Science of Training

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SCIENCE OF TRAINING
Perspective

Myth:

Training should be grueling day after day in order to arrive at the event in the best shape possible.

Reality:

Unregulated intense training across time leads to over-training, reduced health, injury and burnout.

SCIENCE OF TRAINING
Overtraining

Increases displayed for

- heart rate or blood pressure
- white blood cells and eosinophils
- cortisol
- lactic acid for sub-max exercise

Decreases displayed for

- blood sugar and muscle glycogen
- testosterone or estradiol
- muscular power at max exercise

SCIENCE OF TRAINING
Rules of Engagement

Train healthy – Athletes who are frequently ill or injured cannot accomplish their goals or reach their full potential.

Train sensibly – Managed, varied intensity and volume will safeguard health and provide the training response to compete successfully.

Train intelligently – Applying the fundamentals of the science of training to work-out design and execution will create the most effective and efficient training response.

SCIENCE OF TRAINING
Scientific Domains of High Performance

Physics

Biomechanics = Mechanics of Sport Skill Proficiency

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Chemistry

Sport Nutrition = Energy Production

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Cardiovascular Physiology = Energy Mobilization

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Muscular Physiology = Energy Utilization

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Psychology

Sport Psychology = Attributes of Achieving

SCIENCE OF TRAINING
Energy Production

During training and racing, the body needs a constant supply of energy, realized through complex chemical processes that metabolize (break down) food and yield a substance called ATP.

The body only stores enough ATP in blood and muscle tissue to last enable 2-3 seconds of intense work; enough creatine phosphate to enable 4-5 additional seconds of intense work.

The body uses two general methods to produce ATP – aerobic metabolism or production of ATP with oxygen, and anaerobic metabolism or production of ATP without oxygen.

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Energy System Selection

The method of energy production depends on the demand for energy as measured by INTENSITY (pace) and DURATION (time or distance) of the activity.

As the pace of activity increases, the body makes greater use of anaerobic metabolism and less use of aerobic metabolism.

As the distance of the activity increases, the body makes greater use of aerobic metabolism and less use of anaerobic metabolism.

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Lactic Acid and Thresholds

A by-product of anaerobic metabolism is lactic acid. At low to moderate intensity, lactic acid is re-used to create ATP.

At high intensity, lactic acid accumulates faster than it can be removed or re-used and muscle function becomes impacted.

This point is marked by labored breathing and a burning sensation in the muscles and is called LT1.

If intensity exceeds LT1, athletes can only continue for a short period of time. The point at which discomfort forces athletes to slow down or stop is called LT2.

SCIENCE OF TRAINING
Aerobic Energy Systems

Slow long distance – aerobic metabolism of fat

REC – aerobic fitness; facilitates regeneration

AEG1 - aerobic endurance; increases

- stroke volume
- capillary network
- aerobic energy transport

SCIENCE OF TRAINING
Aerobic Energy Systems

Fast middle distance – aerobic metabolism of carbohydrates

AEG2 – aerobic speed; optimizes

- steady state
- lactate utilization

LAC – aerobic power, LT1; maximizes

- lactate removal from muscle
- muscle tolerance of lactate

SCIENCE OF TRAINING
Anaerobic Energy Systems

Fast short distance – anaerobic metabolism of carboydrates and accelerated lactate accumulation

ANG1 – anaerobic speed; increases

- anaerobic energy transport
- buffering capacity of muscle

ANG2 – anaerobic endurance, LT2; maximizes

- lactate production
- pain threshold

SCIENCE OF TRAINING
Anaerobic Energy Systems

Explosive sprints – non-glycogen anaerobic metabolism

ATPCP – anaerobic power; optimizes storage and use of

- creatine phosphate in blood and working muscle
- ATP in blood and working muscle

SCIENCE OF TRAINING
Energy System Distribution

Anaerobic and aerobic energy systems work simultaneously and contribute differently at different intensities of performance.

System Role Event Time	ATP-CP	ANG2-ANG1	LAC-AEG2	AEG1-REC
0:00:10	50.0	50.0		
0:00:20	25.0	65.0	10.0	
0:00:45	12.5	60.0	27.5	
0:01:45	5.0	50.0	45.0	
0:03:30		25.0	75.0	
0:15:00		12.5	87.5	
0:30:00		2.5	97.5	
3:00:00			75.0	25.0

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Rowing Energy System Utilization

Using men's and women's lightweight and heavyweight 2000 meter times as the guideline, rowing energy is metabolized by the following systems:

Gender	PR Range	ATP-CP	ANG2-ANG1	LAC-AEG2	AEG1-REC
Men	6:33-6:47	0.000	0.217	0.783	0.000
Women	7:07-7:28	0.000	0.207	0.793	0.000

For all practical purposes, rowing is 80% aerobic (AEG2 and LAC) and 20% anaerobic (ANG1-ANG2).

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Energy System Monitoring

There are several ways to gauge/prescribe the intensity of rowing training and thus the energy system being used:

- Aerobic demand in % VO_2 max
- Heart rate in % of Max HR
- Power in % Max Watts
- Perceived exertion in RPE units, descriptors, or breathing

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VO_2max

VO_2 max is a measure of the capacity for aerobic metabolism of ATP and is a major determinant in the ability to sustain intense activity over time.

VO_2 max is measured in mL of O_2 per kg of body weight per minute as obtained from a progressive exercise test to exhaustion or estimated from power output in 2000 meter erg:

VO_2 max = 1.682+ 0.0097 WM / Wt * 1000 in males

VO_2 max = 1.631+0.0088 WM / Wt * 1000 in females

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Percent Maximum Heart Rate

There is a linear relationship between VO_2max and the percentage of your maximum heart rate (% HR max).

Maximum heart rate is measured in beats per minutes from a progressive exercise to exhaustion or estimated by 220 - age.

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Perceived Exertion

The perceived difficulty of a particular training intensity (how it "feels") is critically important for training.

Ratings of perceived exertion are classified by

Numerical values: 1 to 20
Demand descriptions: Light to All Out
Breathing descriptions : Gentle to Max

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Intensity and Training

There is a predictable relationship between the amount of oxygen consumed (% VO_2 Max), cardiovascular demand (% Max HR), the accumulation of lactic acid (mMol) and perceived exertion (RPE).

This relationship is used to establish the level of intensity for training in each of seven training zones.

SCIENCE OF TRAINING
Training Zones

SYSTEM	REC	AEG1	AEG2	LAC	ANG1	ANG2	ATPCP
Training Purpose	Keep Fitness	Raise VO2 max	Aerobic Speed	Raise LT1	Tolerate Lactate	Raise LT2	Increase Power
Word Cue	Light	Moderate	M Hard	Hard	V Hard	Max	All Out
Breathing	Gentle	Deep	Hard	Heavy	Forced	Labored	Max
RPE Scale	<11	11-13	14-15	16-17	18-19	>19	N/A
% VO_2 Max	<60	60-69	70-78	79-86	87-93	>93	N/A
% Max HR	<75	75-81	82-87	88-92	93-97	>97	N/A
% Watts Max	<55	55-67	68-76	77-85	86-94	>95	N/A
Duration	Any	0:40	0:30	0:20	0:15	0:10	0:05
Rest:Work	N/A	Any	0.5:1	1:1	2:1	4:1	6:1

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Aerobic Training - Contiguous

The best method for increasing aerobic capacity is through numerous long distance workouts of moderate intensity.

VO_2 max can be improved by 5%-20% and generally the improvement is related to the volume of training.

SCIENCE OF TRAINING
Anaerobic Training - Intervals

Intensity (pace) is critical for improving anaerobic power since muscle fiber selection differs with intensity. Rowers who train at slow pace will not train the muscles fibers needed for racing.

Train for pace through alternating high and low intensity which allows for maximal oxygen uptake with reduced lactate.

Set	Pace (92%)	Rest	Sys	Time	Work (m)	VO_2 (L)	Lactate (mMol)
1 x 2000 m	7:00	0:00	7:00	7:00	2000	5.5	150
6 x 1000 m	3:25	3:25	20:30	41:00	6000	4.5	20
12 x 500 m	1:40	1:40	20:00	40:00	6000	5.0	40

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Heart Rate Monitors

Training must focus on the energy systems required for successful performance in the desired event.

In order to ensure that training is occurring at an intensity appropriate for each energy system, it is essential to monitor heart rate.

A critical piece of rowing training equipment is a heart rate monitoring system that includes a transmitter chest belt and a receiver wrist watch.

SCIENCE OF TRAINING
Training Principles

Individuality – every athlete responds differently

Specificity – specific adaptation to imposed demand

Progressive overload – systematic small adjustments

Periodization – cyclical and phasic adjustments

Reversibility – overtraining and under-training yield regression

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Overload Variables

Intensity – effort required; the most important training variable,

Rest – recovery time between intervals, sets, training bouts; the intensity-rest ratio controls energy system used

Volume – duration or distance

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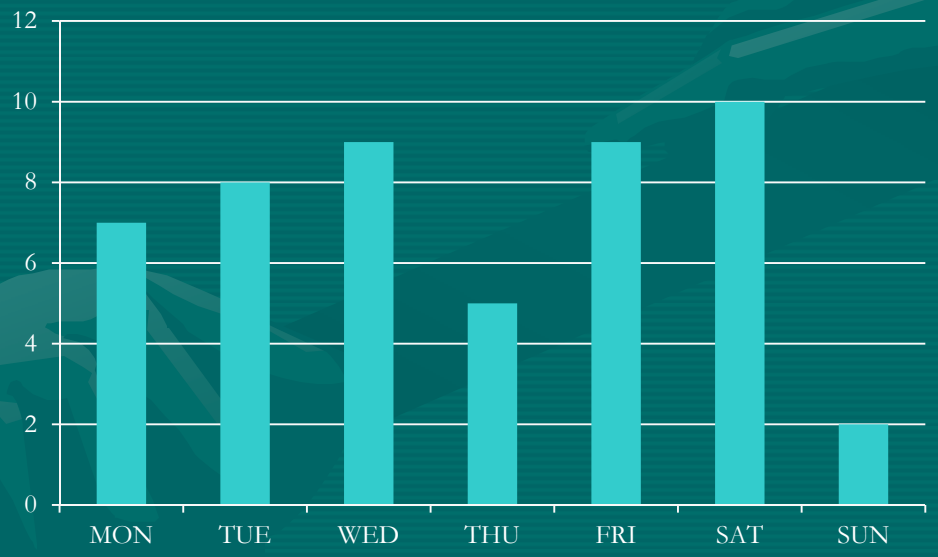
Overload and Fatigue

Intense training causes physiological strain and psychological stress. Athletes must replenish energy and emotional readiness. Training must be designed with intensity gradients, regeneration (physiological) and rejuvenation (mental).



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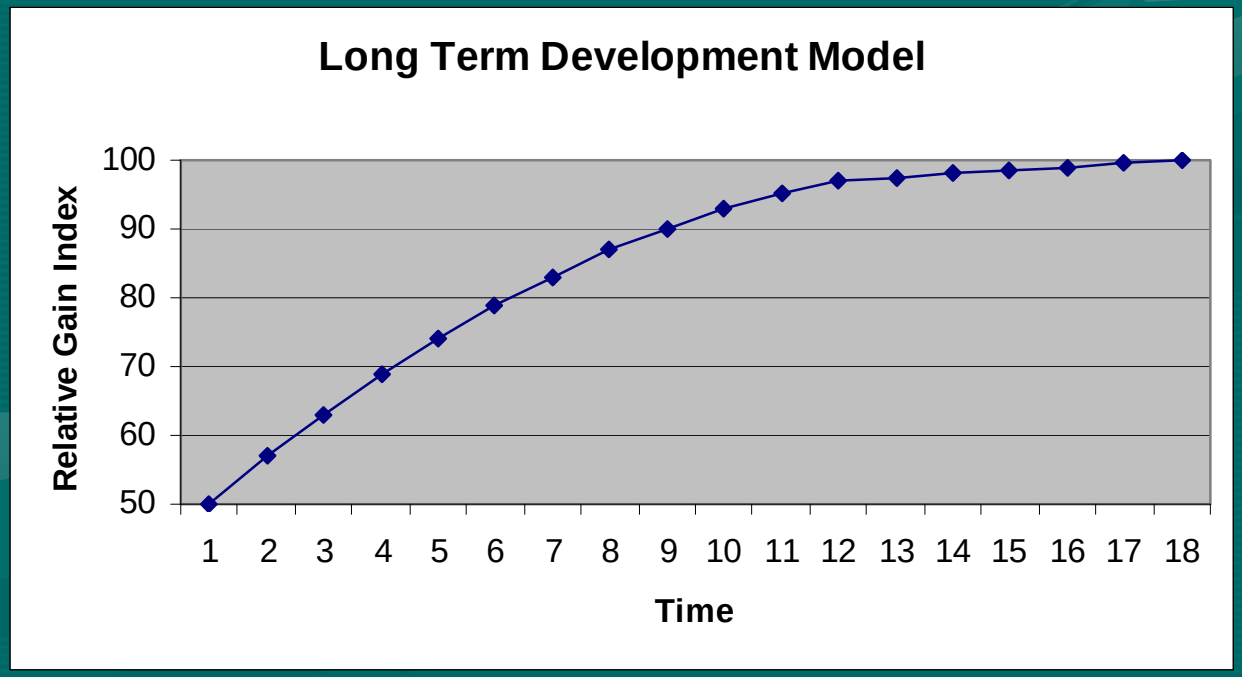
Adaptation and Staleness

Physiological gain from training (adaptation) occurs rapidly in initial phases but continued gain toward genetic capacity is minimum and increasingly difficult thereafter (staleness).



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Nutrition

Dietary planning centers on nutrient supply for energy (carbohydrates) and caloric demand, all of which is calculated per kg of body weight.

Daily lifestyle demand = 30kcal per kg

Rowing demand = .32 kcal per minute

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Fueling

Meet your caloric demand with 4-6 small meals during the day.

60-65% carbohydrates (fruits, vegetables, whole grains, beans)

15-20% protein (soy, low-fat dairy, chicken, fish, turkey)

15-25% fats (avocado, nuts, seeds, olives)

Science of Training
Carbohydrates

The most important macronutrient for rowers are carbohydrates from fruit, 100 percent fruit juice, whole grains, starchy vegetables and low-fat milk.

Training volume impacts carbohydrate intake:

- <90 min/day =5-7 grams/kg of body weight
- 90-120 min/day = 7-10 grams/kg of body weight
- >120 min/day = 10+ grams/kg of body weight

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Protein and Fat

Rowers also need protein at approximately 1g/kg for light training and 1.2-1.7g/kg for moderate to intense training.

Healthy proteins occur in chicken, eggs, soy, beans, legumes, nuts, and fish.

Fat intake for rowers should is most often acquired in association with protein intake and must be monitored to prevent excessive cholesterol.

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Hydration

Rowers should drink:

- 16 to 20 oz. 2-3 hours prior to training
- 8 to 10 oz. every 20 minutes during warm-up and training
- 16 to 24 oz. for every pound that is lost

Water is the best fluid to meet hydration needs but rowers who train for >60 minutes many benefit from beverages to replace the loss of electrolytes.

Science of Training
Pre- and Post-Workout Meals

Pre-workout meals should include carbohydrates and be consumed two to three hours before an activity.

Post-workout meals, especially after an intense training session or long race, should include carbohydrates and protein.

Snacks that combine protein and carbohydrate include soy milk and fruit smoothies, yogurt with fruit and granola, peanut butter sandwich, apples with cheese, turkey wrap or chocolate milk with a whole wheat bagel.

Science of Training
Making Weight

Rowers who need to make weight for a competition still need to focus on eating healthy.

Healthy weight loss occurs at one to two pounds per week and can be achieved through a moderate reduction in calories.

A severe reduction in calories to lose weight fast can result in a reduction of metabolic rate, loss of power and muscle mass.

Don’t Just Do It.

Do It Right.

Enjoy the Results!

http://www.kossevconsortium.org/