Anaerobic Conditioning to the Max

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Rec. Reading: Kravitz, L. et al. (2014) Anaerobic metabolic conditioning. IDEA Fitness Journal (see Len's Website)

I. What is metabolic conditioning? (from Bergeron et al., 2011)

A. "Exercises that impose a moderate to high demand on the cardiovascular system and energy metabolism of the active muscle fibers to meet with the muscles' repeated high energy requirement."
B. Anaerobic-type metabolic conditioning: "Motor unit activity, substrate flux and force-speed production patterns such that anaerobic bioenergetics pathways are preferential." (Plisk, 1991) Peripheral in nature
C. Aerobic-type metabolic conditioning: Dynamic exercise integrating cardiorespiratory parameters, including heart rate, cardiac output, blood flow distribution, left ventricular stroke volume, arterial pressures, total peripheral resistance, and arterial and venous blood oxygen content. Central in nature
D. Newest form of met. conditioning. Non-exercise activity thermogenesis (NEAT). NEAT is the energy expended for everything we do that is not sleeping, eating or sports-like exercise. "Changes in NEAT accompany experimentally induced changes in energy balance and may be important in the physiology of weight change." (Levine, 2004). Can burn 269 to 477 kilocalories/day

II. Anaerobic metabolism basics and terms

A. Glucose and glycolysis: 'glyc' is Greek for glucose; glycolysis is the splitting of sugar; gluc is Greek for sweet; 'ose' means sugar; glucose means 'sweet sugar'; glycolysis kicks in within 3-5 sec of exercise
B. Where do anaerobic energy reactions take place? Sarcoplasm of muscle cell
C. Phosphagen: ATP=PC or ATP-phosphocreatine or creatine phosphate; 10-30 sec
D. Anaerobic is also referred to as glycolytic; predominates for 2 minutes; no oxygen needed
E. NADH: coenzyme in anaerobic metabolism that carries electrons and hydrogen ions (H atom=H+ and e-)
F. Pyruvate: end product of glycolysis; junction between anaerobic and aerobic metabolism
G. Glycogenolysis: the breakdown of glycogen in muscle and liver
H. Gluconeogenesis: metabolic pathway that results in generation of glucose from non-CHO carbon substrate
I. Lactate: produced in muscle cells during the breakdown of CHO to use for energy in low oxygen level

III. Plisk, S.S. (1991). Anaerobic metabolic conditioning: A brief review of theory, strategy, and practical application. Journal of Applied Sport Science Research, 5(1), 22-34. Excellent Scientific Review

IV. Anaerobic metabolic conditioning: Recruiting the anaerobic bioenergetics pathways

A. ATP hydrolysis = ADP + Pi + energy for work and heat; 7.3 kilocalories of usable energy
B. Review of the phosphagen system; observing the 3 high energy phosphates attached to the ribose
C. Hydrolysis of ATP: Splitting of ATP occurs by water: One proton (H+) is released from reaction
D. Phophocreative CrP or PCr is high energy molecule which synthesizes ATP in cell
E. Why is there such a drop in PCr in sprint exercise? 40%-60% depletion of ATP; more for PCr. ATP is supplied by the phosphagen, glycolytic and mitochondria respiration; PCr just from phosphagen: phosphagen replenishment occurs in recovery by oxidative means: Thus aerobic training improves recovery for anaerobic exercise: important training implications
F. Enzymes: biological catalysts; lower activation energy of a reaction; unaltered by reaction
G. Why does our body prefer glucose for fuel; plenty of it and have all enzymes to break it down fast
H. Glycolysis is oldest metabolic pathway known. Why do we need 10 reaction steps? All about heat
I. Training implications of the hexokinase reaction (first reaction). Glucose is 'stuck' in cell.
J. In reaction 3 of glycolysis the enzyme is PFK. It is an allosteric enzyme. Means it is rate limiting.
K. Importance of pyruvate kinase reaction (10) is the body produces a lot of heat
L. Net yield of glycolysis: 2 water, 2 ATP, 2 pyruvate, 2 NADH+H+ (shuttled to 2 FAD in the ETC)
M. Lactate formation explanation:

1. At end of glycolysis the two molecules of interest are two NADH+H+ (a vitamin carrying a proton with another loosely coupled proton) and two pyruvate molecules
2. Under steady state conditions the two pyruvate go to the TCA cycle and the two NADH+H+ go to the Electron Transport Chain to be used for ATP synthesis
3. Strenuous exercise, energy demands exceed oxygen supply (pyruvate and NADH+H+ are inhibited)

4. To resolve this situation, pyruvate accepts 2 protons into its structure and temporary converts itself to lactate; so, lactate is actually a 'buffer' to acidosis and not the cause of acidosis; NAD+ returns to step 6
5. Latest on lactate and burn. The cause of the burn (or acidosis) is the accumulation of protons at the muscle myofilaments (from the splitting of ATP); not lactate; aerobic exercise is best way clear acidosis

V. Anaerobic-type metabolic conditioning program design

A. In sets or repetitions; Intervals or sprints (active/passive rest); Multiple-sequence exercises (circuits)
B. Moderate to near maximal to supramaximal (above VO_2max) intensities
C. Usually 15 to 90-sec bouts; can last as long as 120 seconds; Relief of 2 to 3 minutes between circuits
D. Two to 3 times per week for fit persons (based on timeline for glycogen repletion)
E. Anaerobic-type conditioning is best trained by increasing intensity or speed; extending duration of bouts leads to poor exercise technique and longer recovery
F. Special Note: HR is a POOR predictor of exercise intensity during anaerobic training; activation of the sympathetic nervous system disproportionately elevates HR
G. For repeated bouts exercise: initially a 1:4 work-to-relief in intervals recommended; may gradually taper ratio to 1:2, 1:1.5, 1:1 Progression is most important
H. Total exercise volume (repetitions, sets, circuits); at this time there is no evidence-based guideline; Plisk suggests that trainers need to focus on exercise quality (with a sufficient intensity) that elicits targeted responses and adaptations for each client
I. Anaerobic conditioning makers (i.e., PC recovery, muscle activation/recruitment) take up to 5 weeks
J. Athletes with higher aerobic capacity resynthesize PC more effectively…benefit of aerobic exercise
K. Special tip to circuits presented: regularly change the sequence of exercises for variety
L. Anaerobic exercise programs designed by Jon Mike

Circuit A: 30 seconds for each exercise; 2-3-min active (aerobics) rest after each circuit; complete 2x	**Circuit B: 30 seconds for each exercise; 2-3-min active (aerobics) rest after each circuit; complete 2x**
Jump lunge (TRX)	Bear crawls
Kettlebell single arm farmers walk (switch arms)	1/2 knee bottom up with kettlebell (both sides)
Med. ball 1/2 kneel side rotation throw (both sides)	Medicine ball rollover floor slams
Front plank with band row (low row; both sides)	Single arm row standing (with TRX) (both sides)
Mountain climbers	Kettlebell swings
Circuit C: 20 seconds for each exercise; 2-3-min active (aerobics) rest after each circuit; complete 2x	**Circuit D: 20 seconds for each exercise; 2-3-min active (aerobics) rest after each circuit; complete 2x**
Kettlebell swings	Broad jump
Side plank with band row (both sides)	Medicine scoop throw (forward)
TRX shoulder elevated leg curls (SHELCS)	TRX inverted row
Spiderman pushups	Kettlebell single leg deadlift (both sides)
Single arm carry (overhead) with kettlebell (switch)	Front squat to press
Circuit E: 30 seconds for each exercise; 2-3-min active (aerobics) rest after each circuit; complete 2x	**Circuit F: 30 seconds for each exercise; 2-3-min active (aerobics) rest after each circuit; complete 2x**
Dumbbell goblet squat	Front split squat (do both legs)
Kettlebell floor press	Kettlebell overhead walk (both arms)
Star planks	Long lever plank
Zercher reverse lunge	Tall kneeling kettlebell press
½ kneeling medicine ball chop slams	Medicine ball recoiled shot put throw with hot feet
Circuit G: 20 seconds for each exercise; 2-3-min active (aerobics) rest after each circuit; complete 2x	**Circuit H: 20 seconds for each exercise; 2-3-min active (aerobics) rest after each circuit; complete 2x**
Kettlebell deadlift	Reverse lunge to single arm press (both arms)
Plate pushes	Kettlebell halo
Band (or cable) face pulls	Unilateral slide push-ups
Kettlebell bottom-up carry (both arms)	Medicine ball ½ kneeling side rotation throws
Leg body saw (with gliders)	Heavy band row

SPECIAL SUGGESTION: To make each circuit a 'circuit weight-interval training' workout incorporate 30 seconds of high intensity (hard to very hard rating of perceived exertion) on any aerobic modality followed by 3 minutes of active recovery on the modality.
Complex 1: Romanian deadlift {or regular} (3-6 reps)**;** Hang clean (3-6 reps)**;** Front squat (3-6 reps)
Hang snatch and then Overhead press (3-6 reps); Barbell row (3-6 reps)

VI. Special topic with high intensity exercise or more specifically, some extreme conditioning exercise programs: Exertional Rhabdomyolysis: From Bergeron 2011. "A potential emerging problem associated with increasingly popularized extreme conditioning programs (ECP) has been identified by the military and civilian communities. That is, there is an apparent disproportionate musculoskeletal injury risk from these demanding programs, particularly for novice participants, resulting in lost duty time, medical treatment, and extensive rehabilitation….practical solutions to improve ECP prescription and implementation and reduce injury risk are of paramount importance"

X. What is exertional rhabdomyolysis?

A. "Breakdown of striated muscle tissue"; Reports date back thousands of years
B. Elevated proteins in blood (notably myoglobin), renal failure, blood clotting, heart arrhythmias
C. Response to excessive, prolonged or repetitive exercise (hot climate exacerbates) in persons with low fitness and/or too early of an introduction to the demands of the exercise program
D. Exertional rhabdomyolysis triad: reddish brown (cola colored) urine, muscular pain, muscular weakness; (note: symptoms of muscular stiffness and swelling may occur with rhabdomyolysis)
E. Pathophysiology of exertional rhabdomyolysis: 1) Excessive, prolonged or repetitive exercise may overstretch the sarcoplasmic reticulum, 2) Leads to an increase in calcium ion leakage into the muscle cell, 3) This activates special receptors on sarcolemma (cell membrane) that begin releasing very powerful degrading enzymes, 4) This increases the sarcolemma permeability; 5) The sarcolemma releases harmful proteins in the blood that may cause renal failure, blood clotting, heart arrhythmias
F. Trainer recommendations: Ensure suitable rest periods between sets and workouts
G. Vary workouts so all are not to exhaustive fatigue
H. Discourage clients from using caffeine and other stimulants which mask fatigue
I. Monitor clients for signs of overtraining; Track client records to note signs of performance decrements
J. Be cautious of training at high intensities in hot environments