

Core principles and concepts

Muscle physiology

- Muscle fibers: Type I (slow), Type IIa (fast oxidative), Type IIx (fast glycolytic)
- Sliding filament theory: Actin + Myosin + ATP = Contraction
- All-or-none principle: Muscle fibers contract fully or not at all
- Motor unit recruitment: Size principle (small → large)

Bioenergetics

- Phosphagen system: 0–6 sec, anaerobic, CP + ATP
- Glycolysis: Anaerobic, 6 sec–2 min, lactate as byproduct
- Oxidative system: 2+ min, aerobic, fats + carbs
- Energy system dominance depends on intensity & duration

Endocrine responses

- Anabolic hormones: Testosterone, GH, IGF-1
- Catabolic hormone: Cortisol (stress, tissue breakdown)
- Acute hormone response → Resistance training → ↑ anabolic hormones

Legal concepts

- Negligence = Breach of duty + harm
- Liability = Coach responsibility to act safely
- Informed consent ≠ liability waiver

Neuromuscular adaptations

- Neural adaptations → Early strength gains
- Rate coding, recruitment, synchronization ↑ with training
- Myelination & motor unit efficiency improve with practice

Cardiorespiratory

- Stroke volume ↑ with training → ↑ Cardiac output (Q)
- $\text{VO}_2 \text{ max}$ = Max oxygen usage capacity
- Lactate threshold ↑ with endurance training

Testing and evaluation

- Validity = Measures what it's supposed to
- Reliability = Consistency
- Typical order: non-fatiguing → agility → max strength → sprint → endurance
- 1RM prediction formula: $\text{Weight} \times (1 + (0.0333 \times \text{reps}))$

Exercise technique

- Squat: Neutral spine, knees track toes, thighs parallel
- Deadlift: Hinge, flat back, bar close to shins
- Power clean/snatch: Triple extension, catch with elbows high
- Bench press: 5 points of contact, spot from head

Program design

- SAID principle: Specific Adaptation to Imposed Demands
- Progressive overload: ↑ Weight, volume, complexity
- Periodization types:
 - Linear: ↑ Intensity, ↓ Volume
 - Undulating: Changes week-to-week or session-to-session
- Rest periods:
 - Power: 2–5 min
 - Strength: 2–5 min
 - Hypertrophy: 30–90 sec
 - Endurance: <30 sec

Plyometrics

- SSC (Stretch-shortening cycle): Eccentric → Amortization → Concentric
- Safety: Depth jump ≤ 42 inches, surface should absorb shock
- Volume based on experience (80–100 beginner, 100–120 intermediate)

Macronutrients

- Protein: 1.4–2.0 g/kg/day (higher for strength)
- Carbs: 5–10 g/kg/day (higher for endurance)
- Fat: ~20–35% total calories

Hydration

- 1 lb lost = ~16 oz fluid replacement
- Pre-exercise: ~16 oz 2–3 hrs before
- Electrolyte replacement essential for long-duration activity

Supplements

- Creatine: ↑ ATP-PC system, 5g/day
- Caffeine: 3–6 mg/kg, ↑ alertness & endurance
- Beta-alanine: ↓ Fatigue, ↑ buffering

Youth

- Emphasize technique over load
- Growth cartilage = avoid max loading
- 1–3 sets of 6–15 reps, 2–3x/week

Female athletes

- ACL injury prevention: Land mechanics, quad:ham ratio
- Strength differences mostly due to muscle mass

Older adults

- Focus on technique and progressive overload
- 1–3 sets, 8–12 reps, 2–3x/week

Risk management

- Emergency Action Plan (EAP) = REQUIRED
- Spotters: Required for bar over head/face/back
- Facility design: ≥49 sq ft per athlete, mirrors 6" above floor