Muscular Strength and Endurance

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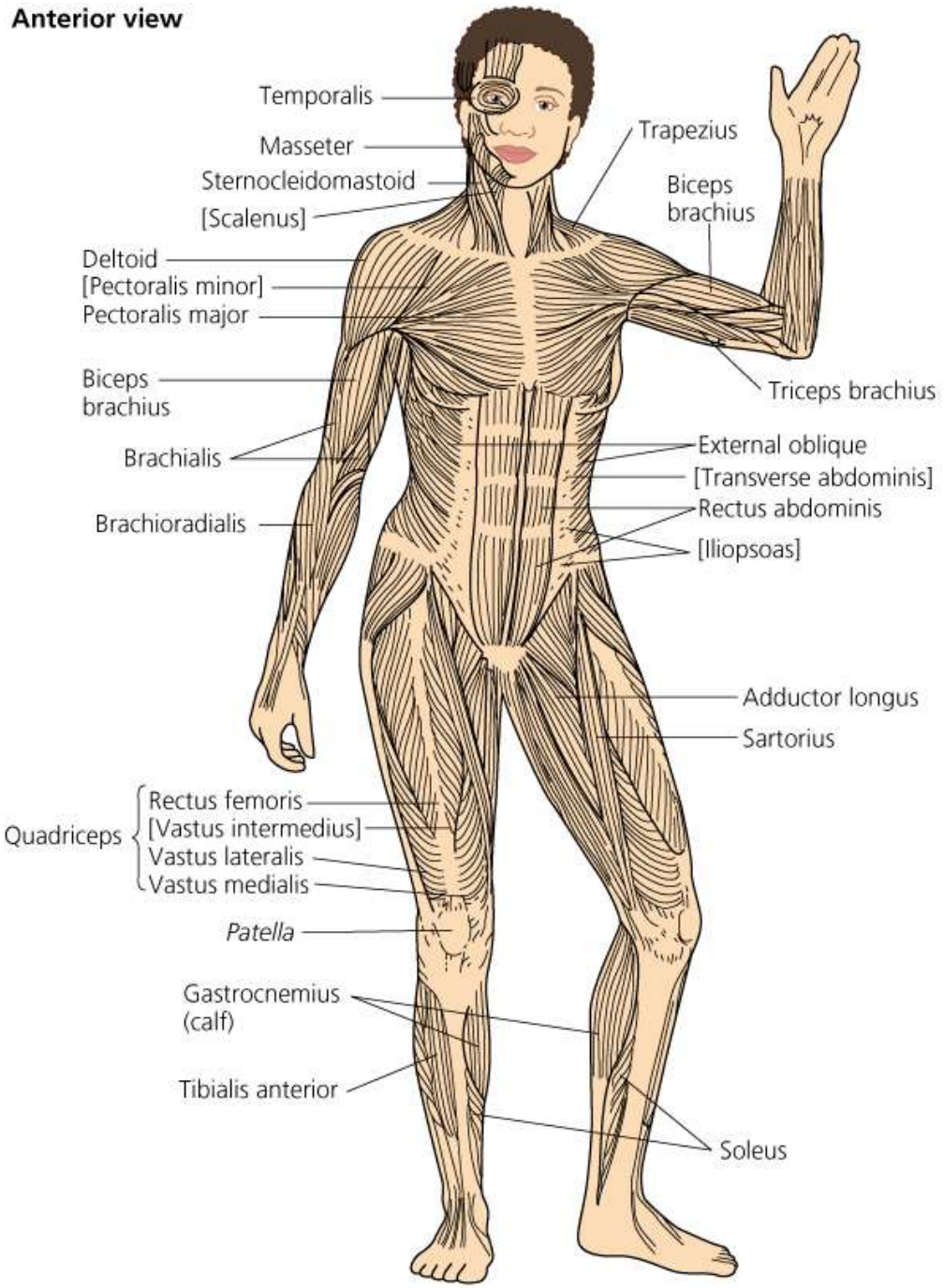
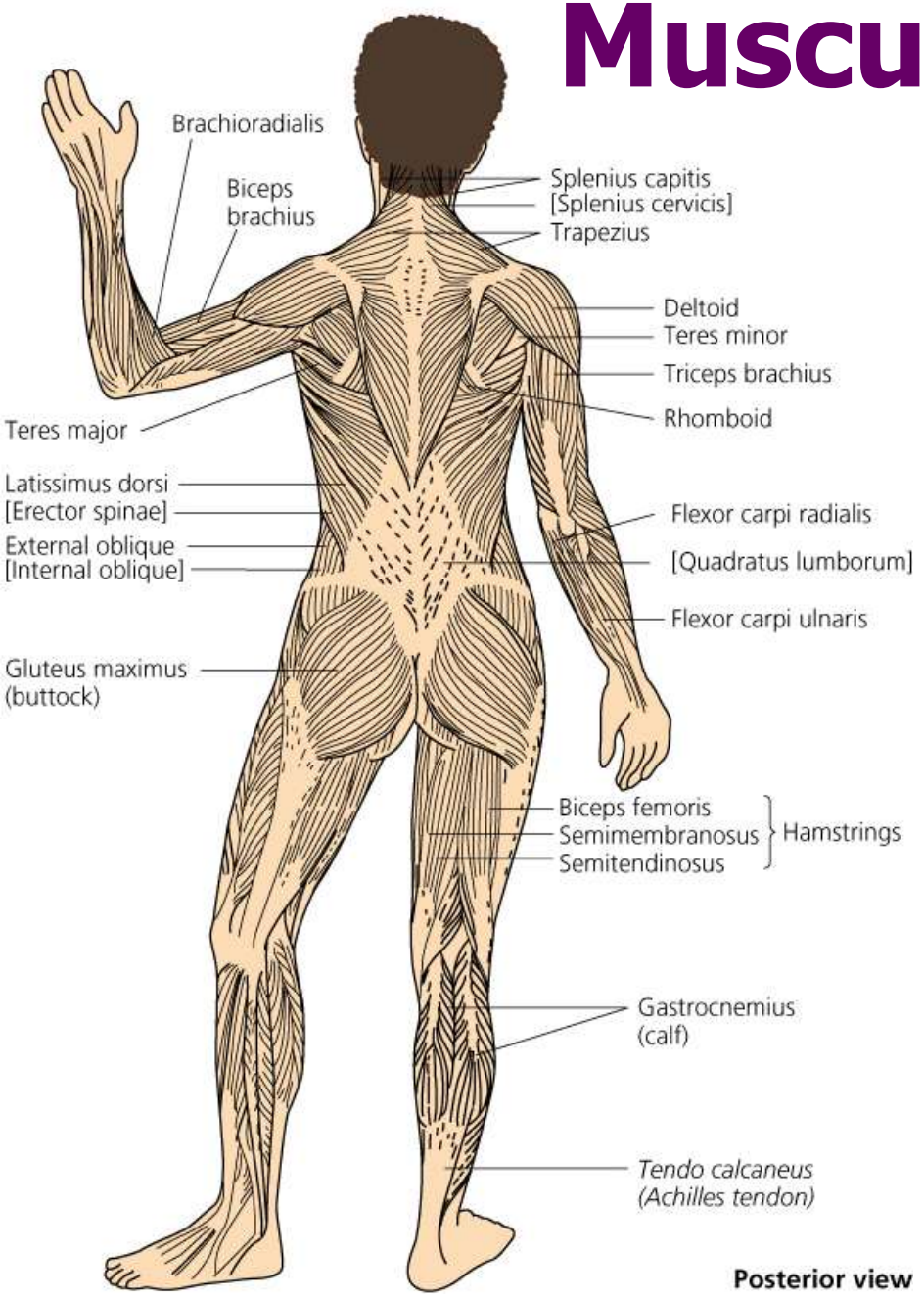
Muscle Physiology

- Muscles consist of many *muscle fibers (cells)* connected in bundles
- Muscle fibers are made up of *myofibrils*
- Strength training increases the number of myofibrils and the size of muscle fibers = *hypertrophy*
- Inactivity reverses the process = *atrophy*

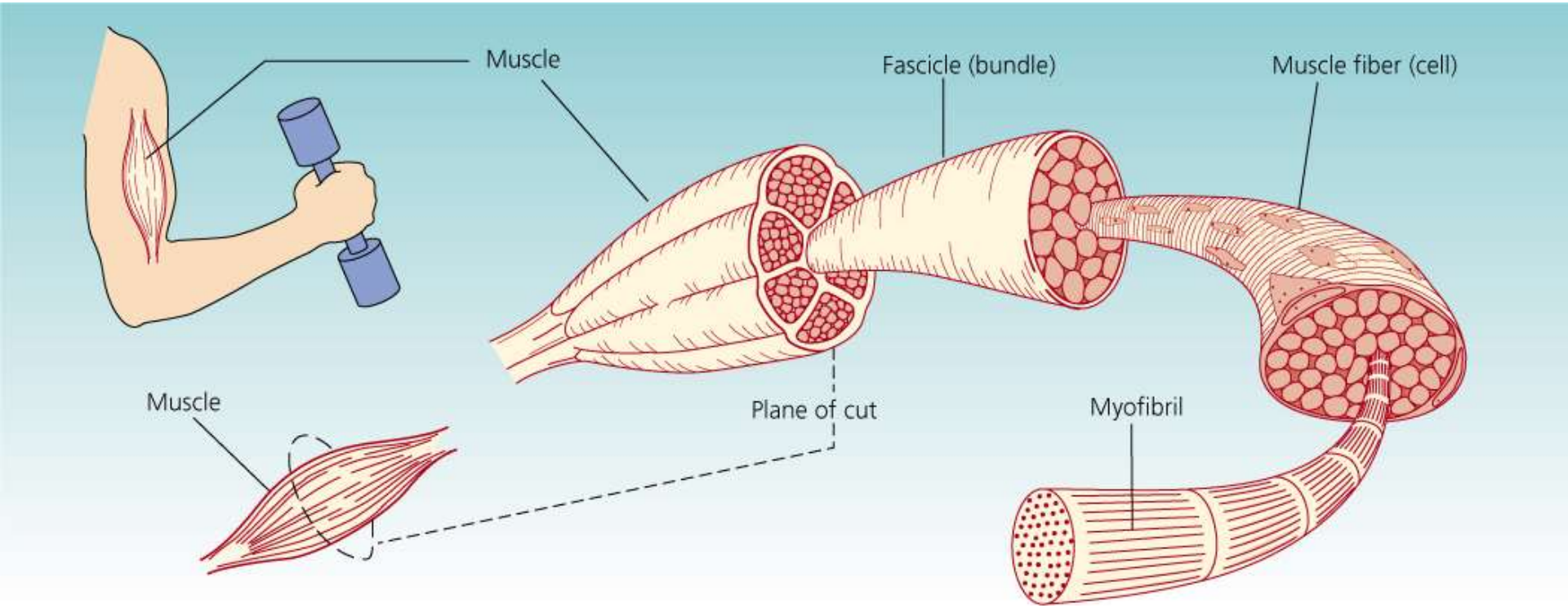
Muscular System



Muscular System



Skeletal Muscle Tissue

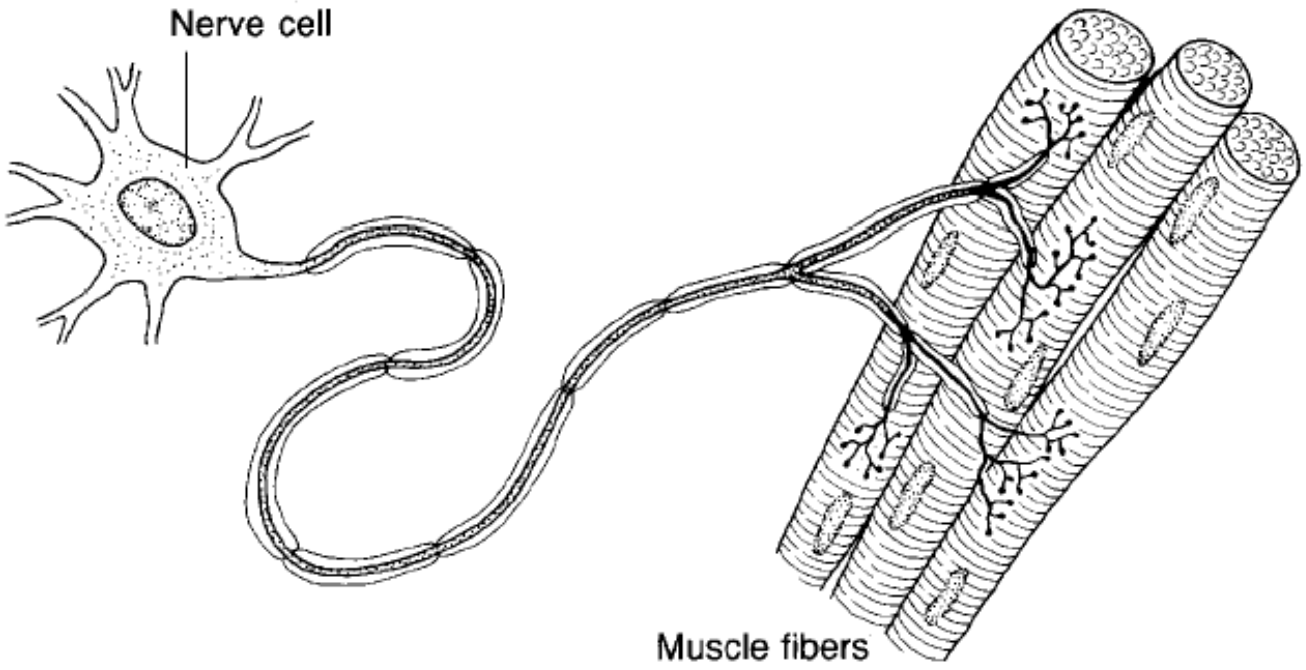


Muscle Fibers

- Slow-twitch fibers
  - Fatigue resistant
  - Don’t contract as rapidly and forcefully as fast-twitch fibers
  - Rely primarily on oxidative energy system
- Fast-twitch fibers
  - Contract rapidly and forcefully
  - Fatigue more quickly than slow-twitch fibers
  - Rely more on nonoxidative energy system

Motor Units

- Motor units (nerves connected to muscle fibers) are recruited to exert force



Physiological Effects of Strength Training

- Increased muscle mass and size of muscle fibers
- Increased utilization and coordination of motor units
- Increased strength of tendons, ligaments, and bones
- Increased storage of fuel in and blood supply to muscles
- Improvements in blood fat levels and biochemical processes

Benefits of Muscular Strength and Endurance

- Improved performance of physical activities
- Injury prevention
- Improved body composition
- Enhanced self-image and quality of life
- Improved muscle and bone health with aging
- Prevention and management of chronic disease

Assessing Muscular Strength and Endurance

- Muscular strength assessed by determining repetition maximum (1 RM), the maximum resistance that can be lifted once
- Muscular endurance assessed by counting the maximum number of repetitions of a muscular contraction

Types of Strength Training Exercises

- Static (isometric) exercise = muscle contraction without a change in the length of the muscle
- Dynamic (isotonic) exercise = muscle contraction with a change in the length of the muscle
  - Concentric contraction = muscle applies force as it shortens
  - Eccentric contraction = muscle applies force as it lengthens

Types of Dynamic Exercise

- Variable resistance = changing load to provide maximal resistance throughout a joint's range of motion
- Eccentric loading = placing load on a muscle as it lengthens
- Plyometrics = sudden eccentric loading and stretching followed by a concentric contraction
- Speed loading = moving a load as rapidly as possible
- Isokinetic exercise = exerting force at a constant speed against an equal force

Creating a Successful Weight Training Program

- Choosing equipment: Weight machines versus free weights
  - Resistance is provided by both types
  - Exercise machines
    - Safer, convenient, and easy to use
  - Free weights
    - Require more care, balance, and coordination
    - Strength transfers to daily activities

Applying the FITT Principle

- **F**requency = days per week
- **I**ntensity = amount of resistance
- **T**ime = number of repetitions and sets
- **T**ype = strength training exercises for all major muscle groups

Frequency of Exercise

- American College of Sports Medicine recommends 2-3 days per week
  - Allow 1 full day of rest between workouts

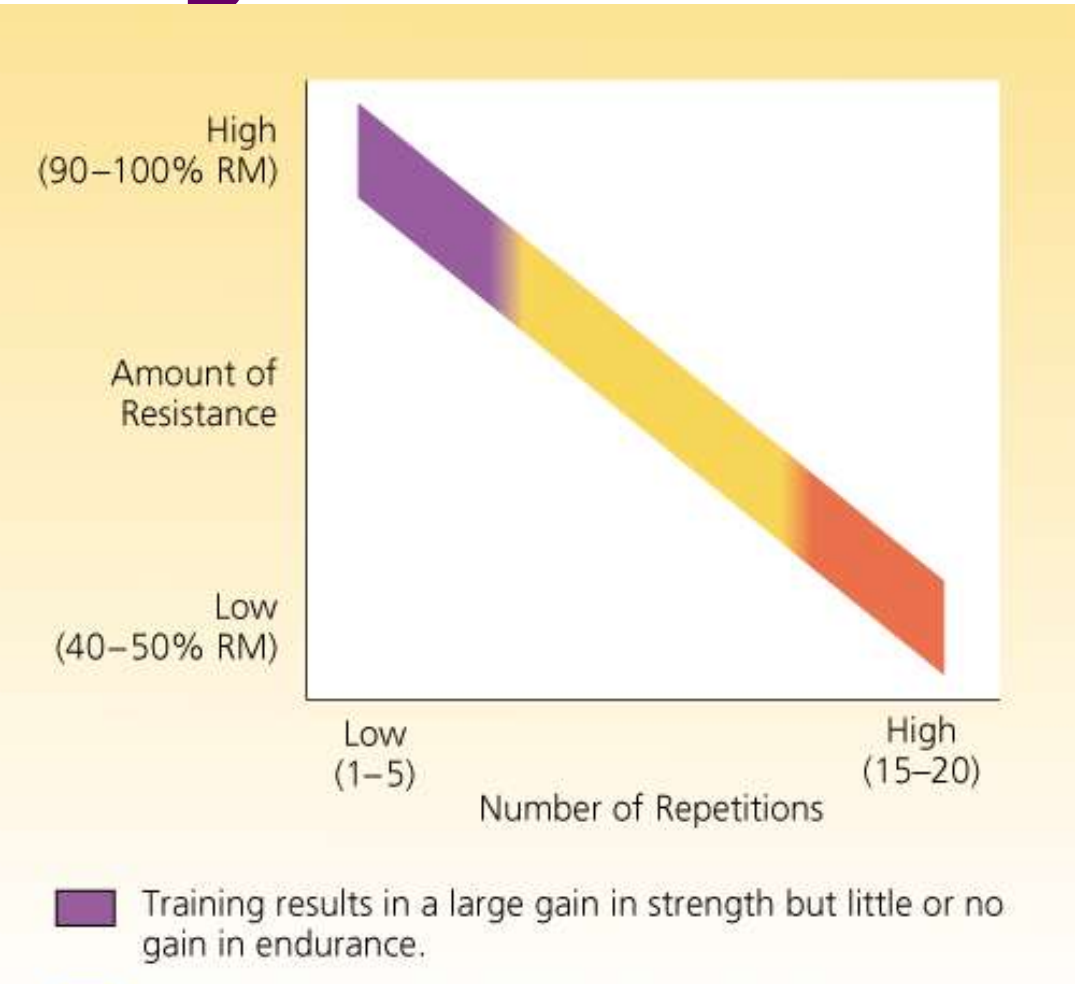
Intensity of Exercise: Amount of Resistance

- Choose resistance based on your current fitness level and goals
- To build strength
  - Lift heavy weights (80% of 1 RM)
  - Perform a low number of repetitions
- To build endurance
  - Lift lighter weights (40-60% of 1 RM)
  - Perform a high number of repetitions
- For a general fitness program
  - Lift moderate weights (70% of 1 RM)
  - Moderate number of repetitions

Time of Exercise: Repetitions and Sets

- To build strength and endurance, do enough repetitions to fatigue the muscles
- The heavier the weight, the fewer the repetitions (1-5) to fatigue = a program to build strength
- The lighter the weight, the higher the number of repetitions (15-20) to fatigue = a program to build endurance
- To build both strength and endurance, try to do 8-12 repetitions of most exercises

Training for Strength versus Training for Endurance



Time of Exercise: Repetitions and Sets

- Set = a group of repetitions followed by a rest period
- For general fitness, 1 set of each exercise is sufficient
- Doing more than one set will increase strength development
- Rest between sets

Type of Exercise

- For a general fitness program:
  - 8–10 different exercises
  - Work all major muscle groups
  - Balance between agonist and antagonist muscle groups
  - Do exercises for large-muscle groups and multiple joints before exercises for small-muscle groups or single joints

Warm Up and Cool Down

- Warm up prior to each weight training session with a general warm-up and a warm-up for the exercises you will perform
- Cool down after weight training, relax for 5-10 minutes, lower your heart rate

FITT Principle for Strength Training

Warm-up 5–10 minutes	Strength training exercises for major muscle groups (8–10 exercises)	Cool-down 5–10 minutes

Sample program

Exercise	*Muscle group developed*
Bench press	Chest, shoulders, triceps
Pull-ups	Lats, biceps
Shoulder press	Shoulders, trapezius, triceps
Upright rowing	Deltoids, trapezius
Biceps curls	Biceps
Lateral raises	Shoulders
Squats	Gluteals, quadriceps
Heel raises	Calves
Abdominal curls	Abdominals
Spine extensions	Low- and mid-back spine extensors
Side bridges	Obliques, quadratus lumborum

Start *Stop*

Frequency: 2–3 days per week

Intensity/Resistance: Weights heavy enough to cause muscle fatigue when exercises are performed with good form for the selected number of repetitions

Time: Repetitions: 8–12 of each exercise (10–15 with a lower weight for people over age 50–60); **Sets:** 1 (doing more than 1 set per exercise may result in faster and greater strength gains)

Type of activity: 8–10 strength training exercises that focus on major muscle groups

Making Progress

- To start: Choose a weight with which you can do 8–12 repetitions with good form
- To progress: Add resistance when you can do more than 12 repetitions
- Maintain good form at all times
- Track your progress

Sample Workout Card

WORKOUT CARD FOR Sara Lopez

Exercise/Date		9/14	9/16	9/18	9/21	9/23	9/25	9/28	9/30	10/2	10/5	10/7	10/9	10/12	10/14	10/16
Bench press	Wt.	45	45	45	50	50	50	60	60	60	65	65	65	70	70	70
	Sets	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Reps.	10	10	12	10	12	12	10	9	12	10	12	12	9	9	10
Pull-ups (assisted)	Wt.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	Sets	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Reps.	5	5	5	6	6	6	7	7	7	8	8	8	9	9	10
Shoulder press	Wt.	20	20	20	25	25	25	30	30	30	30	30	30	35	35	35
	Sets	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Reps.	10	10	12	10	12	12	8	10	9	10	12	12	10	10	10
Upright rowing	Wt.	5	5	10	10	10	10	12	12	12	12	15	15	15	15	15
	Sets	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Reps.	12	12	8	10	11	12	9	10	10	12	8	8	8	9	10
Biceps curls	Wt.	15	15	15	20	20	20	25	25	25	25	25	25	30	30	30
	Sets	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Reps.	10	10	10	10	12	12	8	10	10	10	12	12	9	10	12
Lateral raise	Wt.	5	5	5	5	5	5	7.5	7.5	7.5	7.5	7.5	7.5	10	10	10
	Sets	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Reps.	8	8	10	10	12	12	8	10	10	10	12	12	8	8	9
Squats	Wt.	–	–	–	45	45	45	55	55	55	65	65	65	75	75	75
	Sets	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Reps.	10	12	15	8	12	12	8	12	12	10	10	12	8	10	10
Heel raises	Wt.	–	–	–	45	45	45	55	55	55	65	65	65	75	75	75
	Sets	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Reps.	15	15	15	8	12	12	10	12	12	10	12	12	10	12	12
Abdominal curls	Wt.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	Sets	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Reps.	20	20	20	20	20	20	25	25	25	25	25	25	25	25	25
Spine extensions	Wt.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	Sets	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Reps.	5	5	5	8	8	8	10	10	10	10	10	10	11	12	12
Side bridge	Wt.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	Sets	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Seconds	60	60	60	65	65	70	70	70	70	76	75	80	80	80	80

More Advanced Strength Training Programs

- Performing more sets of a smaller number of repetitions with a heavier weight
- Cycle training (periodization) by varying type and amount of exercise
- Consult a coach certified by the National Strength and Conditioning Association

Weight Training Safety

- Use proper lifting techniques
- Use spotters and collars with free weights
- Be alert for injuries