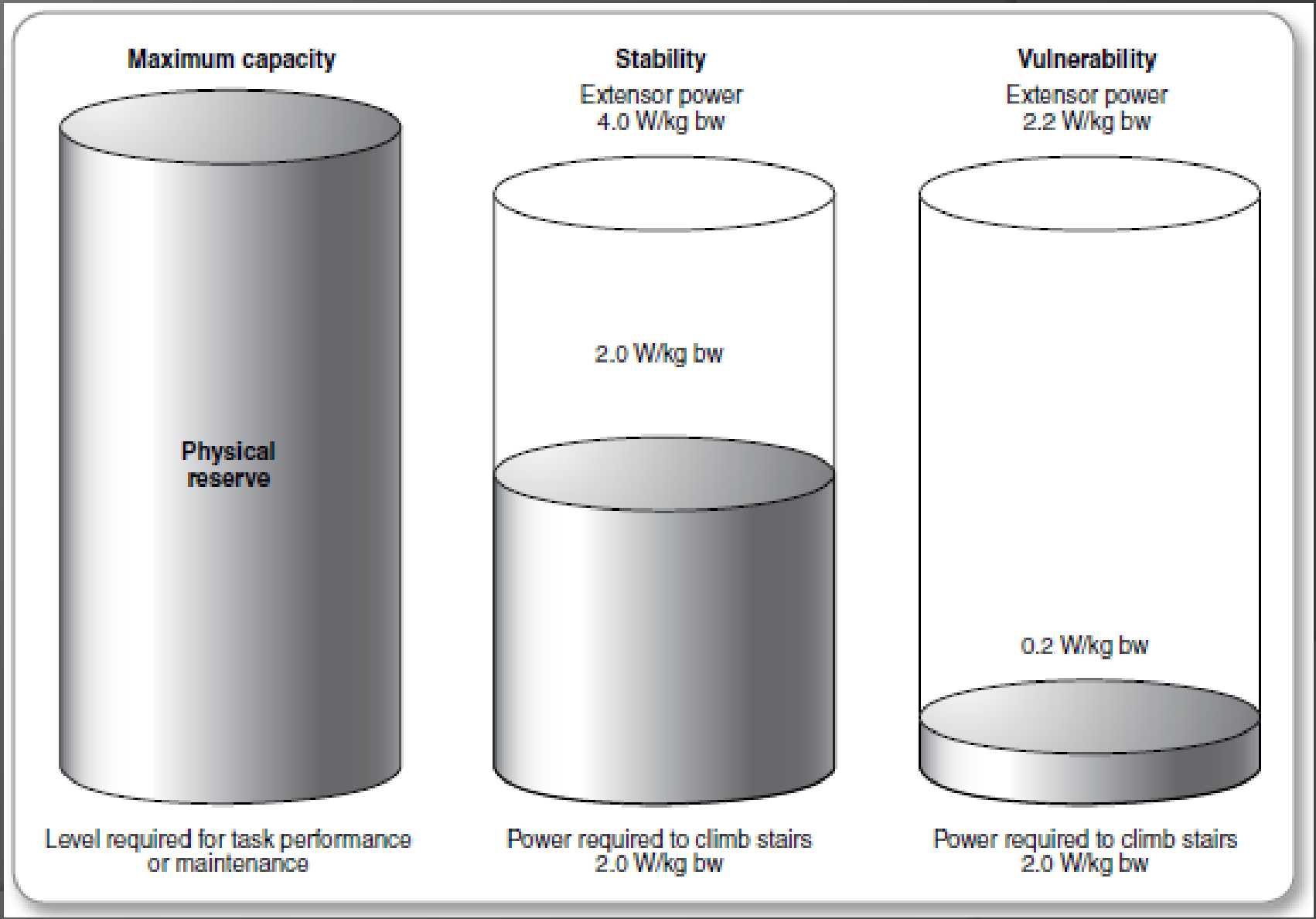
PHYSICAL VULNERABILITY

↓

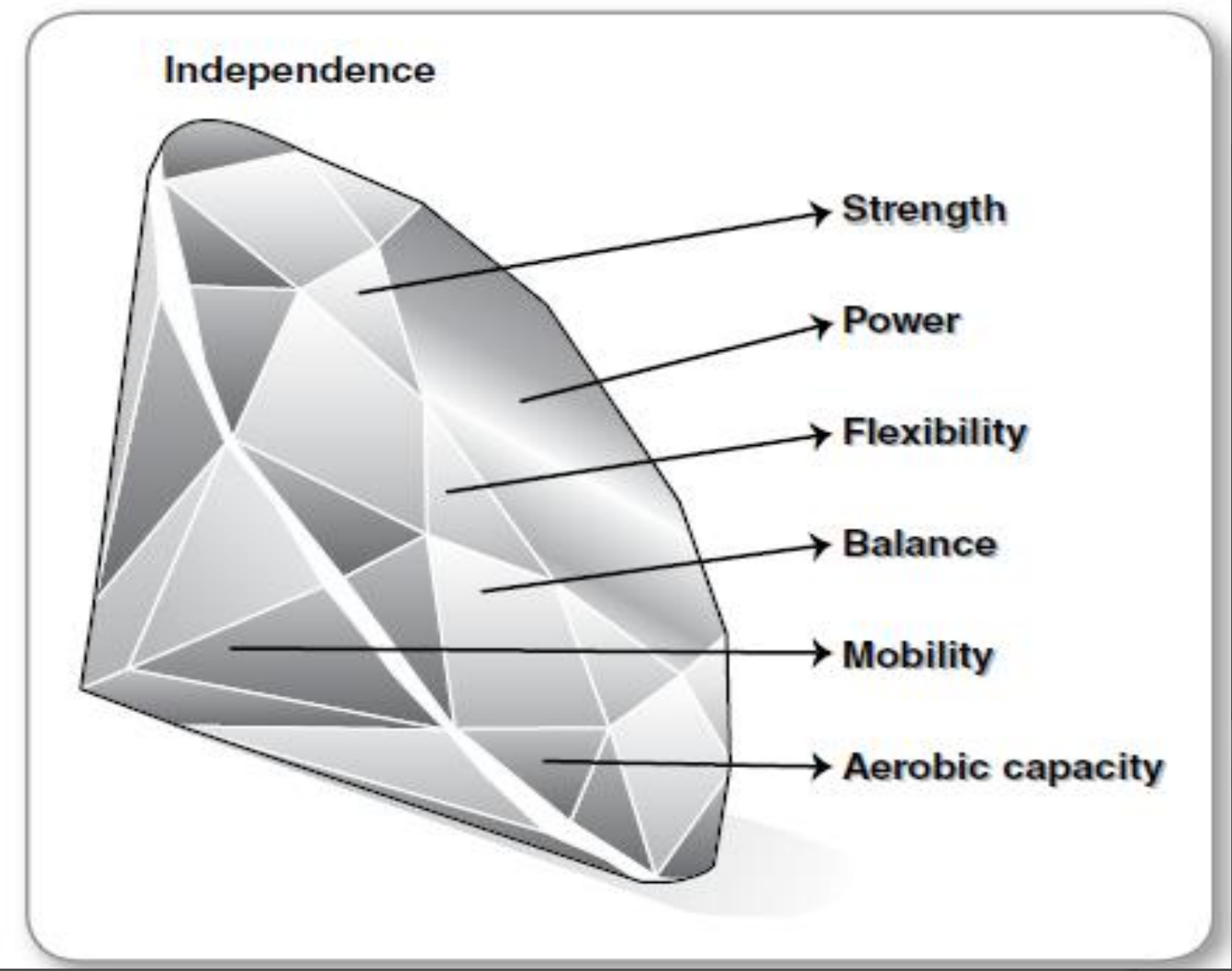
FRAILTY

DECLINING PHYSICAL RESERVE

FRAILTY AND PHYSICAL RESERVE



THE DIAMOND ANALOGY



HOW DO WE TARGET THE SPECIFIC NEEDS OF THE INDIVIDUAL?

THE CLASSIC DIAGNOSIS/PRESCRIPTION

TESTING:
The Diagnosis

GENERAL VS. SPECIFIC DIAGNOSES

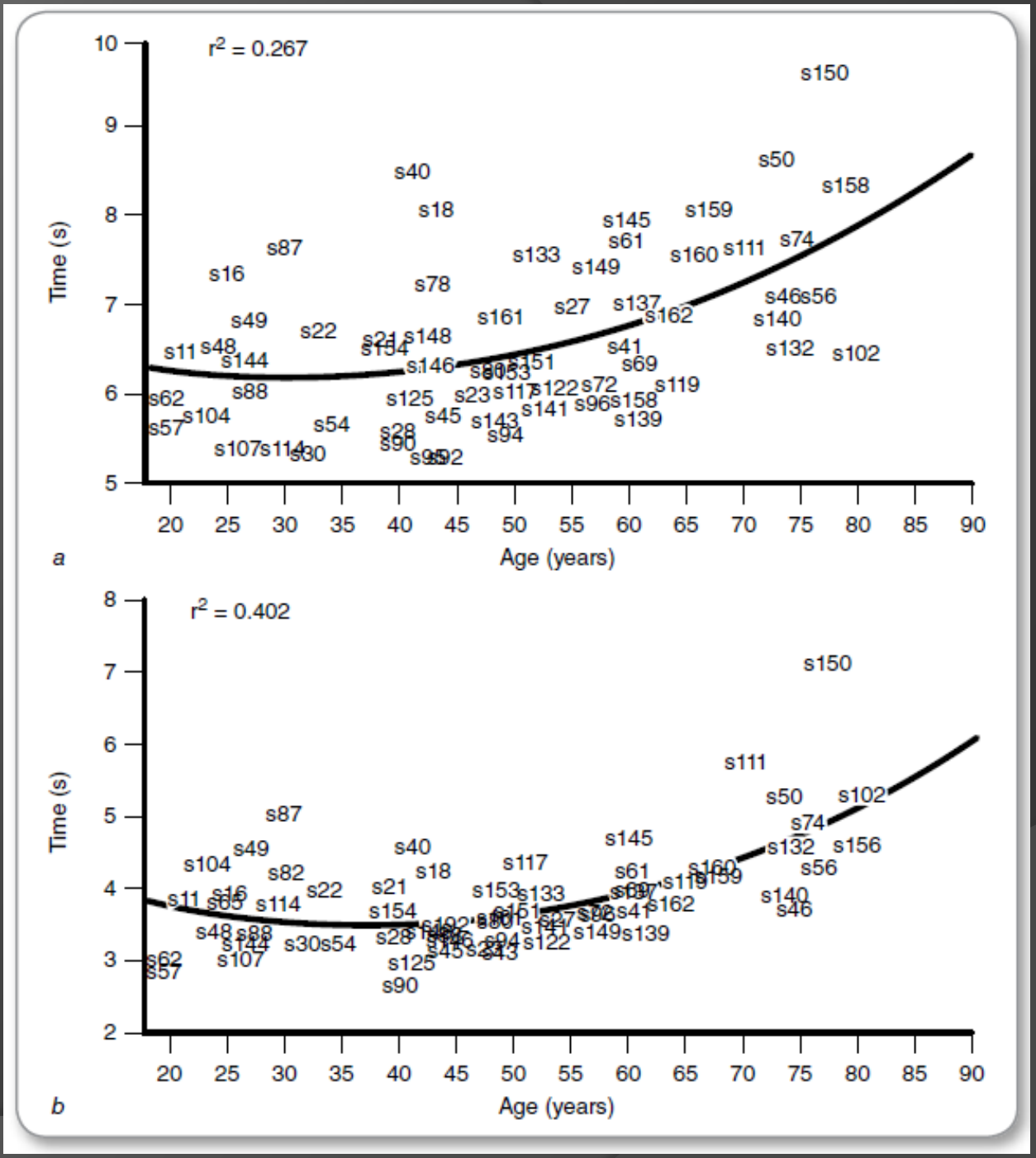


Table 2.1 Sample Diagnostic Sheet

For Females, 65 to 69 Years Old

Name or ID Number	4		**Date**	7/7/2010
Age (years)	67		**Gender**	F
Height (in.)	66		**Weight (lb)**	145
Height (m)	1.68		**Weight (kg)**	65.91

Note: The *Test* column shows the name of the test and the units you should use when entering each trial's result.

Test	**Trial 1**	**Trial 2**	**Average**	**Percentile**
Chair Sit-and-Reach, Left (in.)	2.5	2.5	2.50	50-75
Chair Sit-and-Reach, Right (in.)	2	2.5	2.25	50-75
Back Scratch, Left (in.)	0	0	0.00	50-75
Back Scratch, Right (in.)	0	-1	-0.50	50-75
Modified Trunk Rotation (in.)	27	26	26.50	50-75
Single-Leg Stance Balance (s)	26	25	25.50	50-75
Functional Reach (in.)	15	15.2	15.10	50-75
8-Foot (2.4 m) Up-And-Go (s)	5.6	5.5	5.55	50-75
30-Second Chair Stand (reps)	14	14	14.00	50-75
Modified Ramp Power (s)	1	0.9	0.95	50-75
30-Second Arm Curl (reps)	16	17	16.50	50-75
Gallon Jug Shelf (s)	9	8.9	8.95	50-75
6-Minute Walk (yards)	600		600.00	50-75
15-Foot (4.6 m) Walk, Usual (s)	3.1	3.93	3.52	50-75
15-Foot (4.6 m) Walk, Maximal (s)	2.5	2.4	2.45	50-75
% Body Fat	28.3	28.3	28.3	50-75
BMI			23.40	50-75
Modified Ramp Power Test				
Ramp Height (m)	0.33			
Ramp Power (absolute)	224.73			
Ramp Power (per kg bw)	3.41			
Skinfolds	**Trial 1**	**Trial 2**		
Chest	20	19		
Midaxillary	22	21		
Suprailiac	18	19		
Abdominal	24	23		
Thigh	18	18		
Triceps	16	17		
Subscapular	18	19		
Sum	136.0	136.0		
Body Density	1.0	1.0		
% Body Fat	28.3	28.3		

ELEMENTS OF AN EFFECTIVE TEST

Element #1

ADL / IADL Specific Test

Element #2

Test for Impact on Daily Living

Element #3

Controlling Physiological Factor

THE EVOLVING PATIENT

TRAINING:
The Prescription

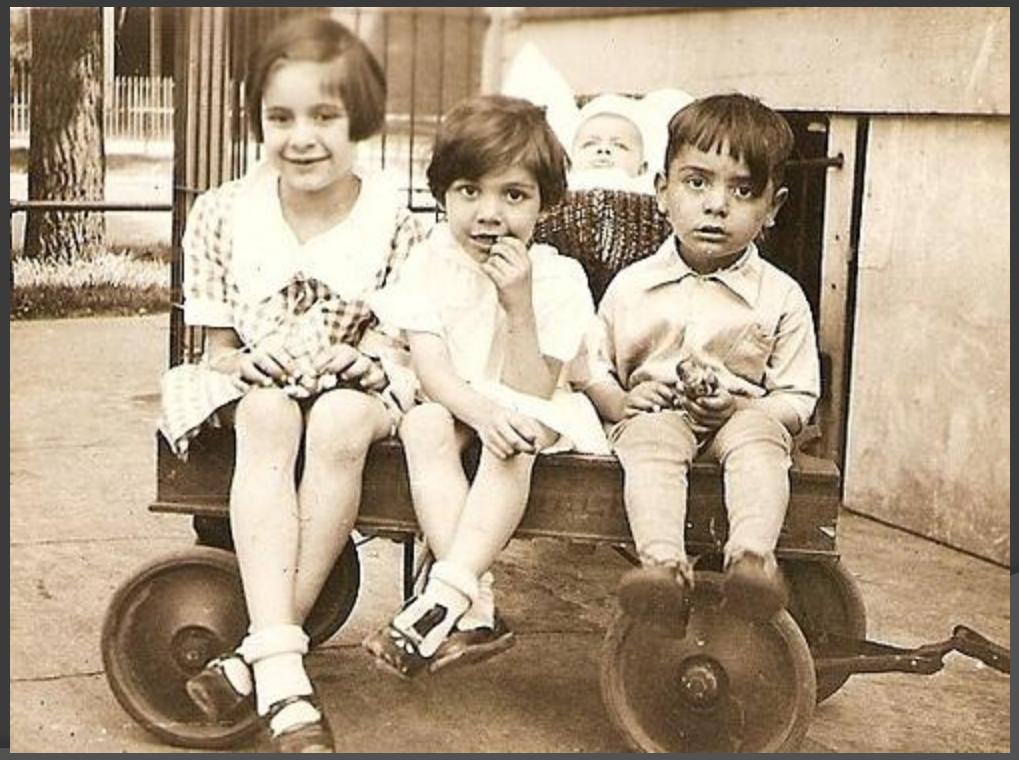
BIOENERGETIC SPECIFICITY:

- Enzyme structure, concentration and distribution
- Organelle structure, concentration and distribution
- Fiber type changes
- Electrochemical changes
- Hypertrophy and Hyperplasia
- Hormones

BIOMECHANICAL SPECIFICITY:

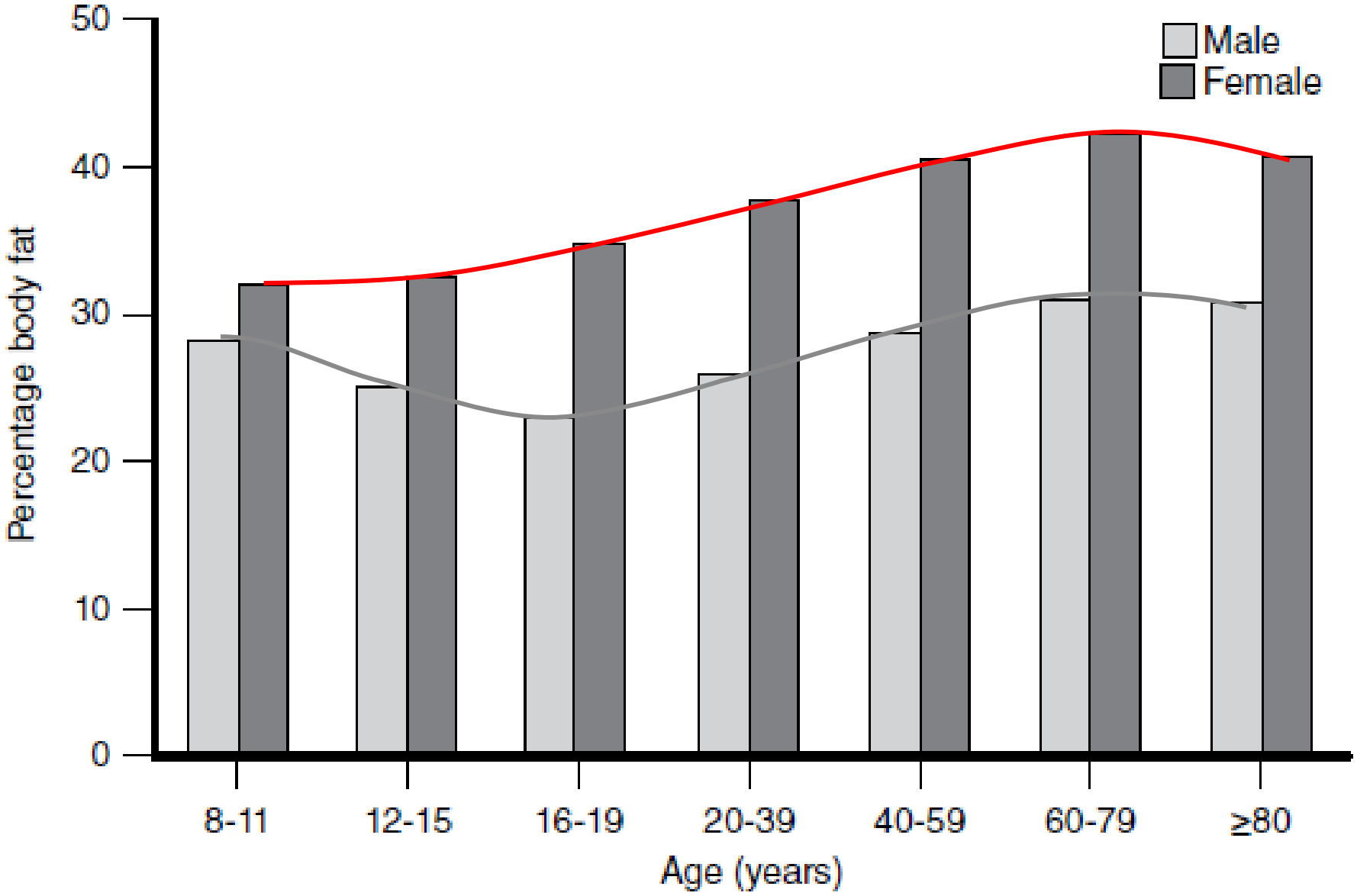
- Specific muscles and muscle groups
- Specific joints
- Specific joint angles and related muscle lengths
- Specific movement speeds
- Specific loads
- Specific contractile states
- Specific motor patterns

BIOENERGETIC SPECIFICITY: KIDS IN A WAGON



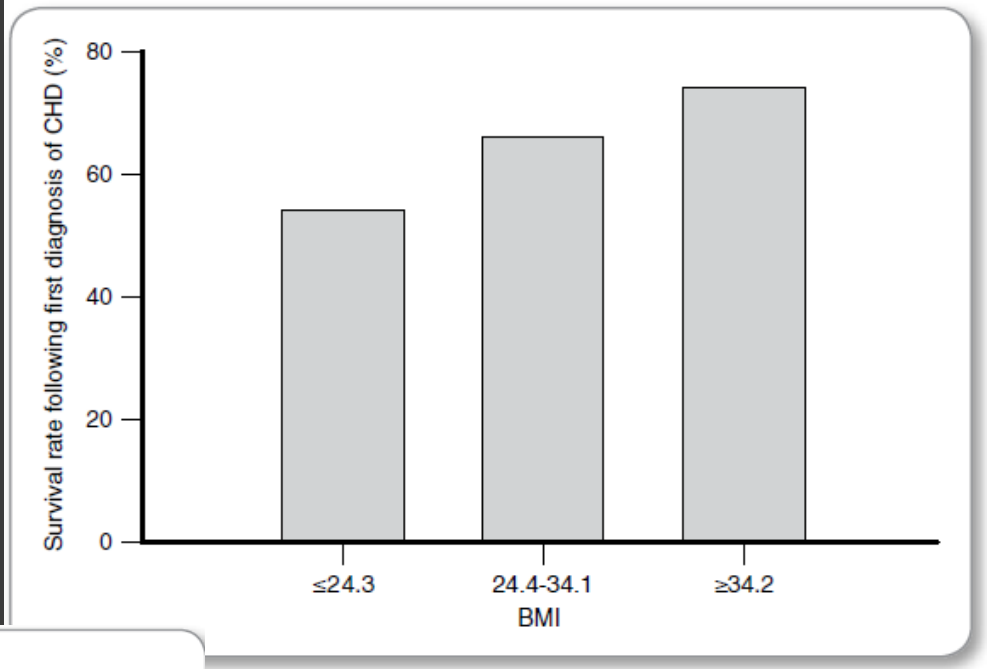
5. Addition of the long bones of the arms and wrist complete the movement
4. Core muscles rotate shoulders to further increase force and velocity.
3. Rotation of the hip further increases force and velocity due to its horizontal width.
2. Rotation is transferred to the thigh and force and velocity increased by large hip and knee extension.
1. Rotation of the foot sends force and velocity to the lower leg

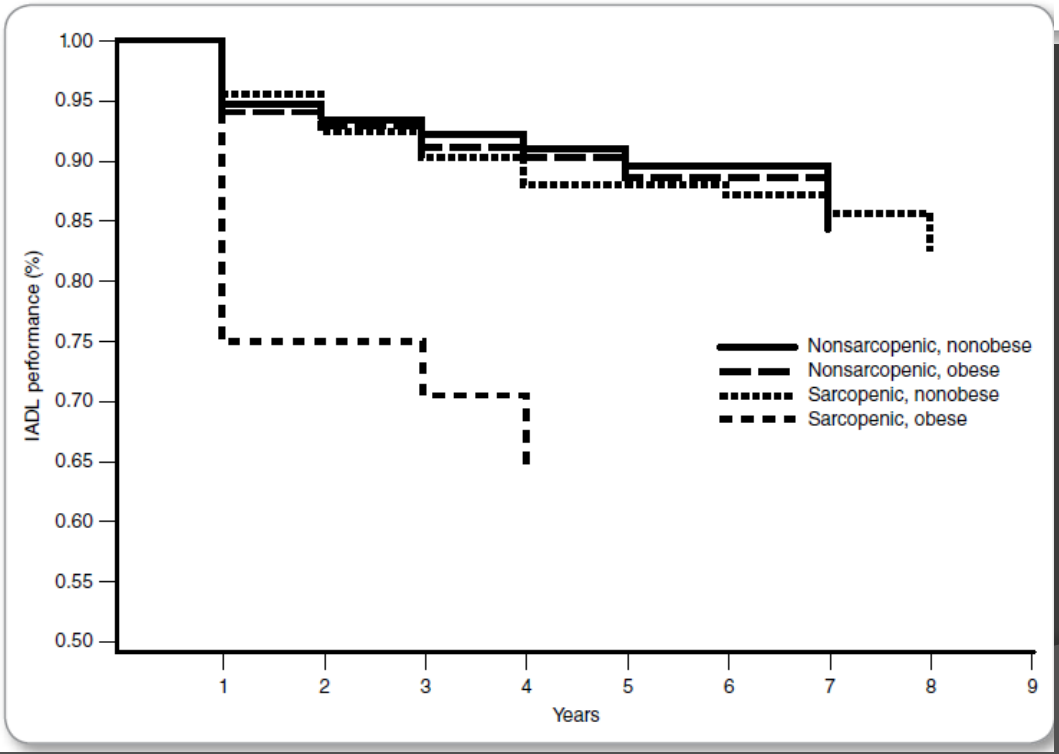
BODY COMPOSITION


Male
Female
Percentage body fat
50
40
30
20
10
0
8-11
12-15
16-19
20-39
40-59
60-79
≥80
Age (years)

IMPLICATIONS

Cardiovascular Disease





Independence

TESTING BODY COMPOSITION

- Dual energy x-ray densitometry (DEXA)
- Hydrostatic (underwater) weighing
- Air displacement plethysmography
- Bioimpedance
- Near-infrared spectroscopy
- Skinfold thickness and anthropometric measures
- Waist-to-Hip Ratio
- BMI

TRAINING INTERVENTIONS FOR SARCOPENIC OBESITY

- aerobic exercise without dieting has limited weight loss potential and little or no effect on lean body mass,
- resistance exercise has little effect on weight loss but can increase FFM,
- weight loss due to dietary changes alone results in a loss of 25% to 30% of overall body mass,
- combining diet and exercise can increase weight loss, and
- an exercise protocol that includes resistance training helps to maintain lean body mass and performance.

Resistance Training

Benefits of Resistance Training

The first thing you should know is that resistance training causes an increase in resting metabolic rate (RMR) in your older clients similar to what you see in younger persons and the increase in RMR is usually accompanied by an increase in FFM. Additionally, resistance training can also produce a significant increase in 24-h energy expenditure and fat utilization.

Most Effective Methods of Resistance Training

You can control a number of factors when designing a resistance training program for your client. They include: resistance level, number of sets and sessions per week, equipment used, training patterns, and movement speed.

Most Effective Methods of Resistance Training

High-speed explosive training using 60%1RM can burn more calories than the low-speed or 80%1RM high-speed explosive conditions and effectively improve ADL performance and reduce fall probability in persons with sarcopenic obesity; therefore, high-speed, moderate-resistance training cycles appear to be the “two-for-one” special on your training menu.

Aerobic Training

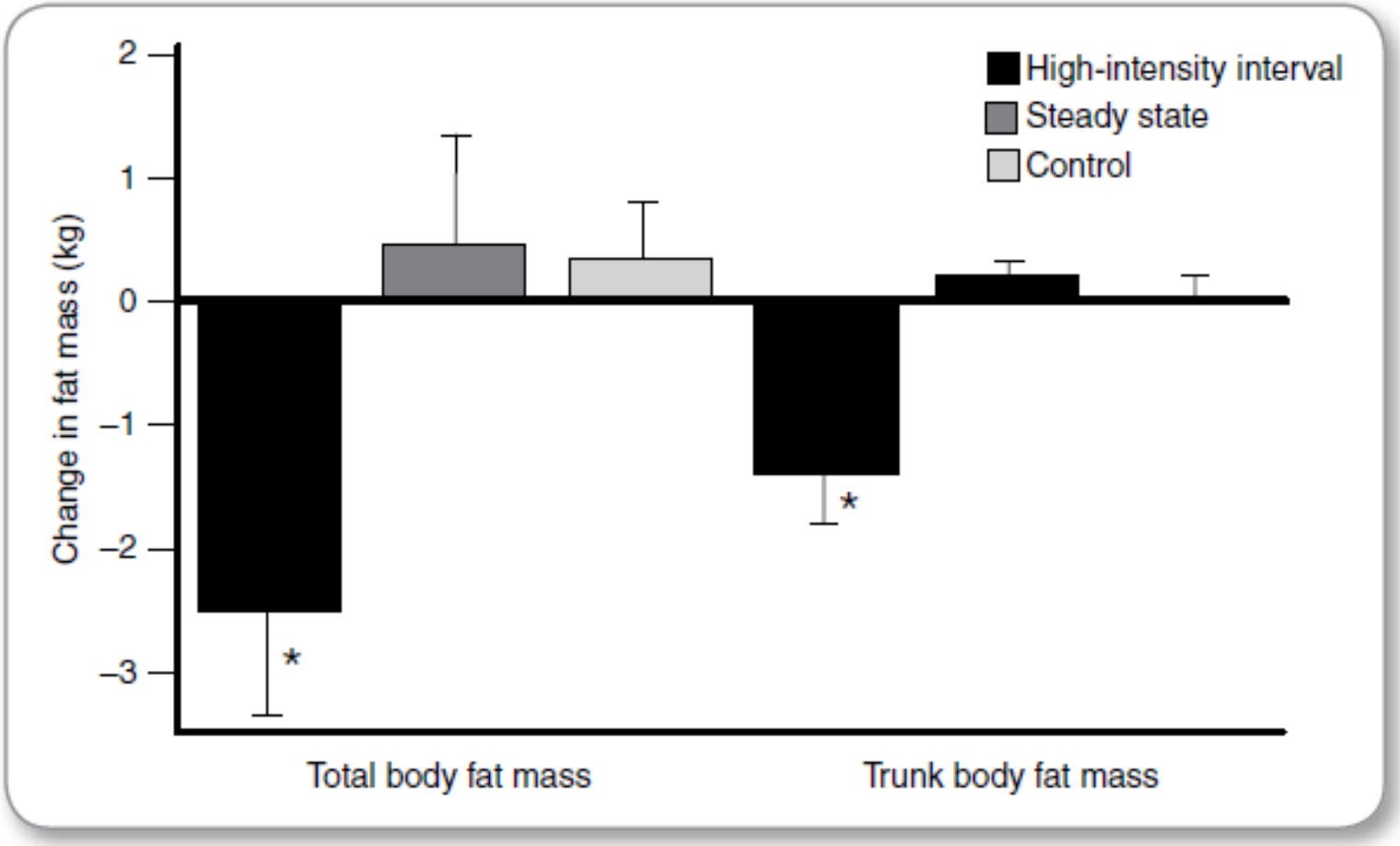


Figure 4.16 Changes in total-body fat mass and trunk fat mass due to high-intensity interval training and steady-state training over a 15-week period.
* Indicates greater decreases than the steady state and control groups.

Data from Trapp 2008.

Both steady state and interval training can be used at various times throughout a training cycle to make the best use of their inherent differences in volume and intensity; however, each method has its own specific strengths and shortcomings when considering a person’s metabolic and body composition-based needs.

Mixed Training

APPLICATION POINT Although data suggest there is an interference effect when mixing cardiovascular endurance and resistance training, combined training is an effective strategy when considering changes in body composition, especially when you understand how to modify the training protocols.

FLEXIBILITY

Types of Flexibility	
static flexibility	The ability to slowly move a specific joint or series of joints to the end range of motions and maintain that position without moving.
dynamic flexibility	The ability to actively move through the full range of motion of a joint or series of joints at a specific movement speed, transitioning through each position.

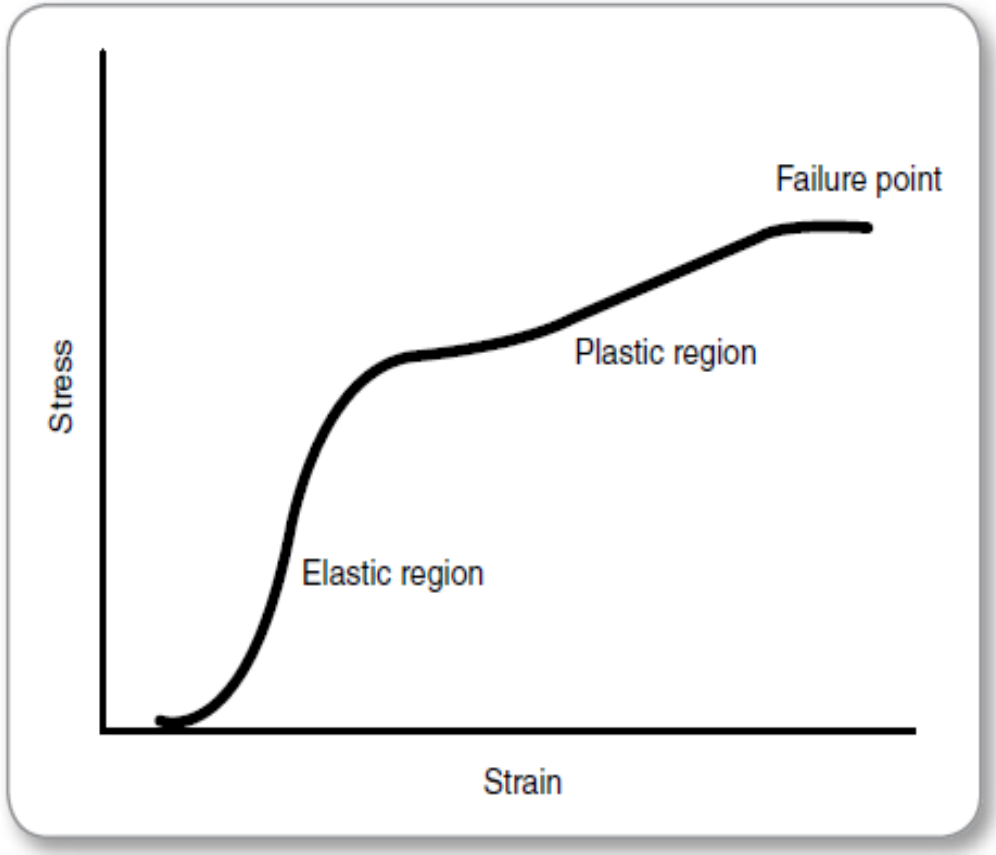


Figure 5.1 The strain–stress curve for flexibility.

APPLICATION POINT Interventions to increase flexibility help older adults to maintain their ability to perform ADLs and to reduce their probability of falling.

Flexibility Testing

Figure 5.4 The chair sit-and-reach test evaluates flexibility in the low back and hamstrings.

Figure 5.6 The modified trunk rotation test assesses core ROM.

Figure 5.5 The back scratch test assesses shoulder flexibility.

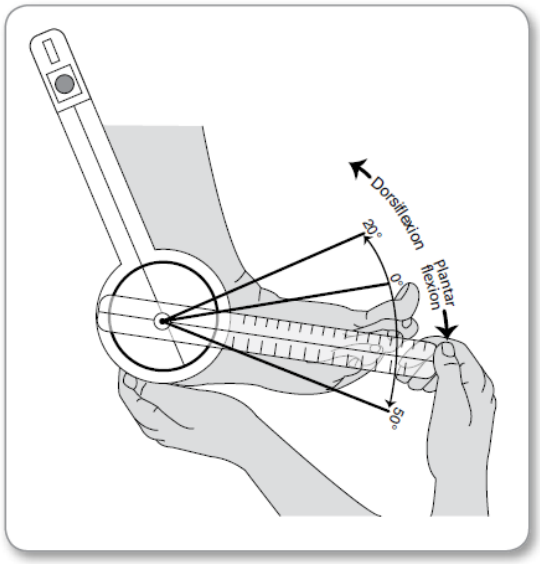


Figure 5.7 Testing for plantar flexion and dorsiflexion.

Types of Stretching

- Static
- Ballistic
- PNF

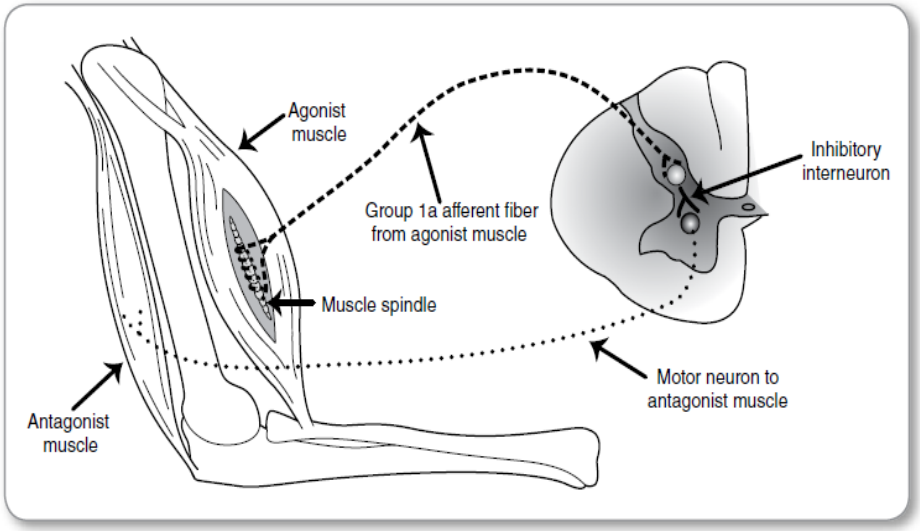


Figure 5.3 Reciprocal inhibition. Note the group 1a afferent nerve fiber running from the muscle spindle of the agonist muscle to the spinal cord (dashed line) and its connection (synapse) with the inhibitory interneuron (solid line), which in turn synapses with the motor neuron (dotted line) of the antagonist muscle. This means that contraction of the agonist muscle causes relaxation of the antagonist muscle. Also shown is the connection to the agonist motor neuron, which causes the stretch reflex.

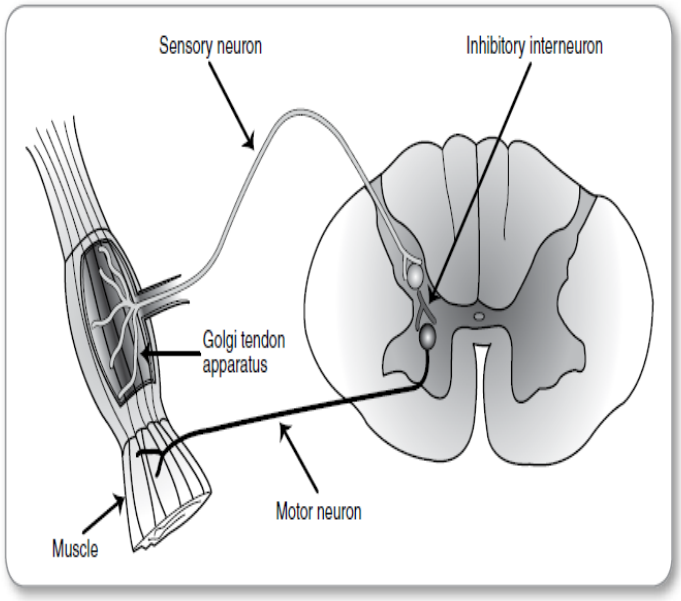


Figure 5.2 The negative (inhibitory) loop from the GTO to the spinal cord and back to the motor nerve. Notice the inhibitory interneuron that tells the motor nerve to reduce its activity and thereby reduce tension on the muscle.

APPLICATION POINT Flexibility training alone, without the addition of any other training modalities, can improve ROM and reduce passive resistance.

APPLICATION POINT Flexibility can be improved even by programs that combine flexibility training with other training modalities; however, mixed programs may be less effective than programs concentrating solely on flexibility.

APPLICATION POINT Regular flexibility training rather than acute stretching leads to long-term changes, including structural changes in muscle and connective tissue, that can protect against injury.

APPLICATION POINT For older persons, flexibility training can improve every aspect of performance, from gait to ADL performance.

BONE DENSITY AND BALANCE

Bone Structure

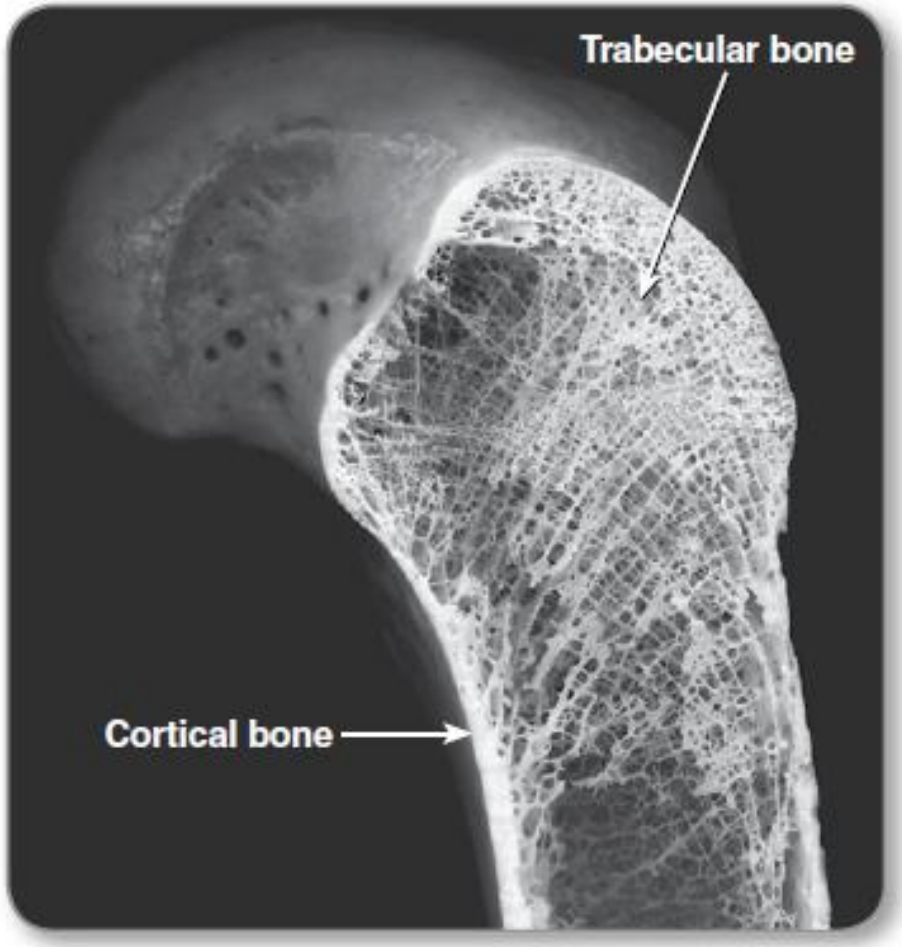


Figure 6.1 Illustration of two major types of bone: cortical and trabecular.

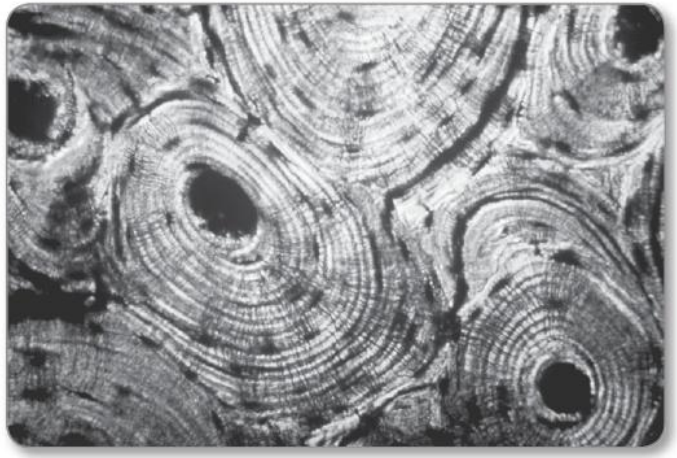


Figure 6.2 Detailed microscopic view of the lamellae in the Haversian system in cortical bone.

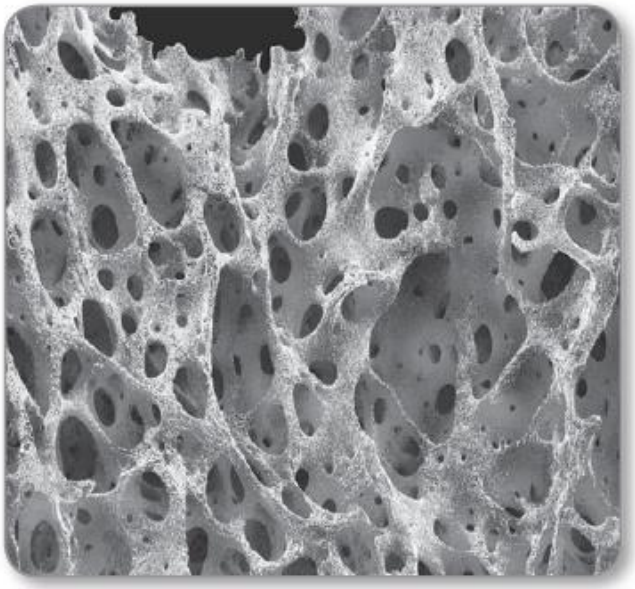
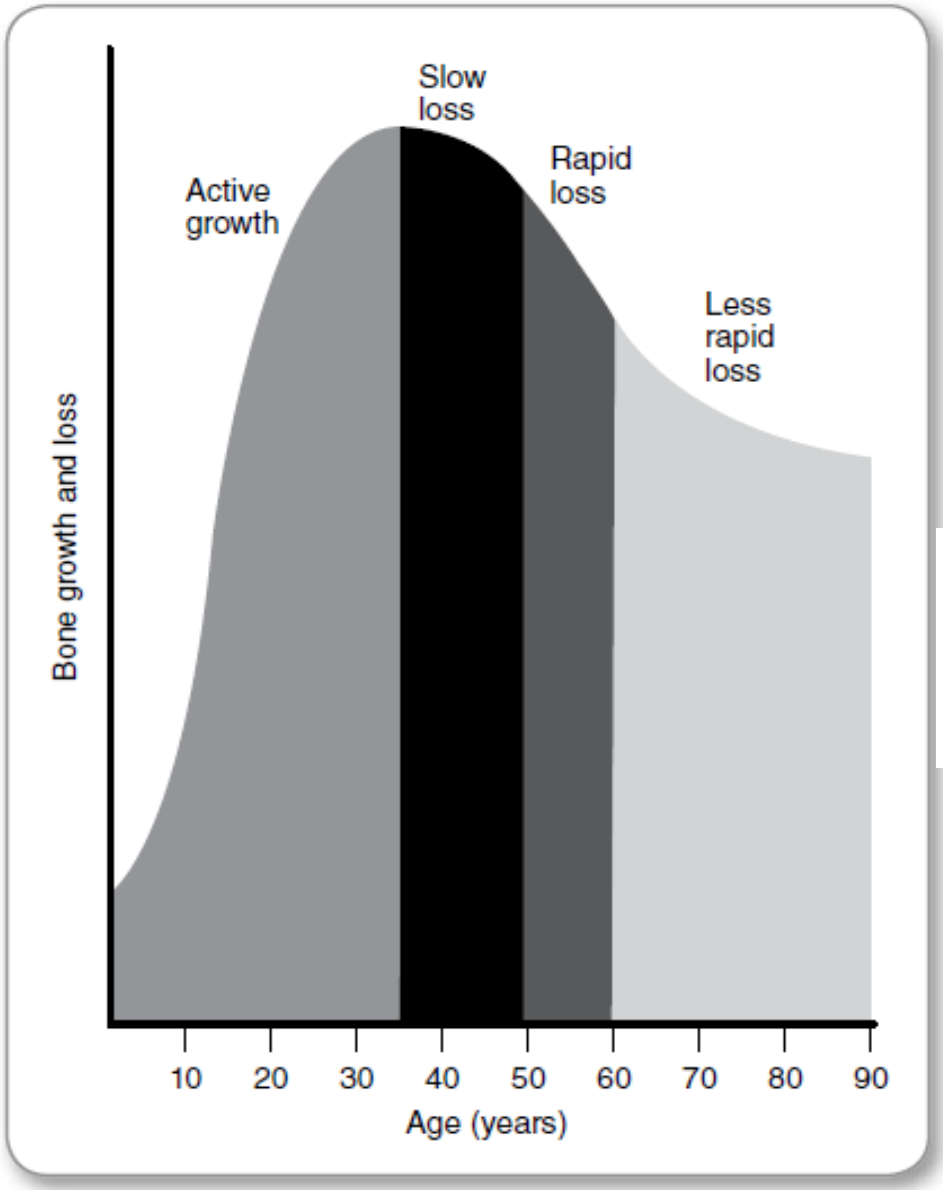


Figure 6.3 Microscopic view of trabecular (spongy) bone.

Factors Affecting Bone Strength



Bone Density

Figure 6.4 Changes in bone growth and bone loss in women from infancy to old age. Notice the rapid bone loss between the ages of 50 and 60 years, when menopause is most prevalent.

Bone Geometry and Training

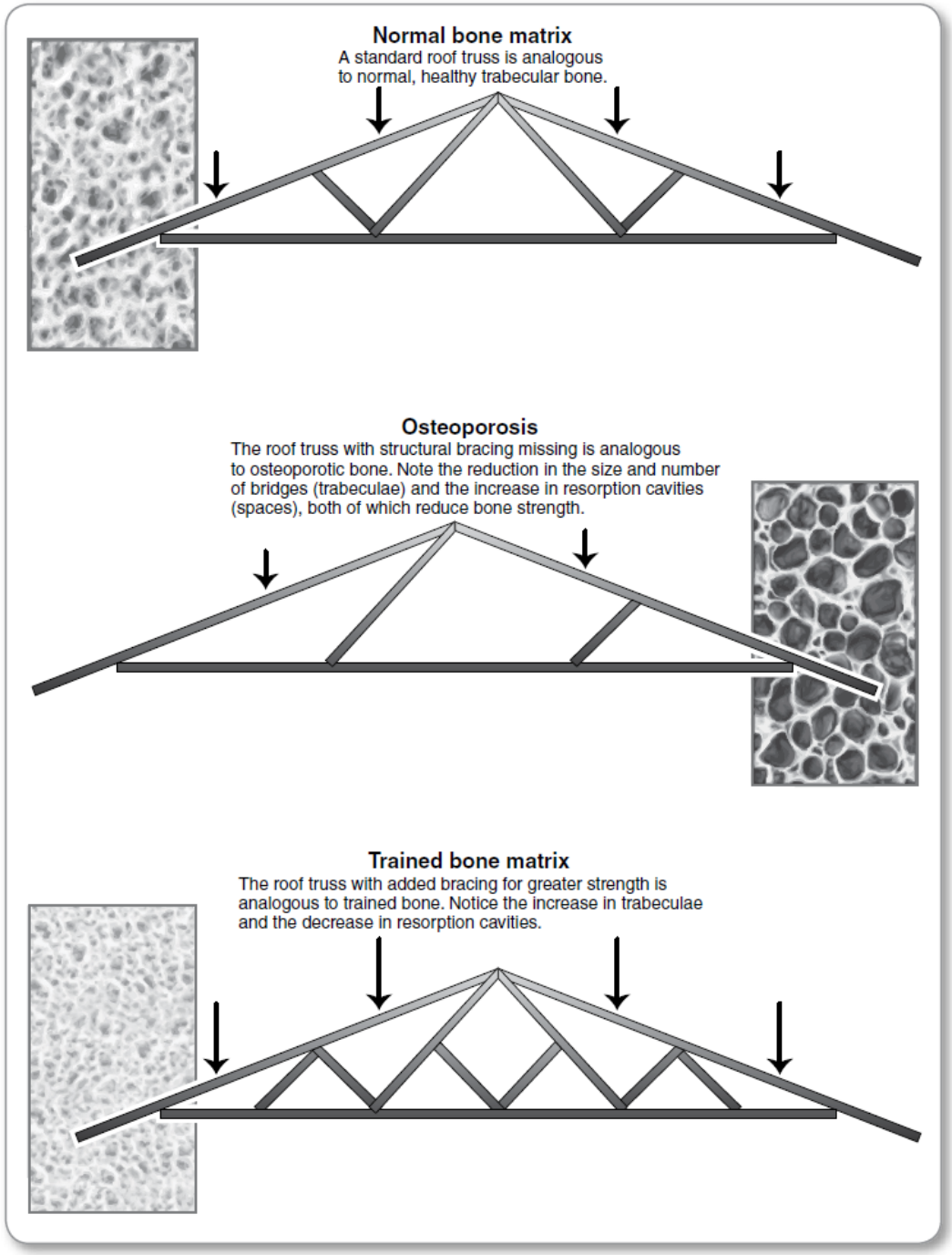


Figure 6.7 Of roof trusses and bone: a comparison of normal, osteoporotic, and trained bone matrix.

Osteopenia and Osteoporosis

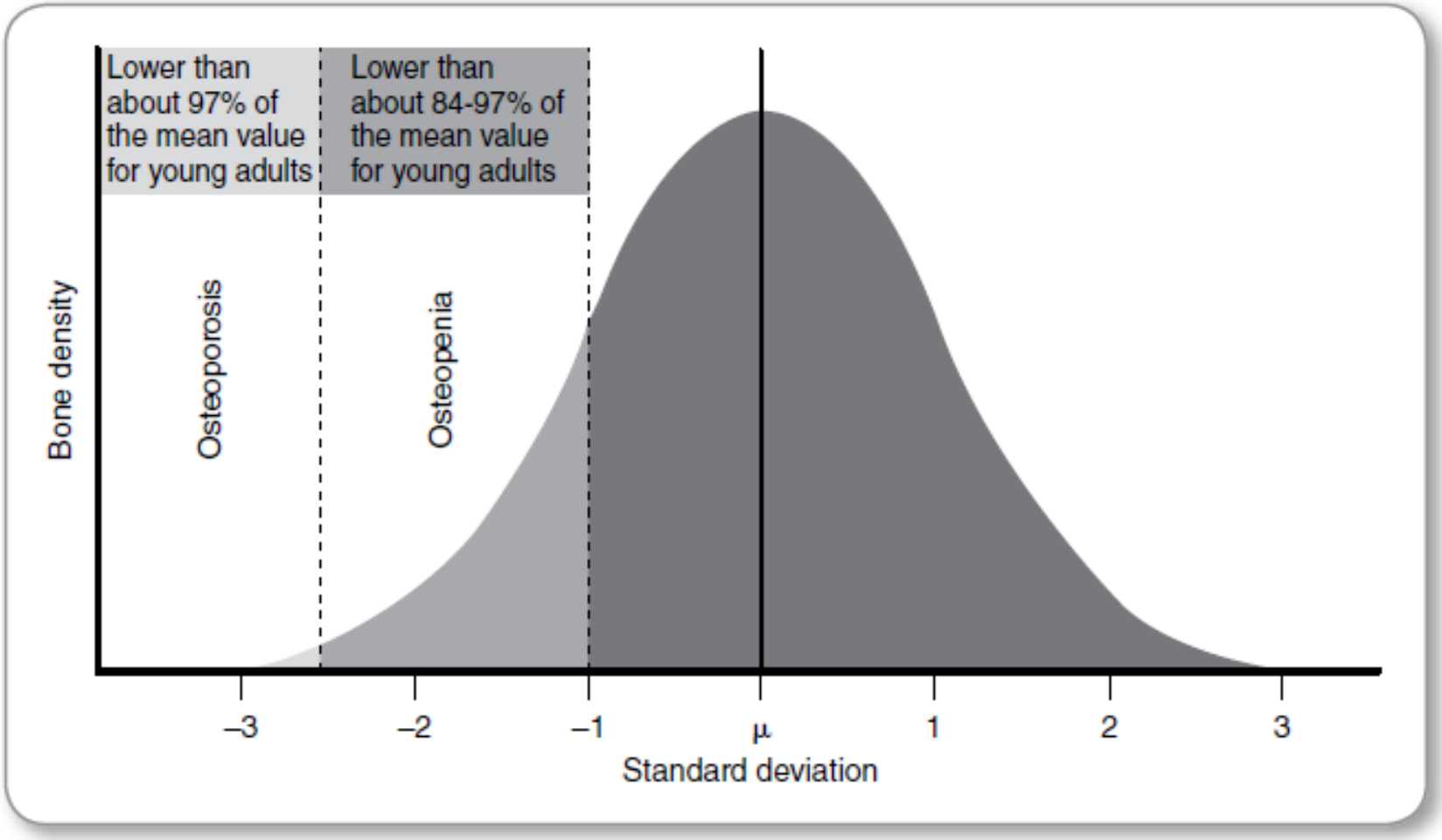


Figure 6.8 A bell-shaped curve showing the standard distribution of bone densities of healthy young adults. Individuals who have osteopenia have bone densities that are 1 to 2.5 standard deviations below the mean, while people with osteoporosis have bone densities that fall at least 2.5 standard deviations below the mean.

Dual Emission X-ray Analysis (DEXA)

Training and Bone Growth

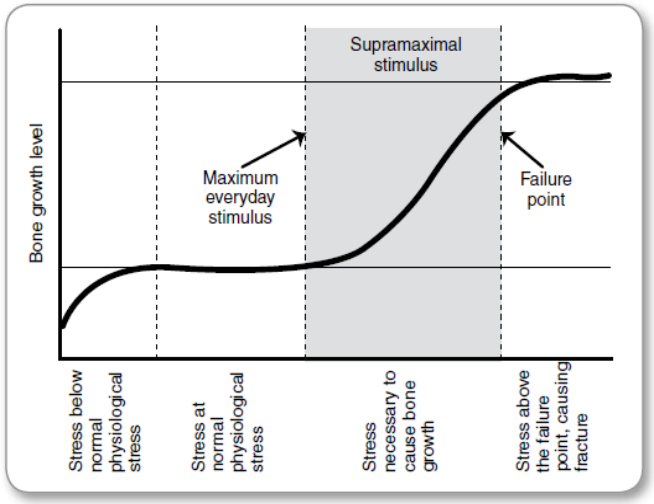


Figure 6.9 Levels of bone growth in response to various stress levels. The highlighted area of the graph shows stress levels above those associated with normal physiological daily functioning and below those causing damage to the bone.

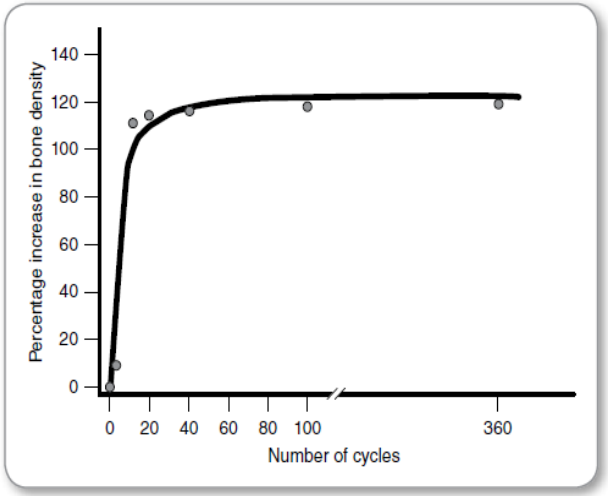


Figure 6.10 Changes in bone mass in response to the number of loading cycles. The rate of improvement plateaus when the number of loading cycles exceeds 40 per day.

1. Bone adapts best to dynamic rather than static mechanical stimulation.
2. If a bone is to respond to training, the stimulus must be at a suprathreshold level.
3. The response that any bone has to a mechanical stimulus such as exercise is proportional to the loading cycle, which is how frequently the stimulus is applied.
4. The response of bone to exercise is improved by brief but intermittent exercise.
5. Bone responds best when the exercise employs a pattern that differs from the usual loading pattern.
6. For bone to adapt, it must have sufficient energy to rebuild itself.
7. For exercise to work there should be abundant calcium and vitamin D availability.

Better Balance and Agility

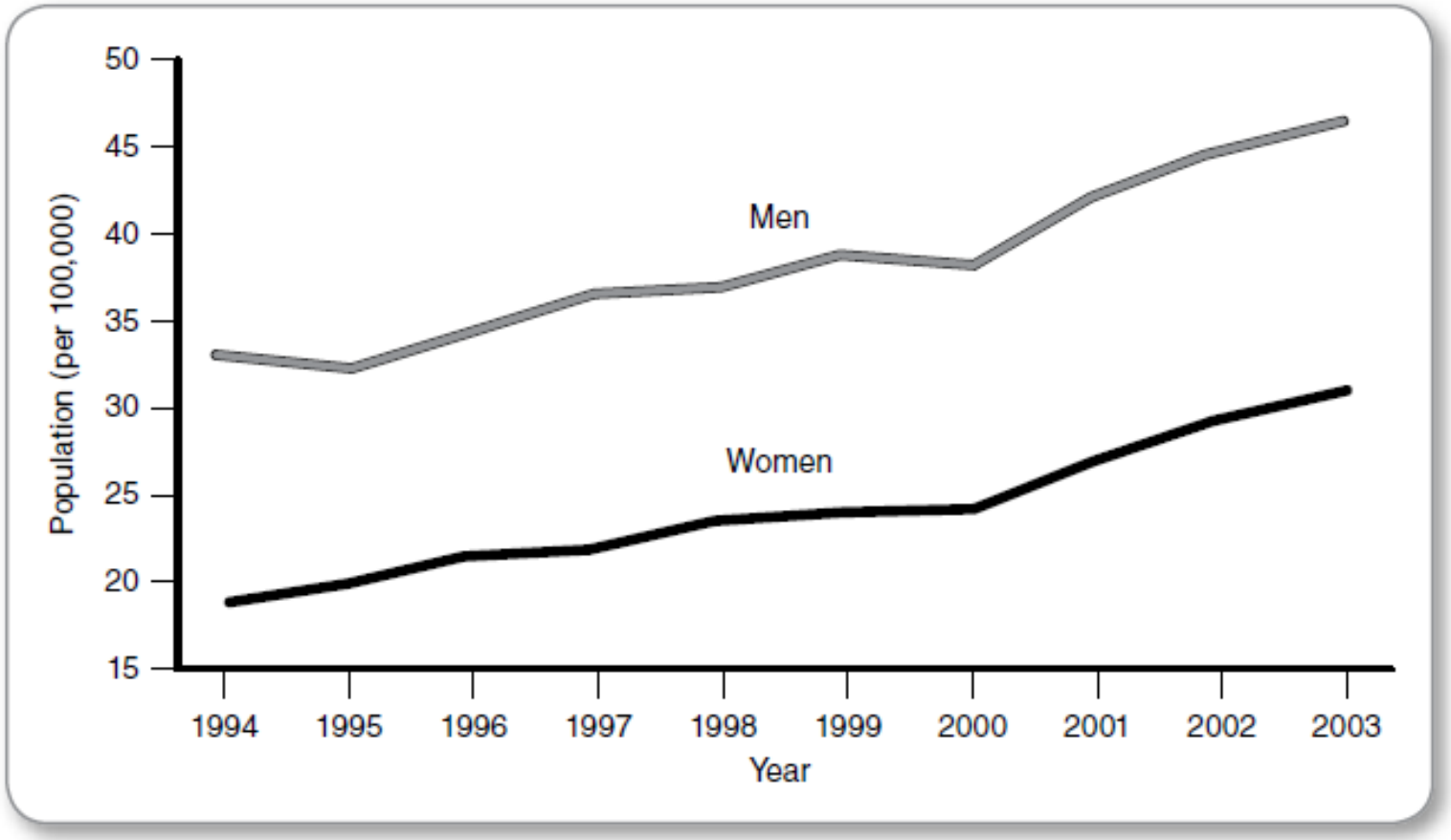
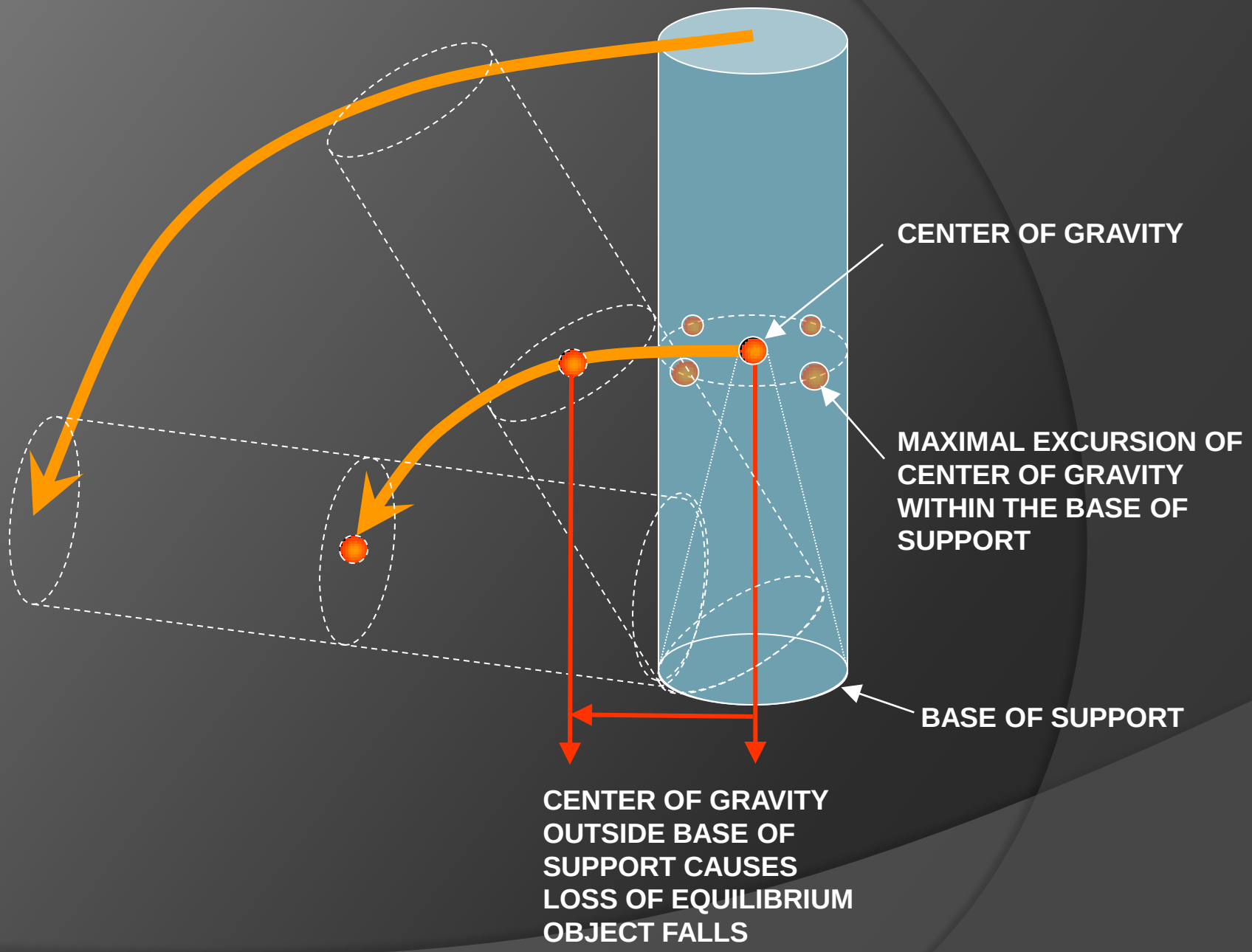


Figure 6.11 Age-adjusted fatal fall injury rates among men and women aged 65 years and older in the United States between 1994 and 2003.

Reprinted from CDC.


CENTER OF GRAVITY
MAXIMAL EXCURSION OF CENTER OF GRAVITY WITHIN THE BASE OF SUPPORT
BASE OF SUPPORT
CENTER OF GRAVITY OUTSIDE BASE OF SUPPORT CAUSES LOSS OF EQUILIBRIUM OBJECT FALLS

THE TESTS

Figure 6.15 The single-leg stance balance test.

Figure 6.16 The functional reach test.

Figure 6.17 The 8-foot (2.4 m) up-and-go test.

THE PRESCRIPTION

TARGETED

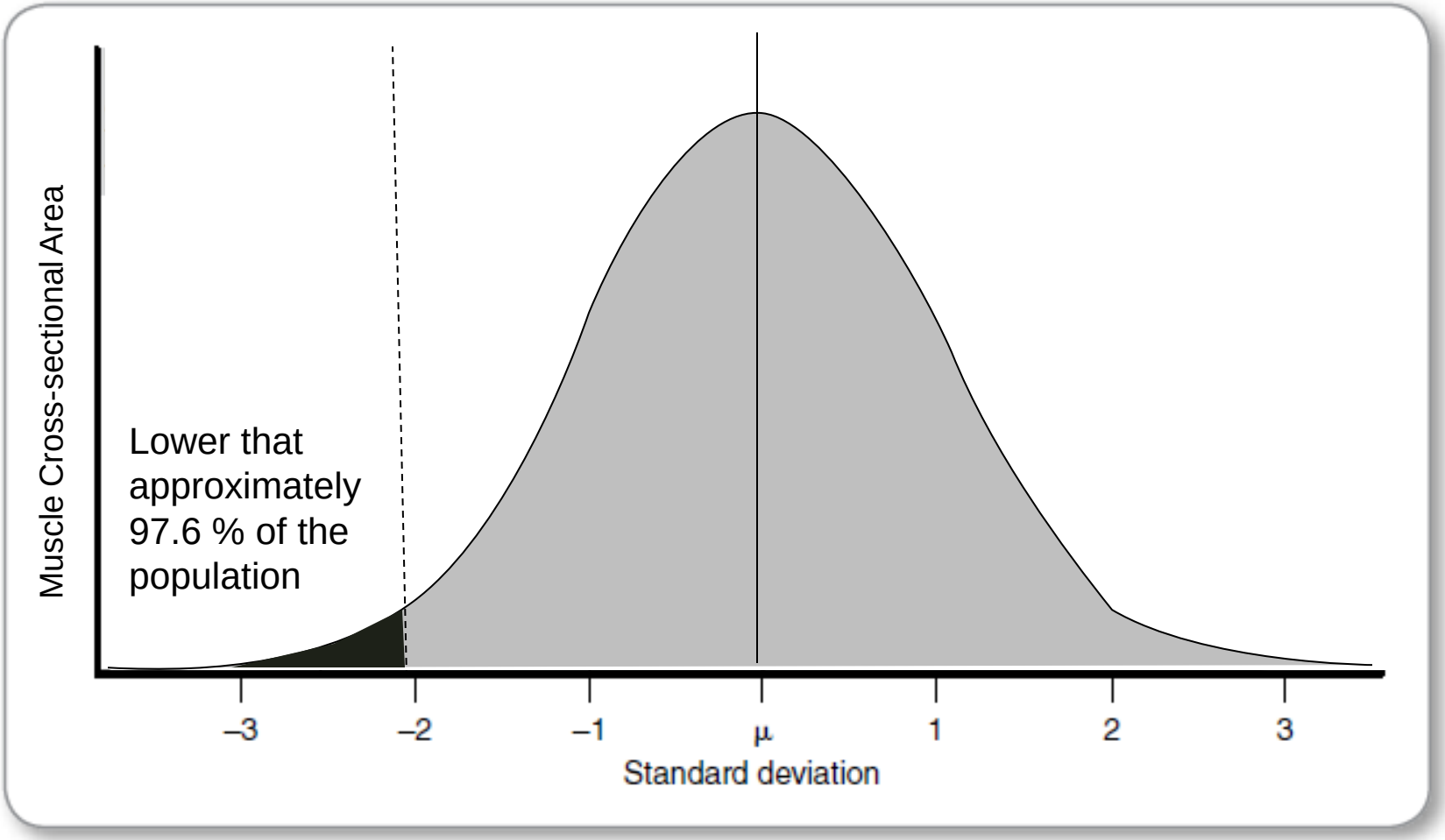
- Tai Chi
- Balance and Agility Training Programs
- Balance Platforms
- Whole Body Vibration
- Activity Promoting Video Games

SUPPORT

- Lower Body Power Training
- Speed Training
- Flexibility Training

MUSCULAR STRENGTH AND POWER

SARCOPENIA


Muscle Cross-sectional Area
Lower that approximately 97.6 % of the population
–3
–2
–1
μ
1
2
3
Standard deviation

Neuromuscular Causes

1. *Shrinking cross-sectional areas of all muscle fibers (muscle cells). This is specially true for the* type II fast-twitch fibers.
2. *Fewer motor nerves and an increase in the size of the remaining motor units.*
3. *Structural changes in the neuromuscular junction.*
4. *Reduced calcium flow inside the muscle, which leads to slower, less powerful contractions.*
5. *Less satellite cell activity.*

Biochemical Causes

1. *Reduced levels of anabolic hormones (*growth hormone (GH), insulin-like growth factor (IGF), and testosterone.
2. *Reduce energy production (especially for protein synthesis).*

Neuromuscular Causes

1. *Shrinking cross-sectional areas of all muscle fibers (muscle cells). This is specially true for the* type II fast-twitch fibers.
2. *Fewer mo* *the remaining*
3. *Structural*
4. *Reduced* *ds to slower, less powerful contractions.*
5. *Less satellite cell activity.*

APPLICATION POINT Resistance training can have a positive effect on all aspects of the neuromuscular decline that accompanies aging.

Biochemical Causes

1. *Reduc* *ormone* (GH), *sterone.*
2. *Reduc* *n synthe*

APPLICATION POINT You can use the resistance training techniques presented in this book to counteract the biochemical changes that occur with aging and thus bend your clients' aging curves.

THE TESTS

1. 30-second arm curl
2. 30-second chair rise
3. Gallon jug shelf test
4. Ramp Power Test

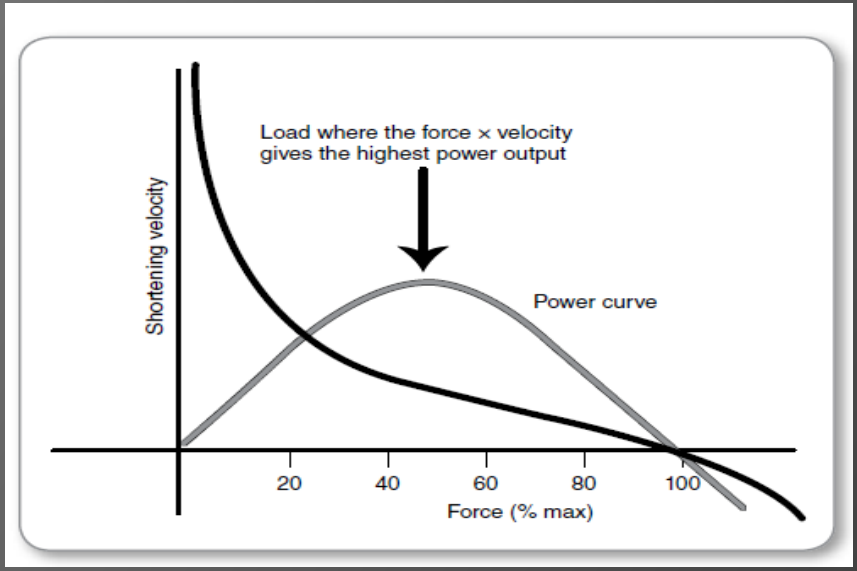
TRAINING CONSIDERATIONS

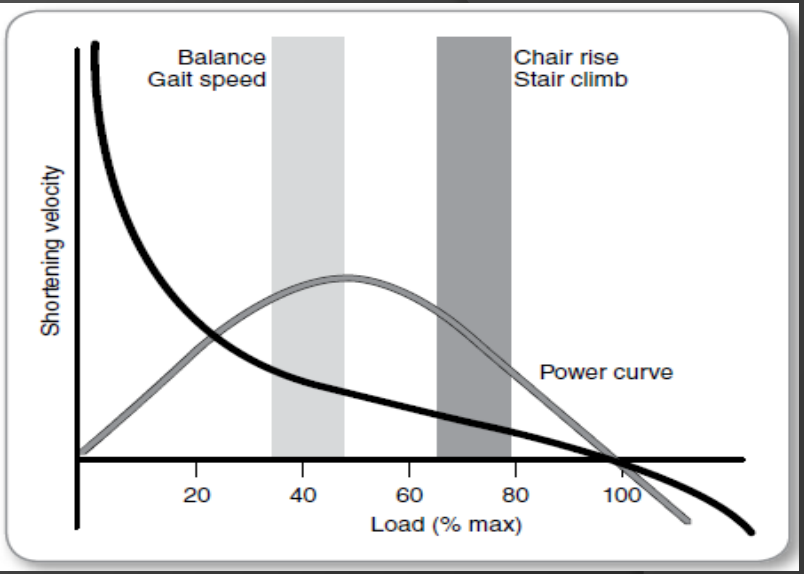
- GOAL
- CURRENT TRAINING STATUS
- WORK AND RECOVERY

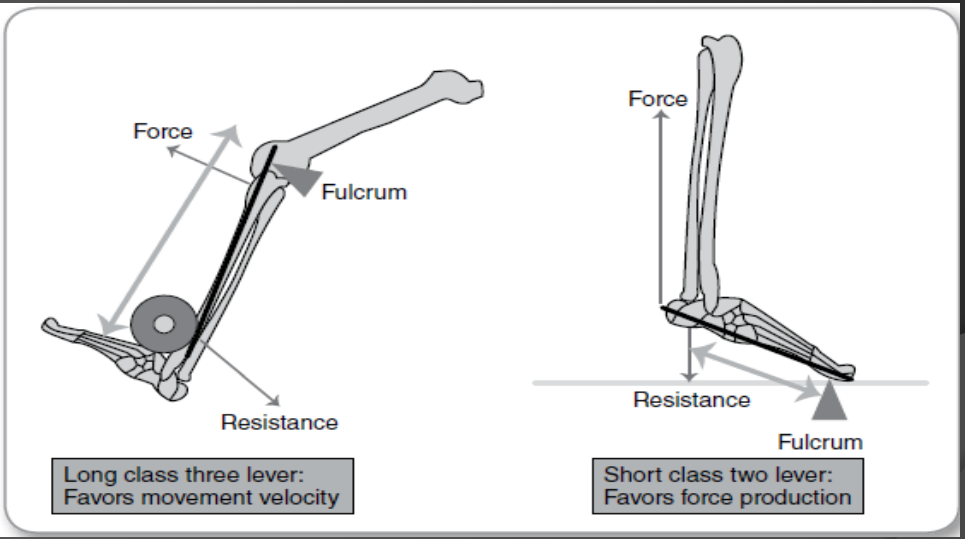
BASIC QUESTIONS

- TRAINING LOAD
- NUMBER OF REPETITIONS
- NUMBER OF SETS
- SESSIONS PER WEEK
- MUSCLE GROUPS
- KINETIC CHAIN

A SPECIFIC EXAMPLE: POWER







CARDIOVASCULAR / METABOLIC TRAINING

CONCERNS

1. *Reduced Aerobic Capacity*
2. *Central Obesity*
3. *Insulin Resistance*
4. *Lipid Profile*
5. *Blood Pressure*
6. *Heart Rate Variability*

TESTING

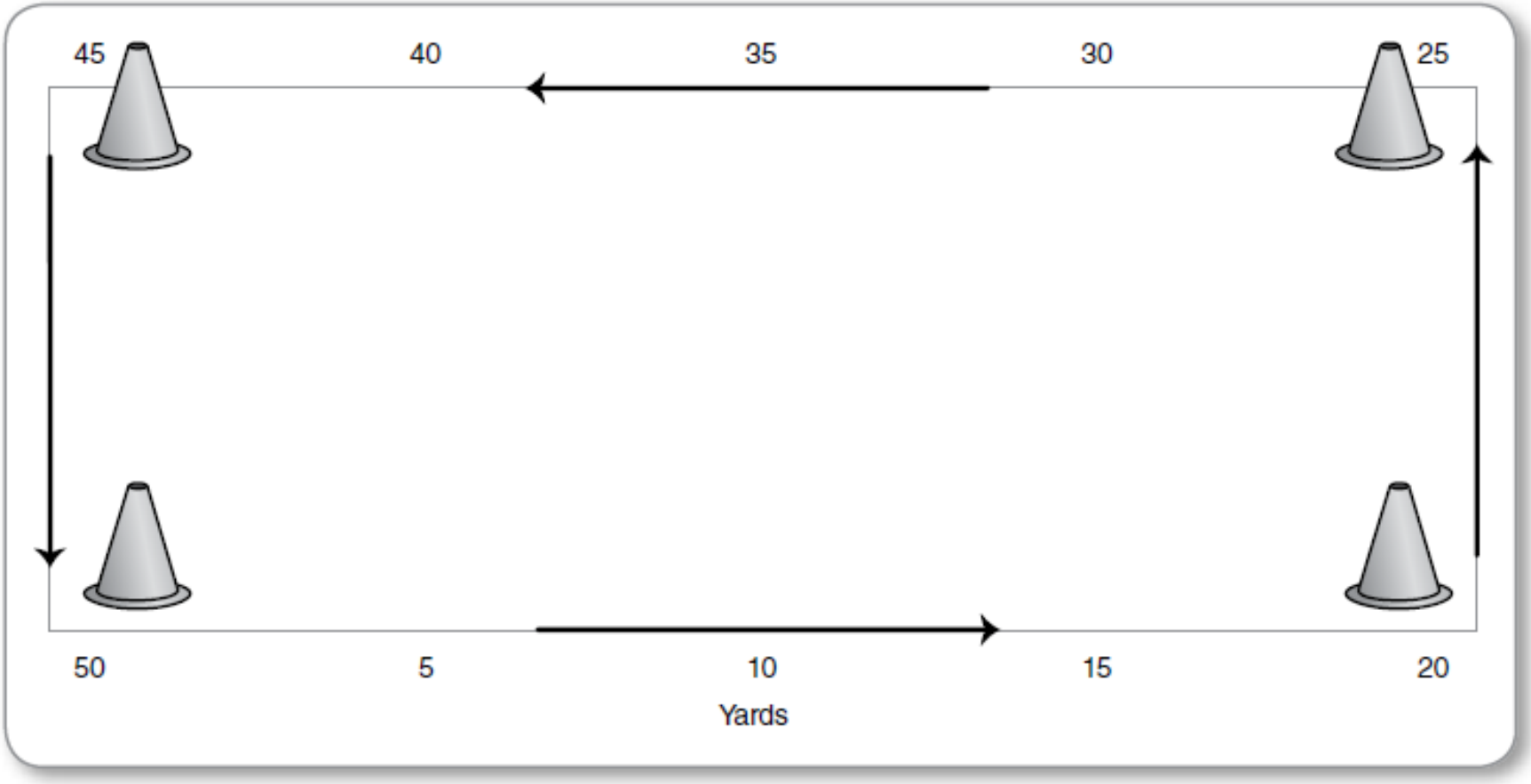


Figure 8.8 The 6-minute walk test.

CONCERNS

Best addressed using high intensity intervals

1. *Reduced Aerobic Capacity*
2. *Central Obesity*
3. *Insulin Resistance*
4. *Lipid Profile*
5. *Blood Pressure*
6. *Heart Rate Variability*

Best addressed using steady state training

CONSIDER THE POSSIBILITIES

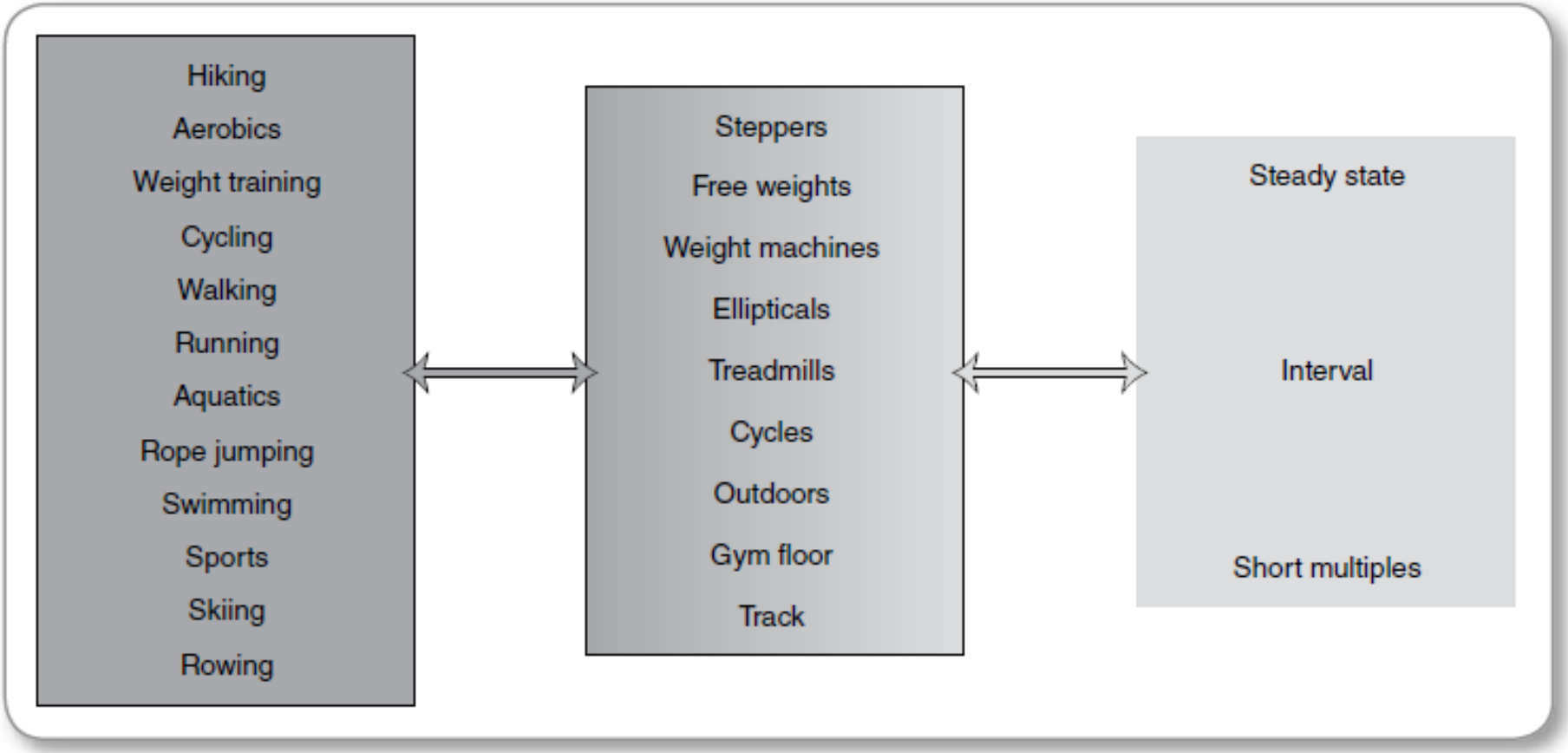


Figure 8.9 The types of exercise, equipment, and training protocols used for improving cardiovascular fitness.

PERIODIZATION:

Putting the Program Together

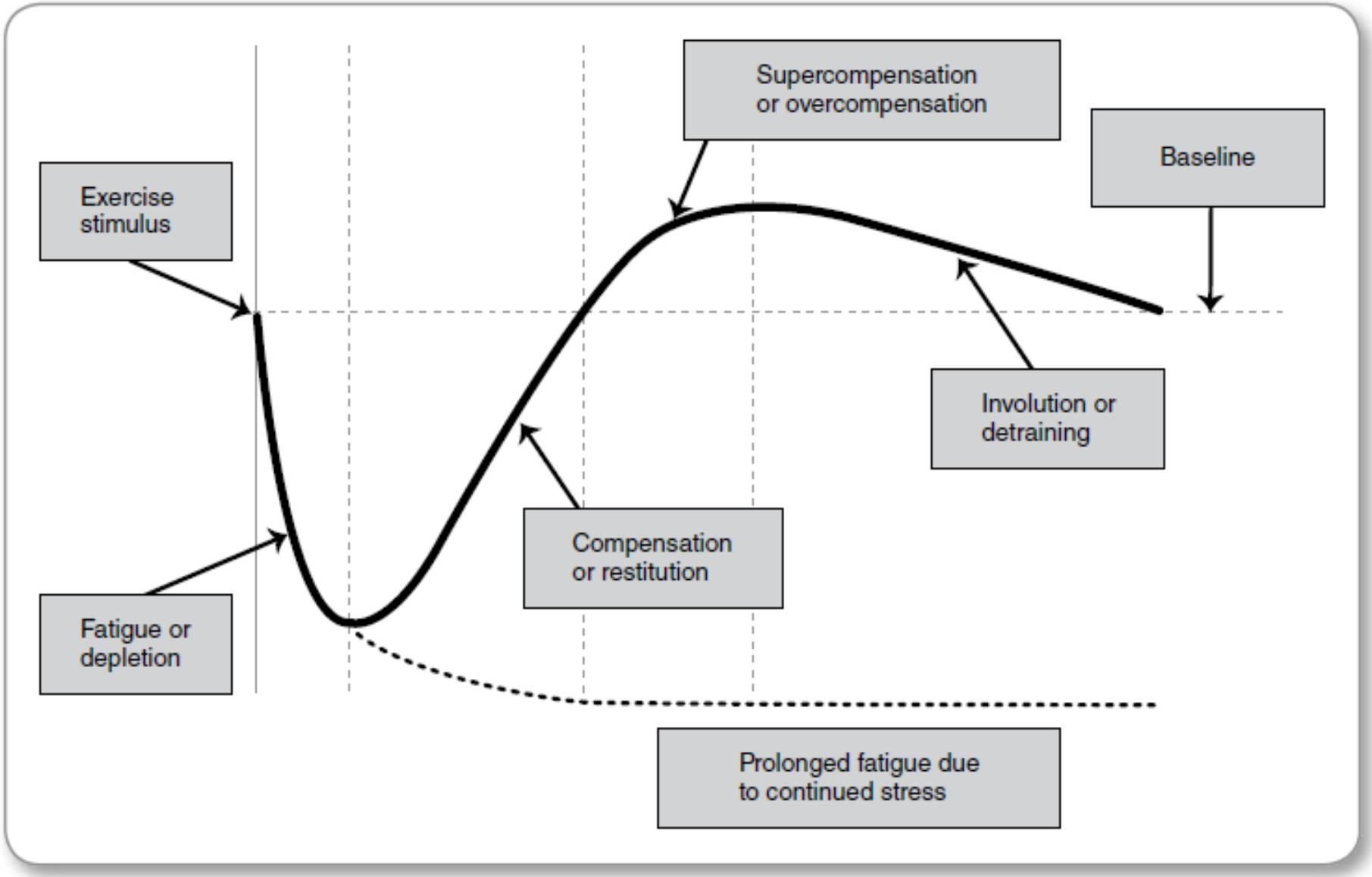
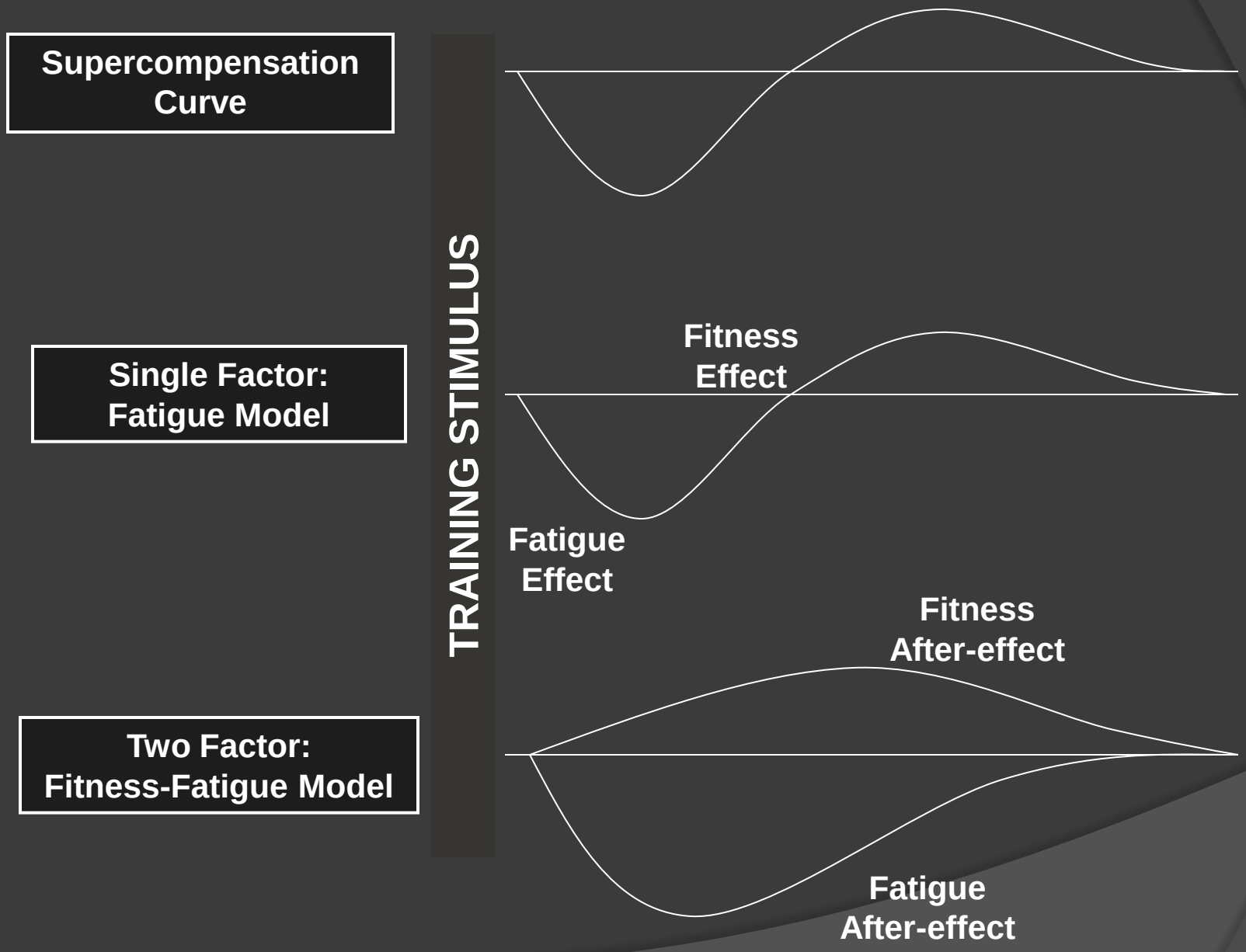
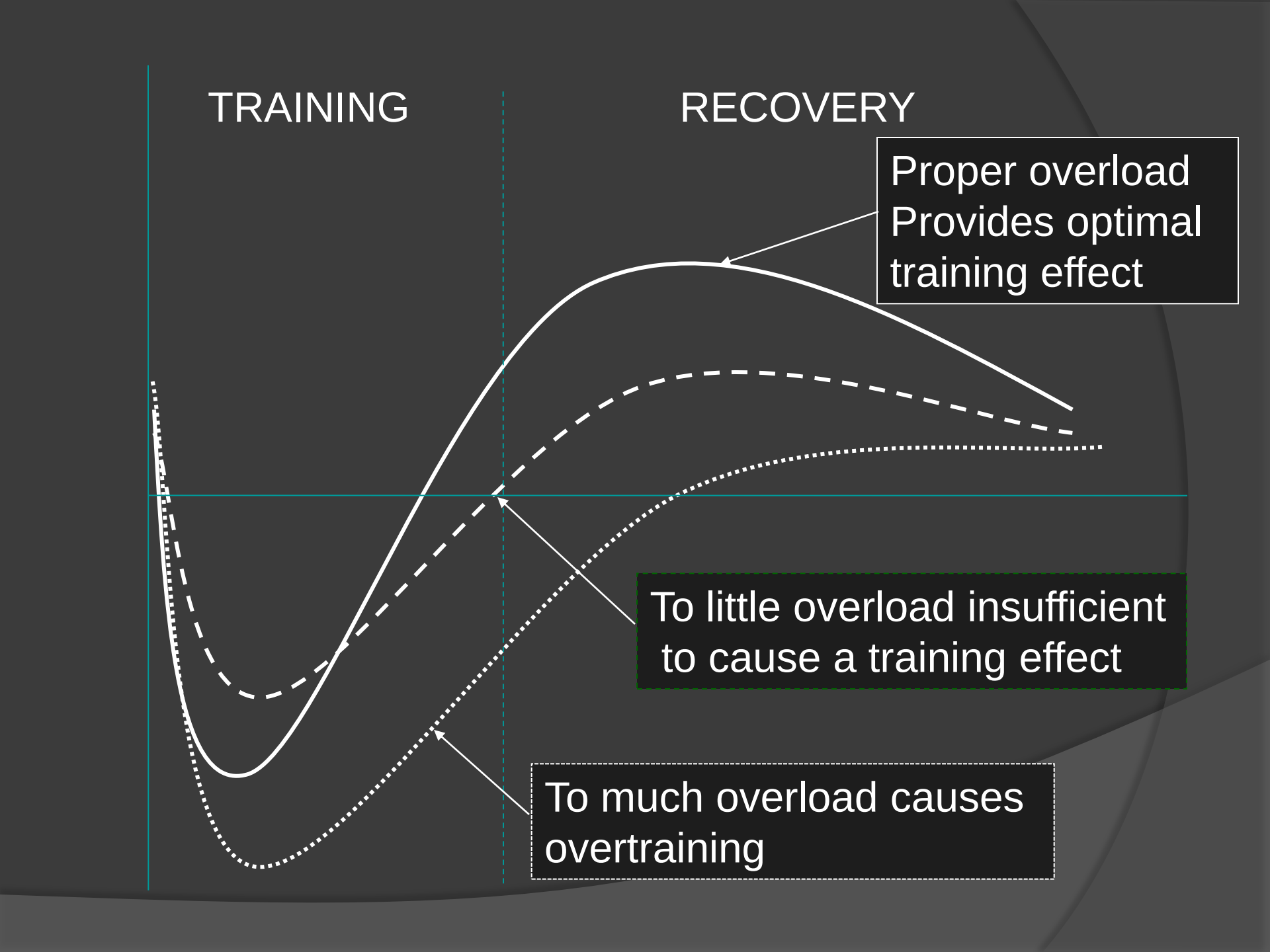
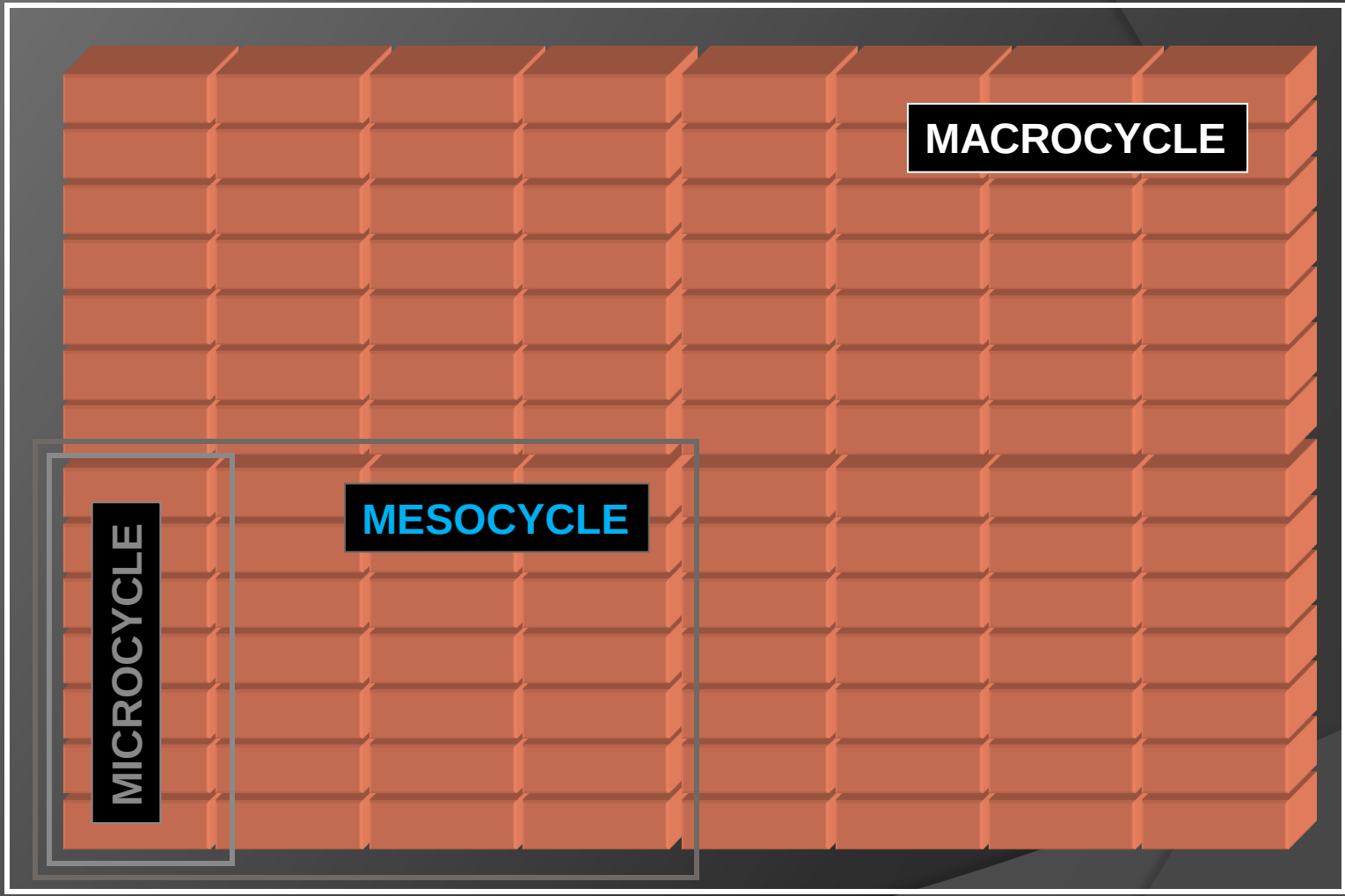


Figure 9.1 The phases of the supercompensation curve.


Supercompensation Curve
Single Factor: Fatigue Model
Two Factor: Fitness-Fatigue Model
TRAINING STIMULUS
Fitness Effect
Fatigue Effect
Fitness After-effect
Fatigue After-effect


TRAINING
RECOVERY
Proper overload Provides optimal training effect
To little overload insufficient to cause a training effect
To much overload causes overtraining


MACROCYCLE
MESOCYCLE
MICROCYCLE

THE NATURE OF VARIOUS CYCLES

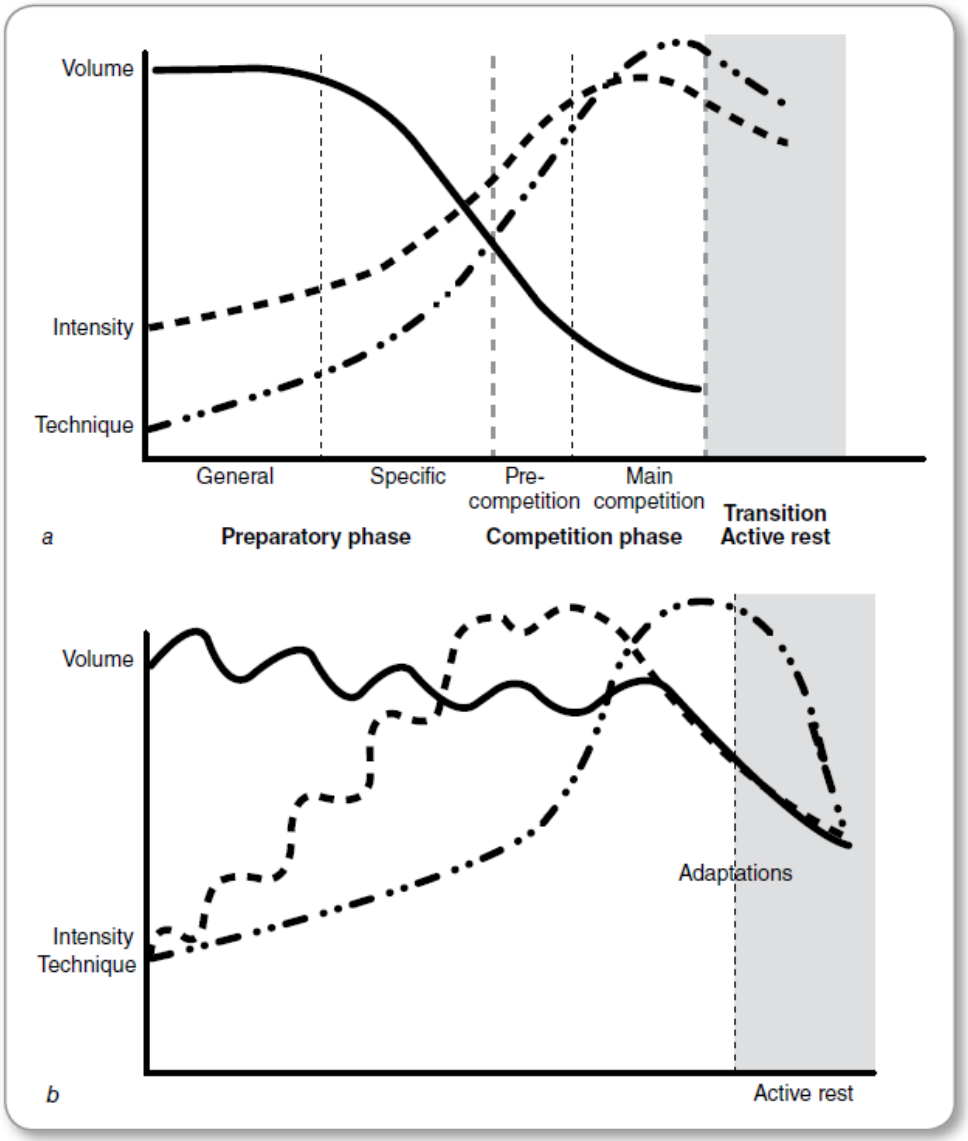
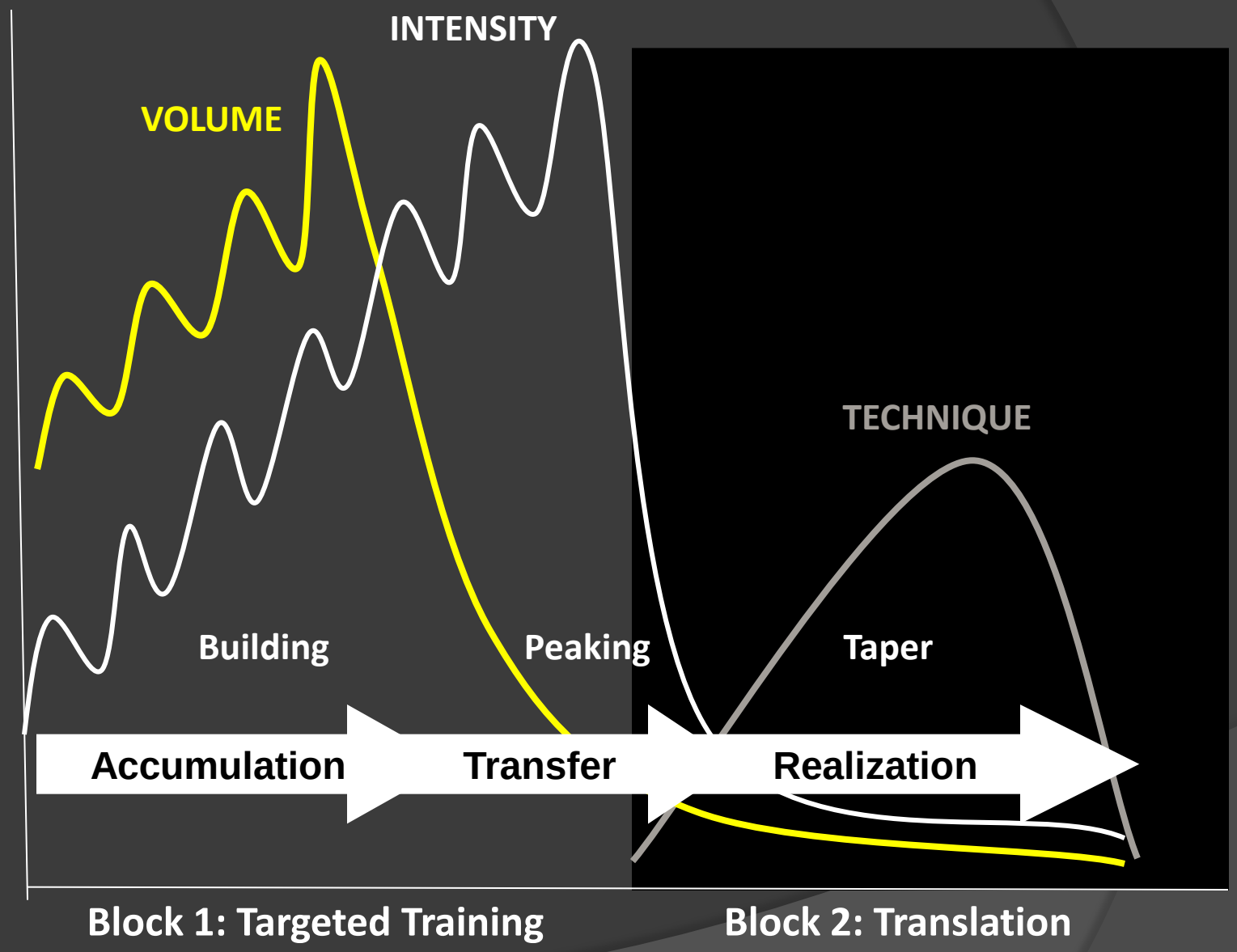


Figure 9.6 *(a)* The classic linear training cycle illustrating a gradual increase in intensity and decrease in volume across the training period. *(b)* An undulating, or nonlinear, mesocycle. Note the fluctuations in intensity and volume and the reciprocating nature of this undulation, in which increases in intensity are associated with decreases in volume and vice versa.

BLOCK CYCLING

Accumulation	Restitution or Transmutation	Competition or Realization
Increases performance variables that prepare the body to maximize specific gains during a targeted cycle.	To increase the intensity and specificity of the exercise and improve goal-specific performance.	To practice goal specific drills designed to translate physiological gains into specific goals.

Residual Effects


INTENSITY
VOLUME
TECHNIQUE
Building
Peaking
Taper
Accumulation
Transfer
Realization
Block 1: Targeted Training
Block 2: Translation

TRANSLATIONAL CYCLES

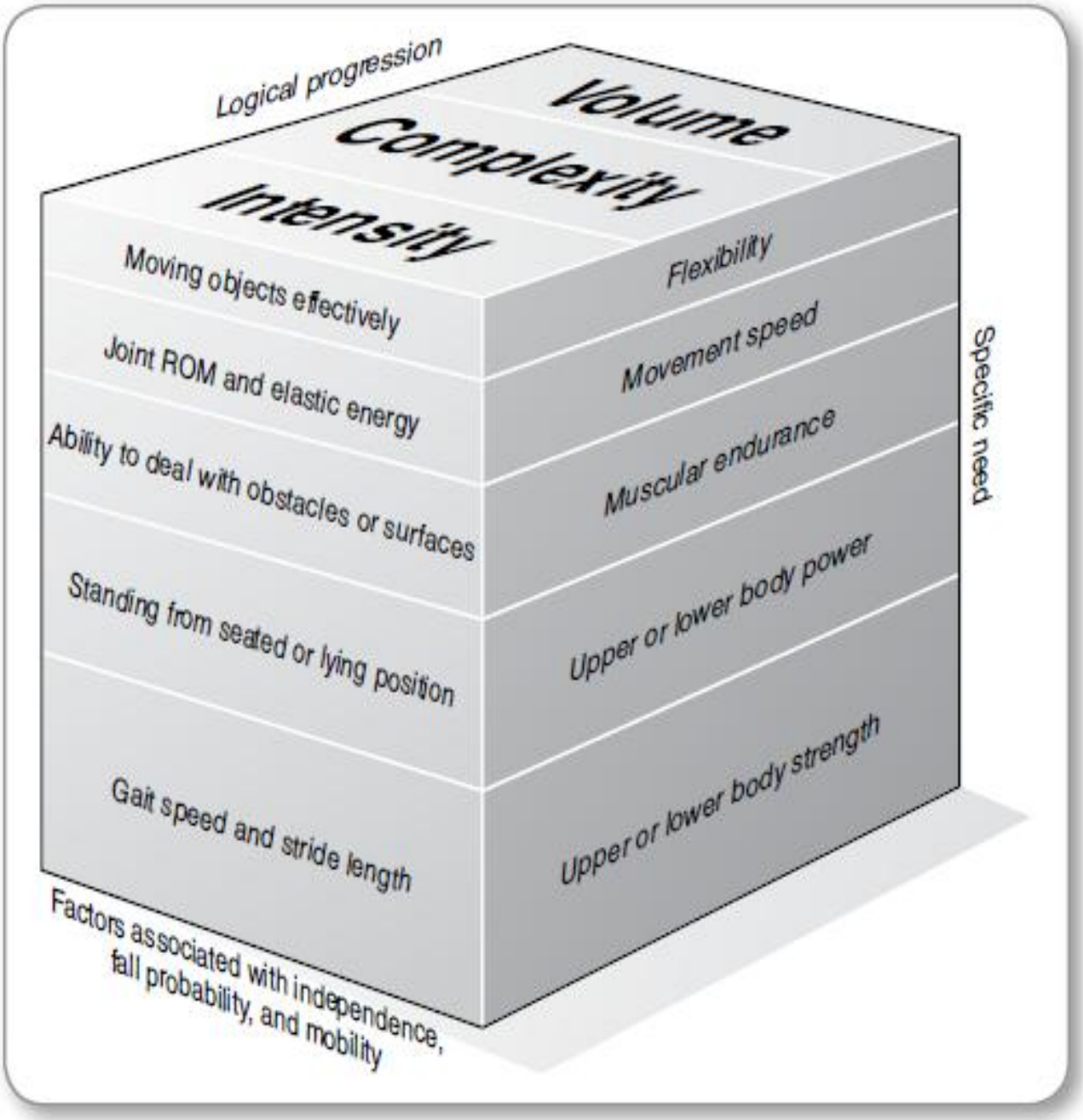


Figure 10.2 Three-dimensional diagram of factors that should be considered when designing a translational cycle.

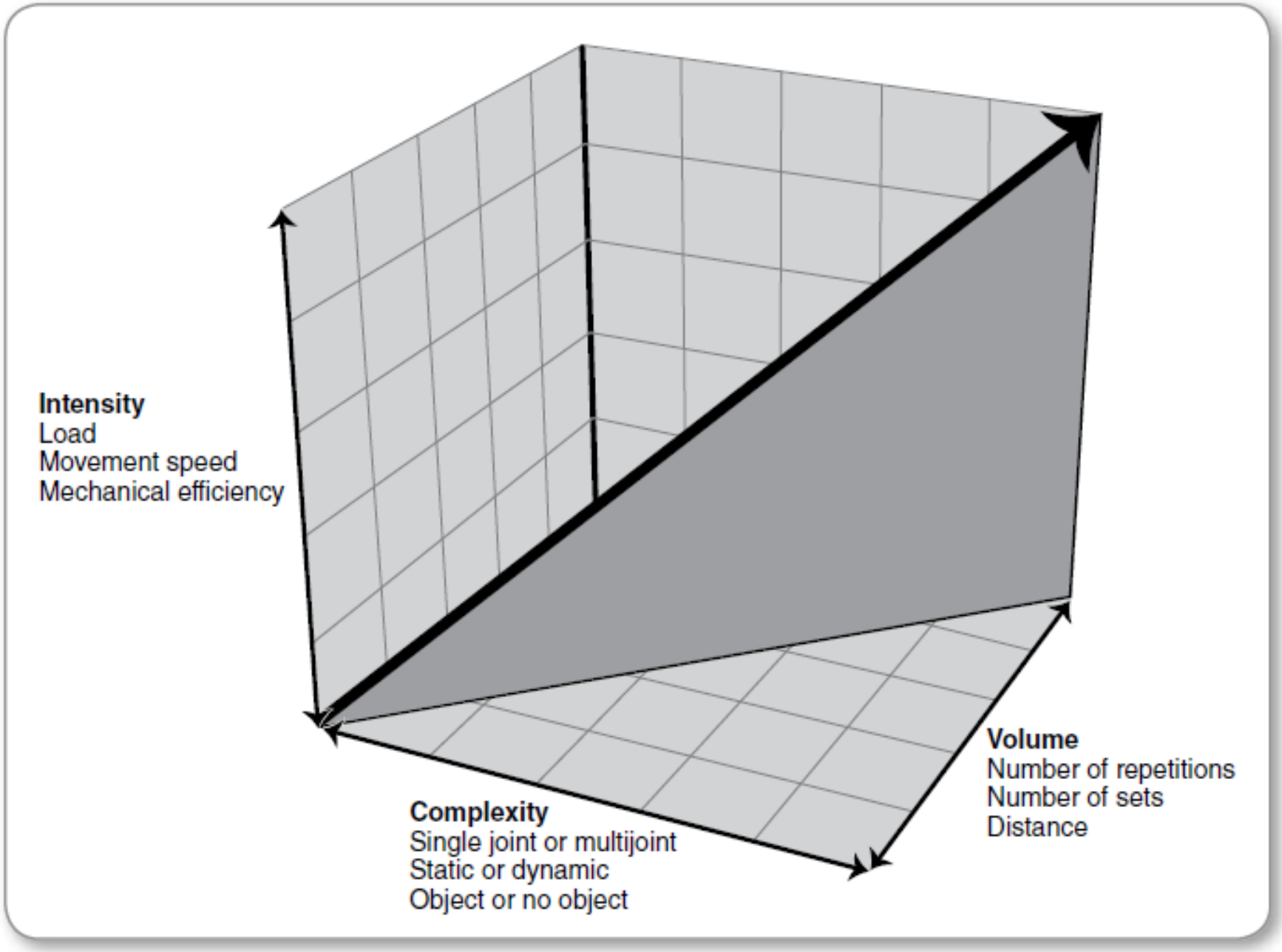


Figure 10.3 The three components (intensity, volume, and complexity) that can be manipulated during a translational cycle.

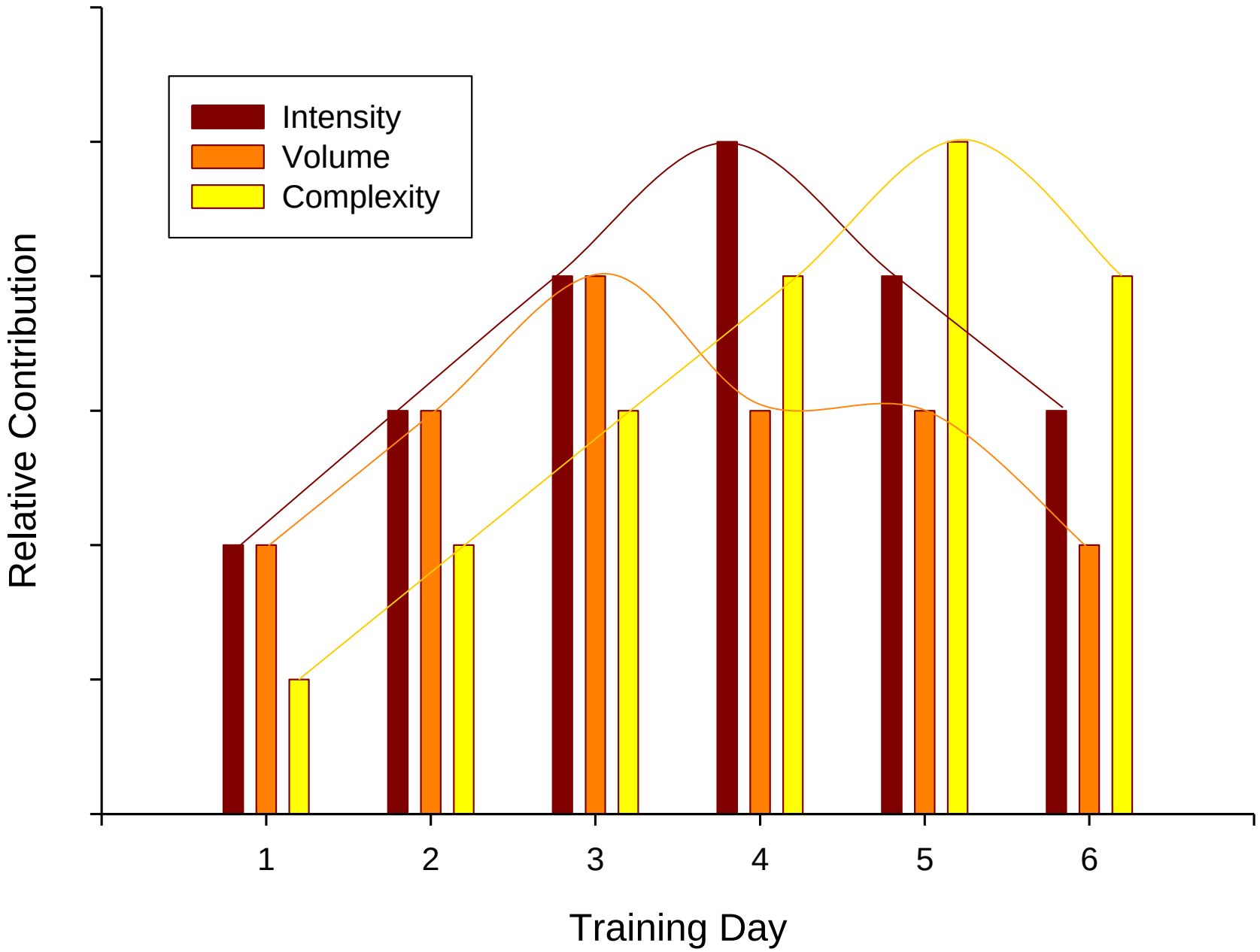
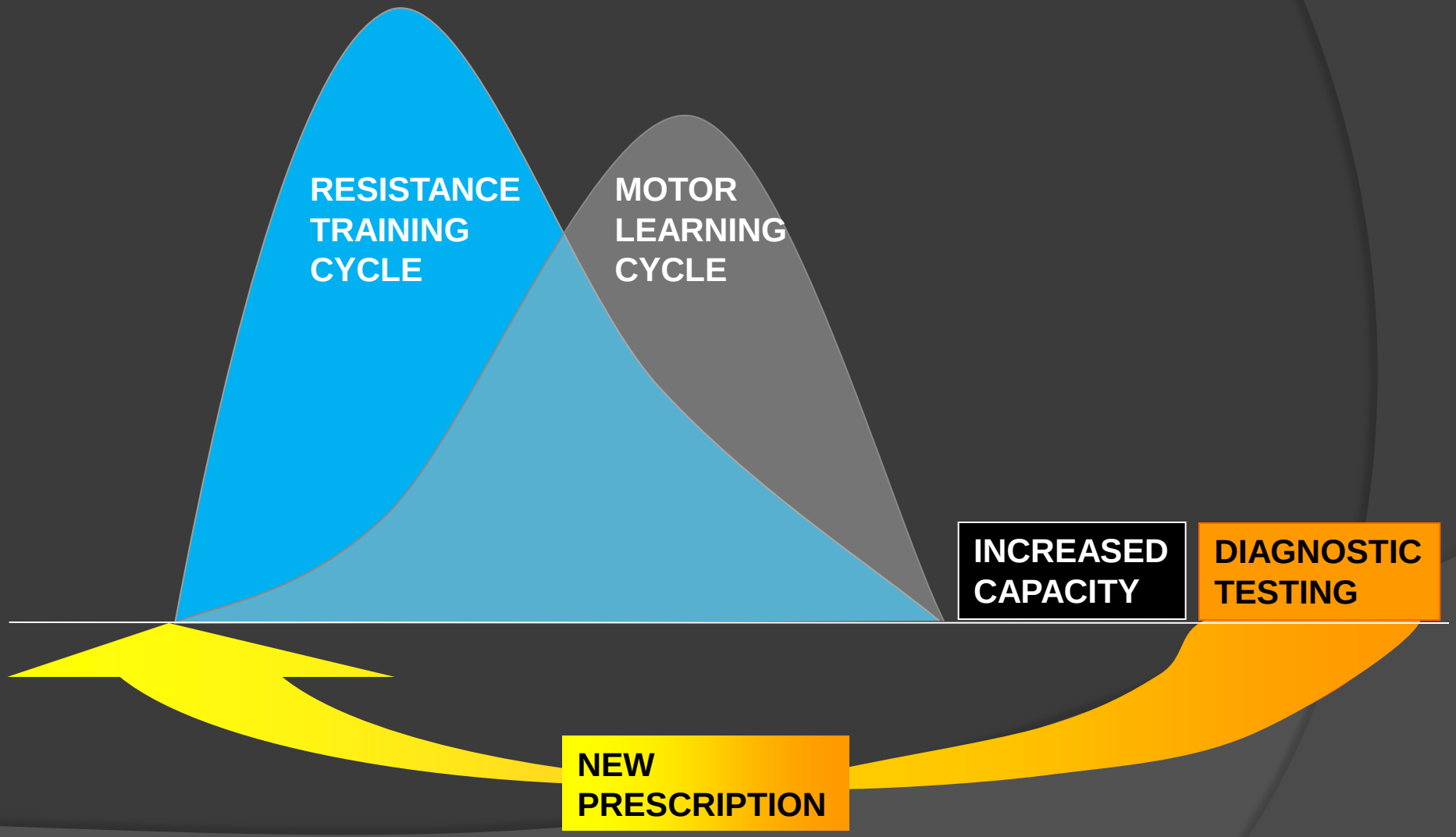

Intensity
Volume
Complexity
Relative Contribution
1
2
3
4
5
6
Training Day

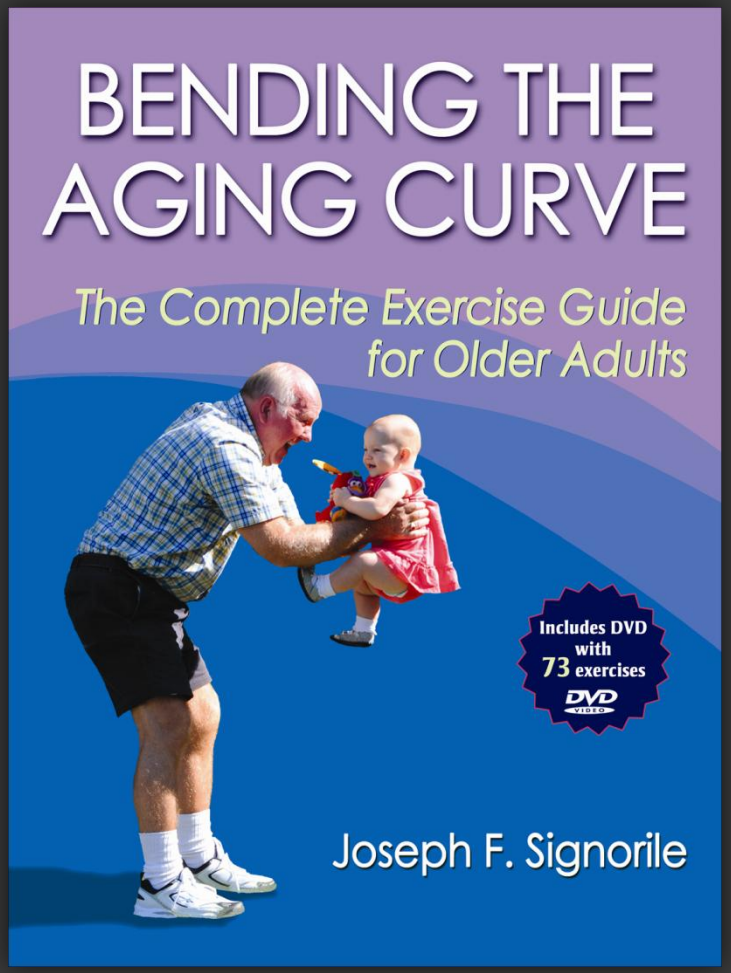
Table 10.1 Training and Translational Matching

Power, balance, and speed	Both	Strength, balance, and control
Functional reach drill	Heel stand	Skating drill
Pillow stands	Heel walk	Lateral advances
Triple-line drill	Lateral throw	Back-to-back handoff
Lateral shuffle drill	Forward and backward passes	Chest pass
Forward and backward cone drill	Truckin' drill	Overhead and lateral throw
Zigzag drill	Dual tasking	Soccer kicks
Cone-touch drill	8-foot (2.4 m) up-and-go drill	Broom hockey
Speed and stride drill	Ladder drills	Step drill
Hexagon drill	Chair drills	Scarf drill
Star excursion drill	Coin pickup drill	Book drills
	Gallon jug drill	Ball-and-pylon drills
	Dot drills	Floor coin pickup drill

THE PATTERN


RESISTANCE TRAINING CYCLE
MOTOR LEARNING CYCLE
INCREASED CAPACITY
DIAGNOSTIC TESTING
NEW PRESCRIPTION

Questions?



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Mark your calendar for 12:00 Eastern (11:00 Central) Thursday, May 5th. The next installment in the series, *Fascial Stretch Therapy (FST): The missing link in training, fitness, and rehab* will feature Chris Frederick, author of *Stretch to Win.*

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