THE JUNIOR ELITE ATHLETE:
Physiological Characteristics and Training Considerations

IAAF World Youth Coaches Conference

Cali, COLOMBIA
20 July 2015

Randall L. Wilber, PhD, FACSM
Senior Sport Physiologist
United States Olympic Committee
Chair, ACSM Olympic/Paralympic Sports Medicine & Sport Science Committee

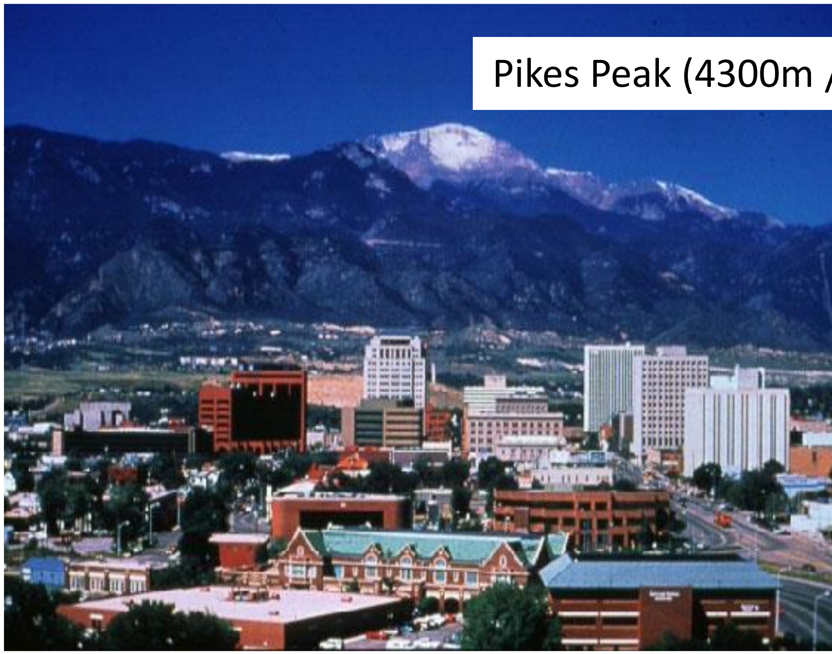
Thank you!

Kamsa hamnida (Korean)
Danke schön (German)
Ameseginalhu (Ethiopia)
Спасибо (Russian)
Arigato (Japanese)
Asante sana(Swahili/Kenyan)
Meitaki Ma’ata (Maori)
Paldies (Latvian)
Fa’afetai (Samoan)
Dziękuję (Polish)
Terima kasih (Malaysian + Indonesian)
Gracias (Spanish)
धन्यवाद (Hindi)
Dank u wel (Dutch)
Merci beaucoup (French)
شكراً جزيلاً (Arabic)
Kiitoksia (Finnish)
ευχαριστώ (Greek)
Благодаря (Bulgarian)
Grazie (Italian)
Obrigado (Portuguese/Brazilian)
Cheers (Australian / New Zealand)
Mahalo (Hawaiian)
Xie xie (Chinese)

US Olympic Training Center

Colorado Springs

Pikes Peak (4300m / 14,115ft)



Colorado Springs (1885m / 6180ft)

Randall L. Wilber, PhD, FACSM
US Olympic Committee

TRACK/CC COACH (1976-1993)

- Pennsylvania
- Wisconsin
- Florida

SPORT PHYSIOLOGIST (1993-present)

US Olympic Committee

- Salt Lake City 2002
- Athens 2004
- Torino 2006
- Beijing 2008
- Vancouver 2010
- London 2012
- Sochi 2014

US Olympic Training Center
Colorado Springs


Environmental
Physiology

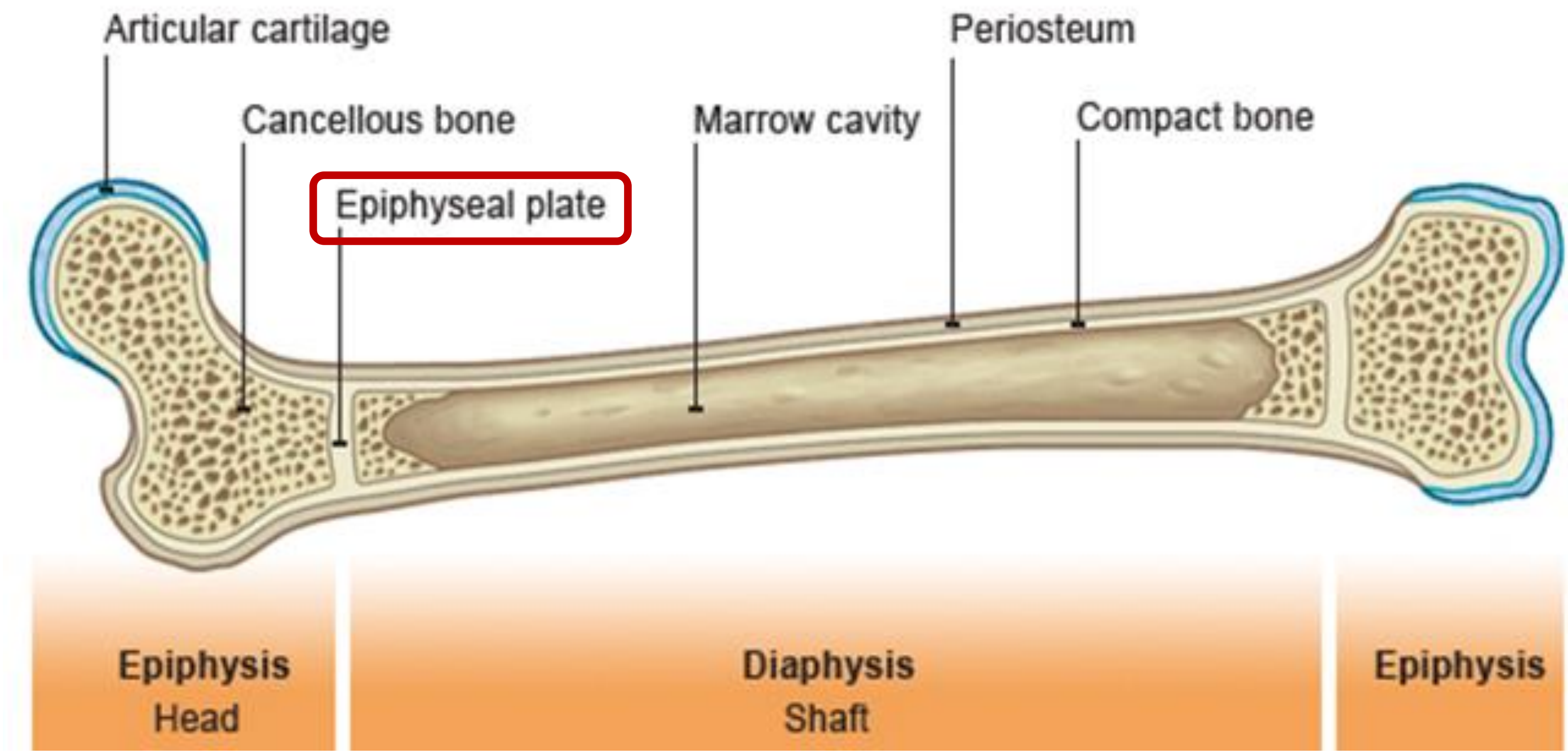
THE JUNIOR ELITE ATHLETE:
Physiological Characteristics and Training Considerations

- Introduction / Physiology 101
- From Childhood to Adolescence to Adulthood
- Increased Risk of Injury
- Training Considerations
- Overtraining
- Summary and Q/A

THE JUNIOR ELITE ATHLETE:
Physiological Characteristics and Training Considerations

- Introduction / Physiology 101
  - Bone Structure & Metabolism
  - Endocrine/Hormone Response
  - Skeletal Muscle Fiber Types
  - Iron Metabolism
- From Childhood to Adolescence to Adulthood
- Increased Risk of Injury
- Training Considerations
- Overtraining
- Summary and Q/A

PHYSIOLOGY 101
Bone Structure and Metabolism



PHYSIOLOGY 101
Endocrine/Hormone Response

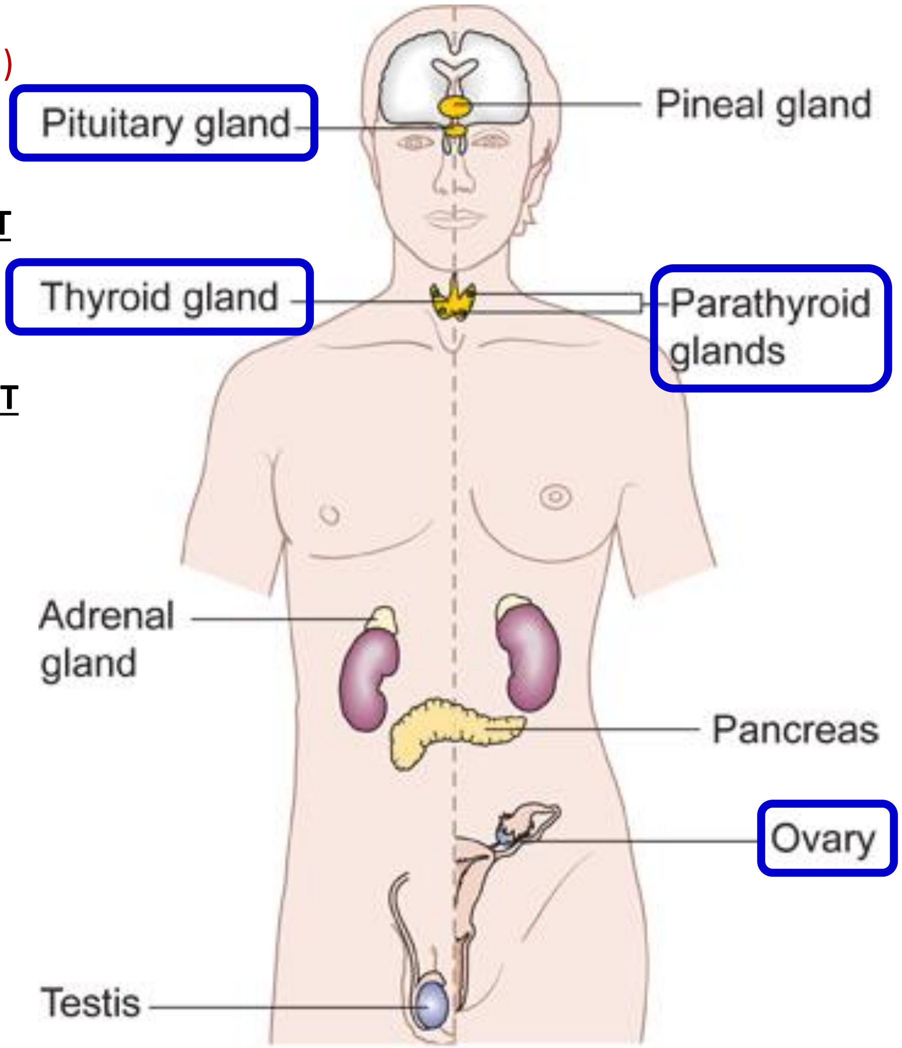
PHYSIOLOGY 101
Endocrine/Hormone Response

REPRODUCTION
Follicle-stimulating h. (FSH)
Luteinizing h. (LH)
Prolactin

GROWTH / DEVELOPMENT
Growth h. (GH)

GROWTH / DEVELOPMENT
ENERGY METABOLISM
Triiodothyronine (T3)
Thyroxine (T4)

BONE DEVELOPMENT
Calcitonin



BONE DEVELOPMENT
Parathyroid h. (PTH)

REPRODUCTION
Estrogen
Progesterone

PHYSIOLOGY 101
Endocrine/Hormone Response

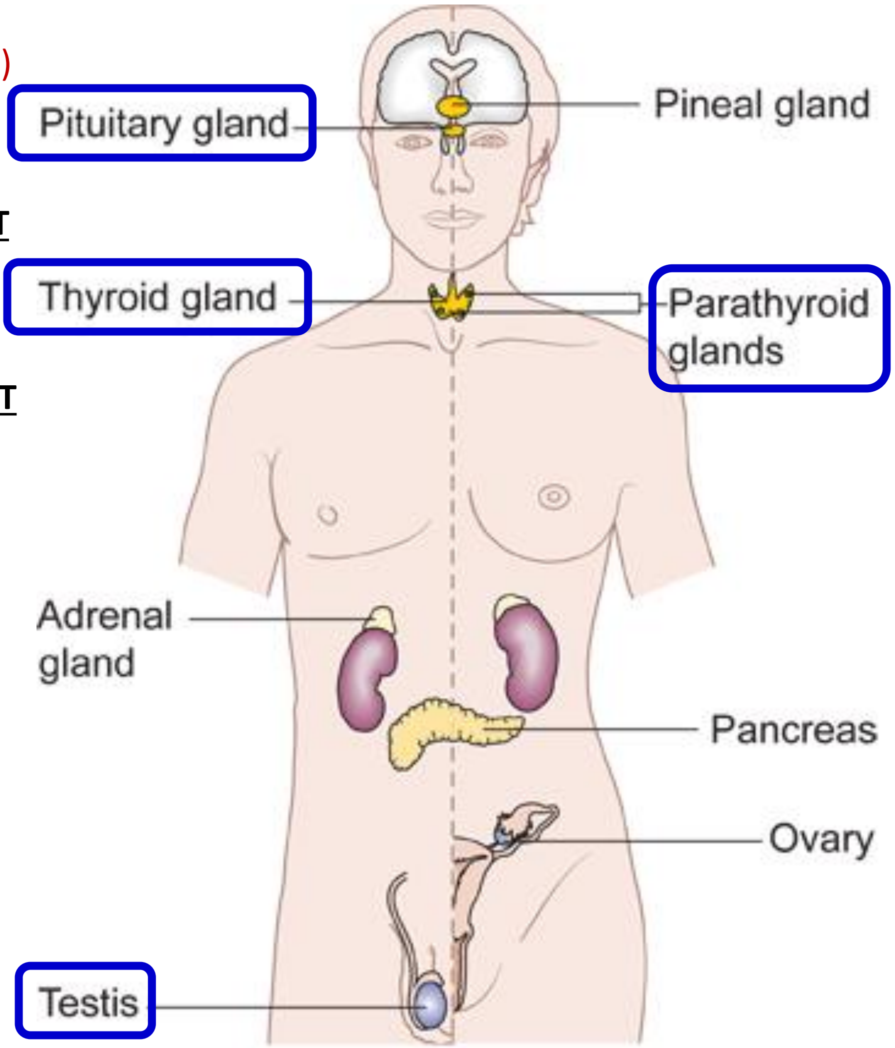
REPRODUCTION
Follicle-stimulating h. (FSH)
Luteinizing h. (LH)

GROWTH / DEVELOPMENT
Growth h. (GH)

GROWTH / DEVELOPMENT
ENERGY METABOLISM
Triiodothyronine (T3)
Thyroxine (T4)

BONE DEVELOPMENT
Calcitonin

REPRODUCTION
Testosterone



BONE DEVELOPMENT
Parathyroid h. (PTH)

PHYSIOLOGY 101
Skeletal Muscle Fiber Types

Type I

"Slow" twitch
Bright red in color
Fatigue slowly

Oxidative Phosphorylation

3000 m SC
5000 m
10,000 m
Marathon

PHYSIOLOGY 101
Skeletal Muscle Fiber Types

Type IIa

"Fast/Slow" twitch hybrid
Pale red in color
Fatigue slowly

Glycolysis (lactate)
Oxidative Phosphorylation

400 m H
800 m
1000 m
1500 m

PHYSIOLOGY 101
Skeletal Muscle Fiber Types

Type IIx

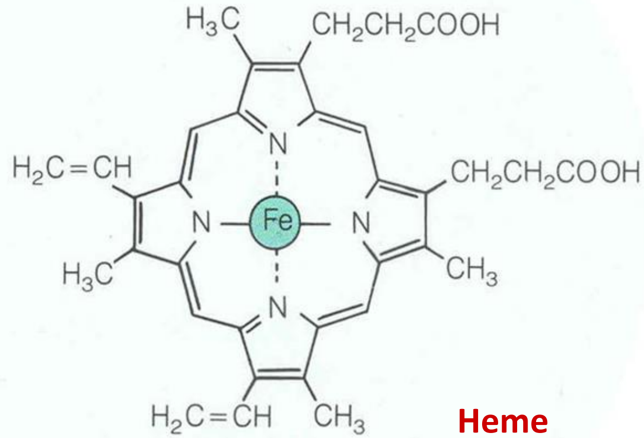
"Fast" twitch
White in color
Fatigue quickly

ATP / CP
Glycolysis (lactate)

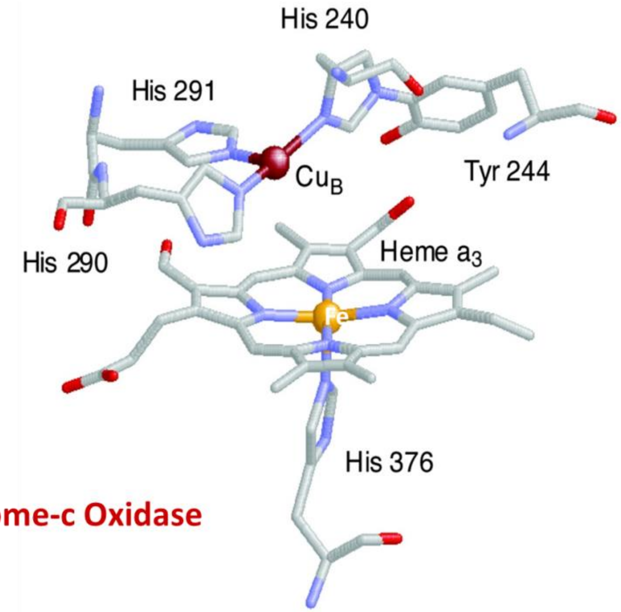
60 m
100 m
100 m H / 110 m H
200 m
400 m
LJ, TJ, PV
SP, D, J, HT

PHYSIOLOGY 101
Iron Metabolism

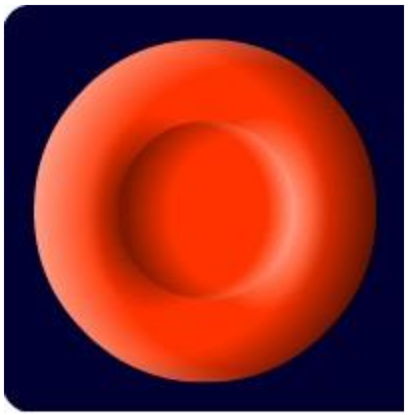
Fe atom structure
The Atomium
Brussels



Heme

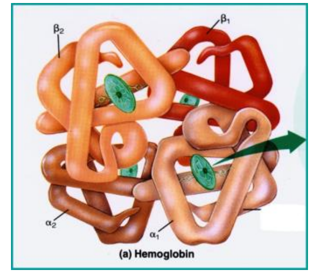


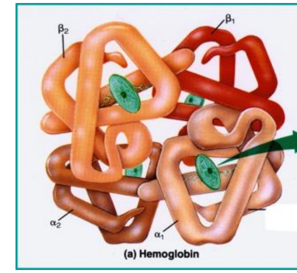
Cytochrome-c Oxidase

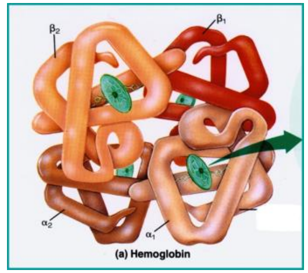


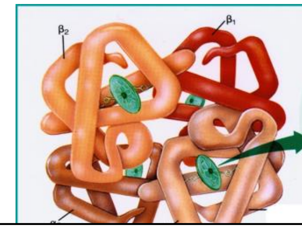
RBC

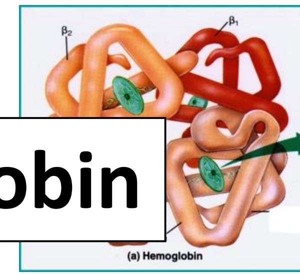
250 million Hemoglobin

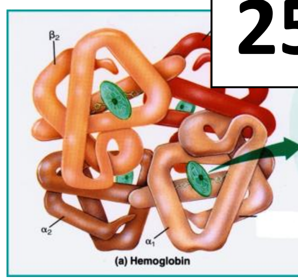


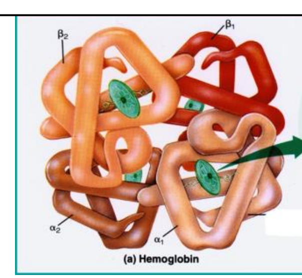


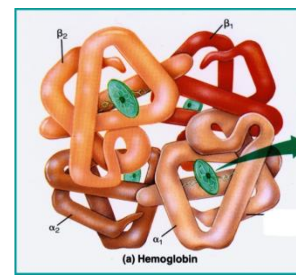


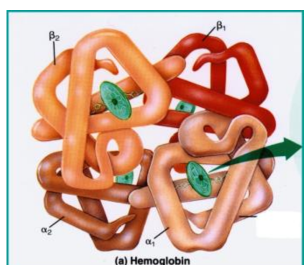


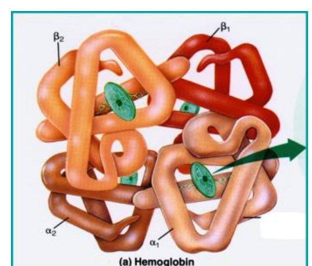


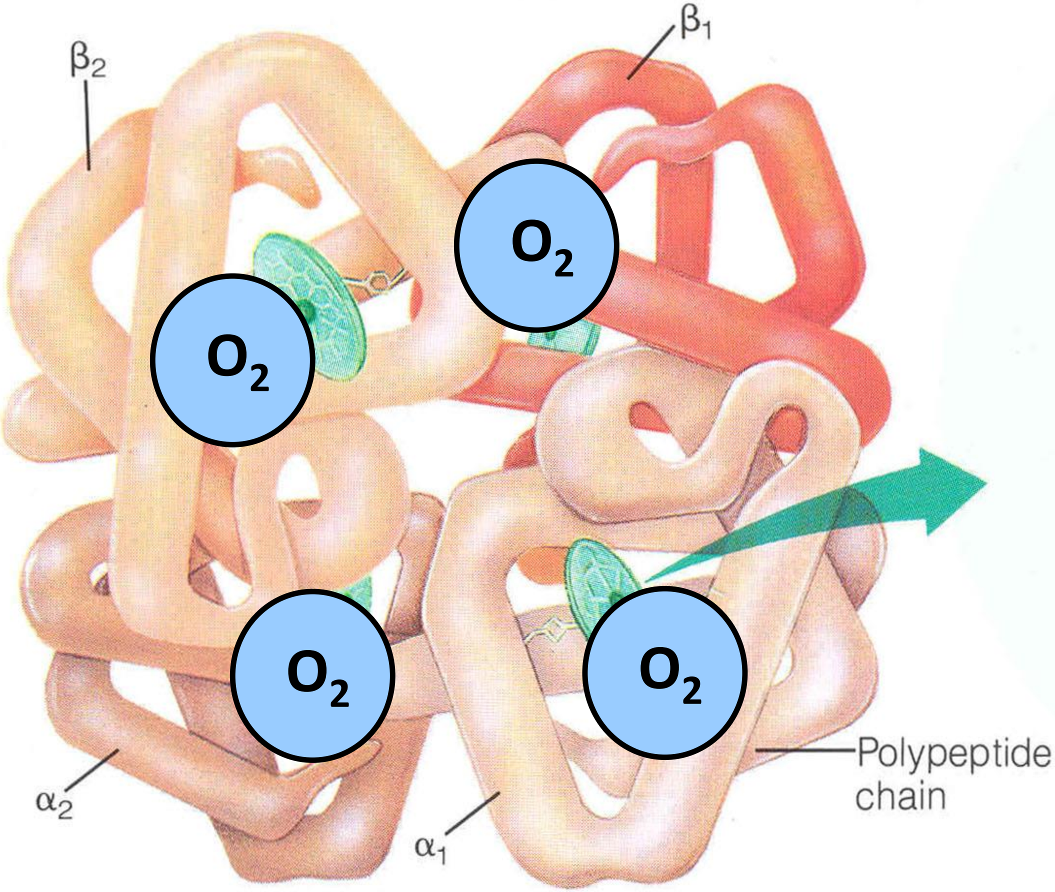




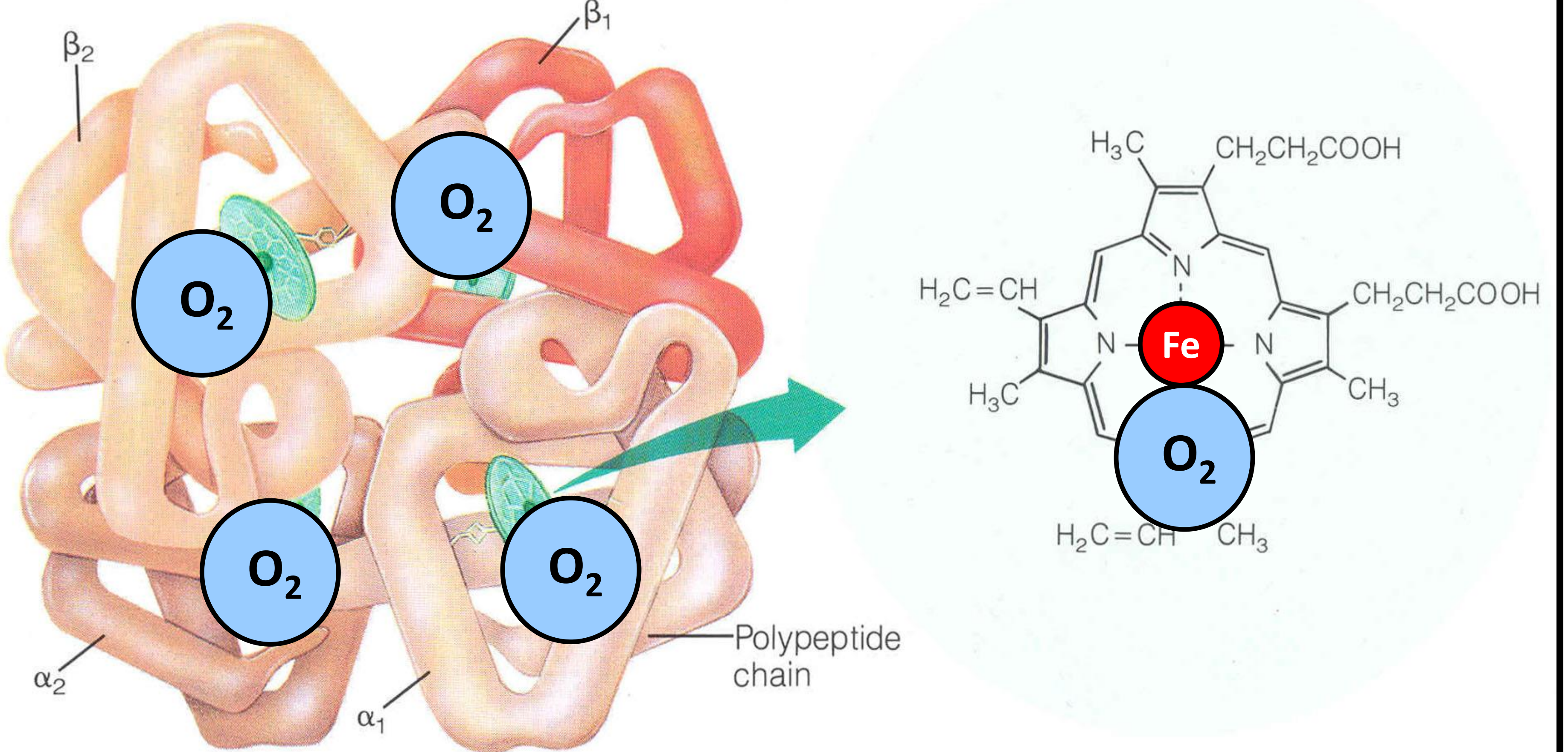






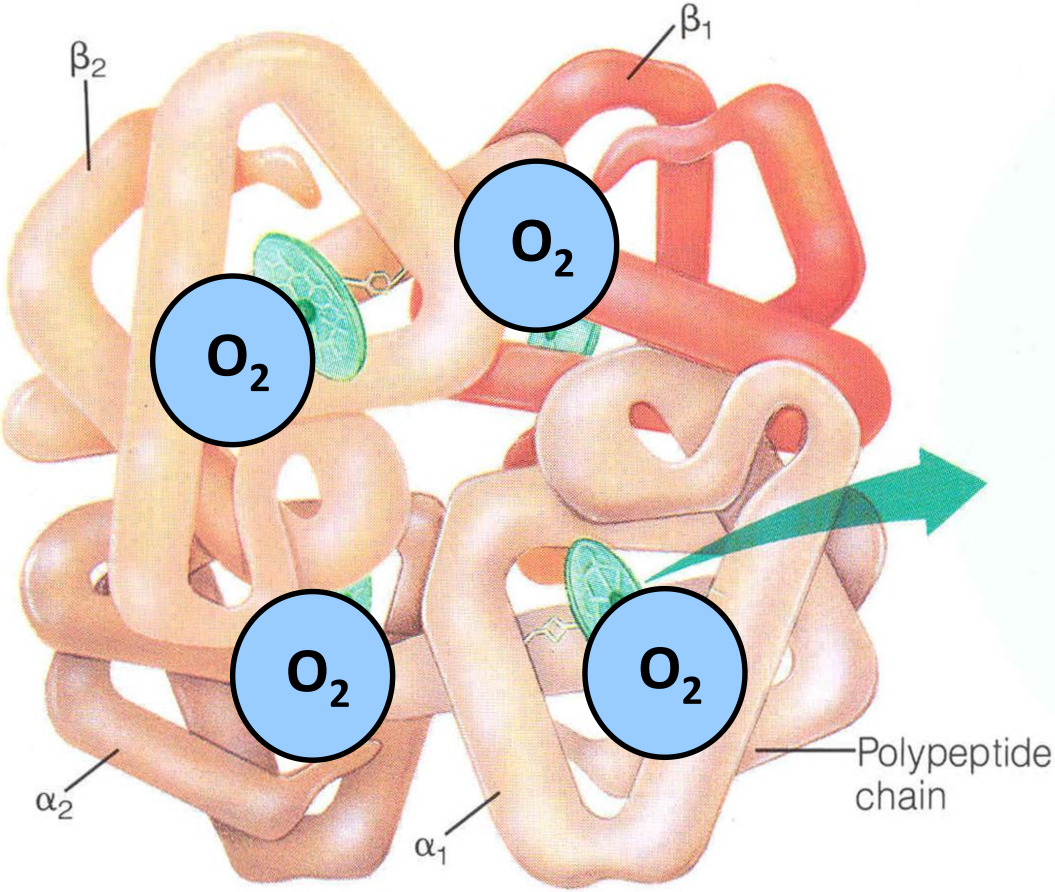


(a) Hemoglobin

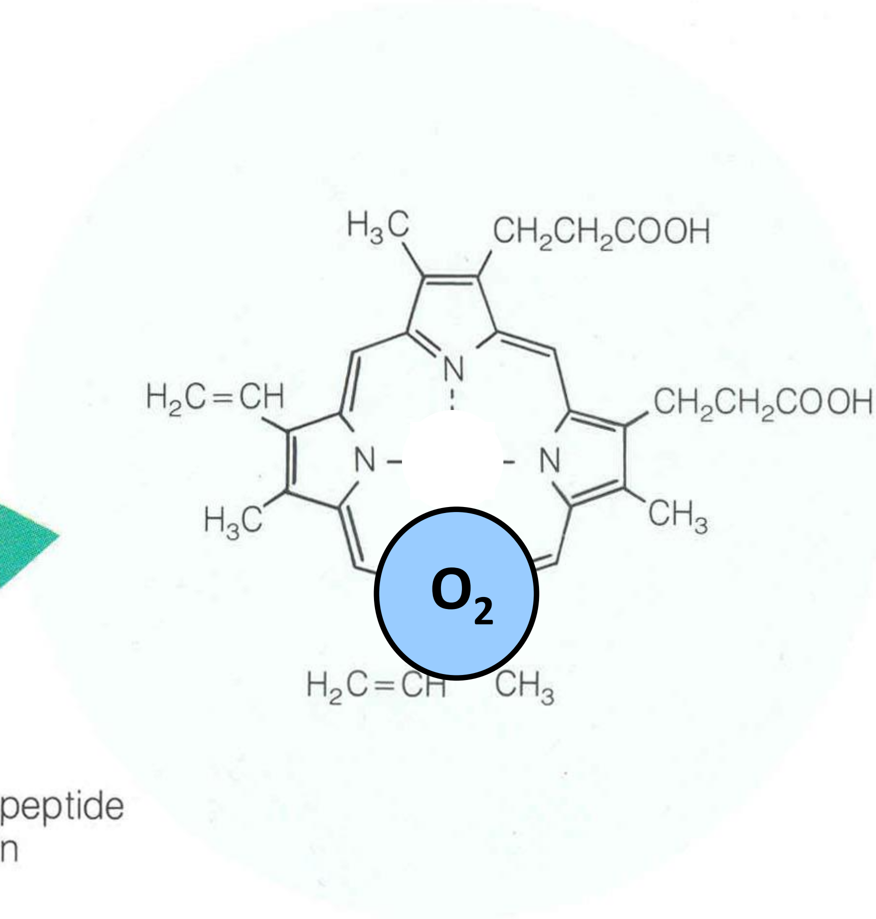


(a) Hemoglobin

(b) Iron-containing heme group



(a) Hemoglobin



(b) Iron-containing heme group

Stage 1: IRON-DEPLETION

COLLECTED: NOT GIVEN REPORTED: 07/17/2004 PAGE: 1

REQUESTS	RESULTS		UNITS	REFERENCE RANGES	LOC
FERRITIN, SERUM	7	L	NG/ML	10-154	DE
IRON & TIBC, SERUM					
IRON, SERUM	63		MCG/DL	35-175	DE
IRON BINDING CAPACITY	386		MCG/DL	250-400	DE
% SATURATION	16		%	15-50	DE
CBC (INC. DIFF & PLT)					
WBC	6.2		THOUS/MCL	3.8-10.8	DE
RBC	4.50		MILL/MCL	3.80-5.10	DE
HEMOGLOBIN	13.5		GM/DL	11.7-15.5	DE
HEMATOCRIT	40.7		%	35.0-45.0	DE
MCV	90.4		FL	80.0-100.0	DE
MCH	30.1		PG	27.0-33.0	DE
MCHC	33.3		GM/DL	32.0-36.0	DE
RDW	14.9		%	11.0-15.0	DE
PLATELET COUNT	288		THOUS/MCL	140-400	DE
MPV	8.0		FL	7.5-11.5	DE
ABSOLUTE NEUTROPHILS	2790		CELLS/MCL	1500-7800	DE
ABSOLUTE LYMPHOCYTES	2877		CELLS/MCL	850-3900	DE
ABSOLUTE MONOCYTES	434		CELLS/MCL	200-950	DE
ABSOLUTE EOSINOPHILS	87		CELLS/MCL	0-500	DE
ABSOLUTE BASOPHILS	12		CELLS/MCL	0-200	DE
NEUTROPHILS	45.0		%	45-71	DE
LYMPHOCYTES	46.4	H	%	15-45	DE
MONOCYTES	7.0		%	0-13	DE
EOSINOPHILS	1.4		%	0-5	DE
BASOPHILS	0.2		%	0-3	DE

USA CYCLING

Female

22 yr

USA CYCLING

Stage 2: IRON-DEFICIENT NON-ANEMIA (IDNA)

REQUESTS	RESULTS		UNITS	REFERENCE RANGES
FERRITIN, SERUM	9	L	NG/ML	10-143
IRON & TIBC, SERUM				
IRON, SERUM	32	L	MCG/DL	35-175
IRON BINDING CAPACITY	444	H	MCG/DL	250-400
% SATURATION	7	L	%	15-50
CBC (INC. DIFF & PLT)				
WBC	7.7		THOUS/MCL	3.8-10.8
RBC	4.64		MILL/MCL	3.80-5.10
HEMOGLOBIN	14.1		GM/DL	11.9-15.9
HEMATOCRIT	42.5		%	35.0-49.0
MCV	91.5		FL	80.0-100.0
MCH	30.5		PG	27.0-33.0
MCHC	33.3		GM/DL	32.0-36.0
RDW	15.8	H	%	11.0-15.0
PLATELET COUNT	270		THOUS/MCL	140-400
MPV	7.9		FL	7.5-11.5
ABSOLUTE NEUTROPHILS	4936		CELLS/MCL	1500-7800
ABSOLUTE LYMPHOCYTES	1987		CELLS/MCL	850-3900
ABSOLUTE MONOCYTES	616		CELLS/MCL	200-950
ABSOLUTE EOSINOPHILS	131		CELLS/MCL	0-500
ABSOLUTE BASOPHILS	31		CELLS/MCL	0-200
NEUTROPHILS	64.1		%	45-71
LYMPHOCYTES	25.8		%	15-45
MONOCYTES	8.0		%	6-13
EOSINOPHILS	1.7		%	0-5
BASOPHILS	0.4		%	0-3

USA TRIATHLON

Female

18 yr

USA TRIATHLON

IRON SUPPLEMENTATION

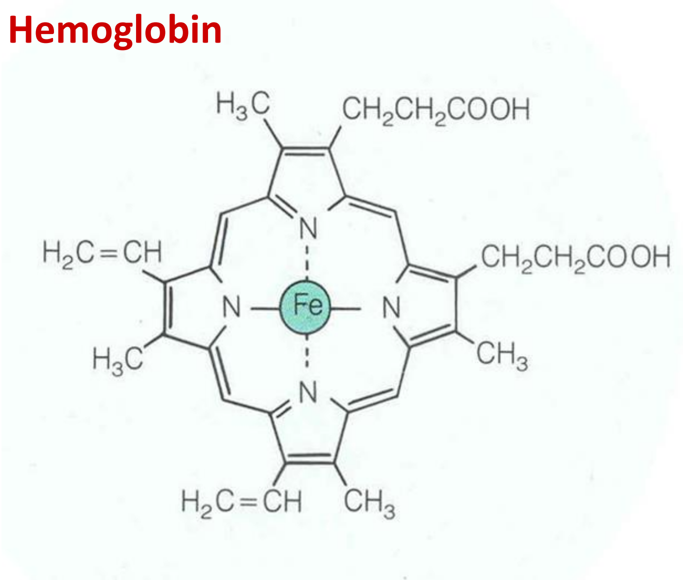
Ferrous sulfate

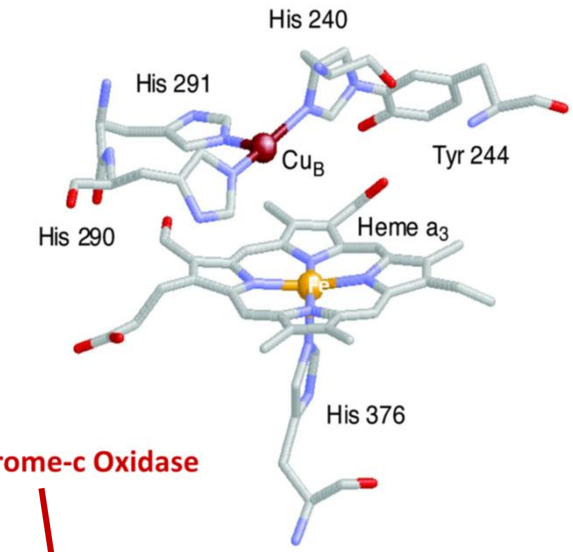
<u>If serum Ferritin is low:</u>

- Attention to "heme Fe" in diet.
- Moderate Fe supplementation
  - 120-130 mg "elemental Fe" divided into 2 doses
  - taken with Vitamin C
  - taken 30 min before or 60 min after meals to increase absorption and decrease GI distress
  - taken daily

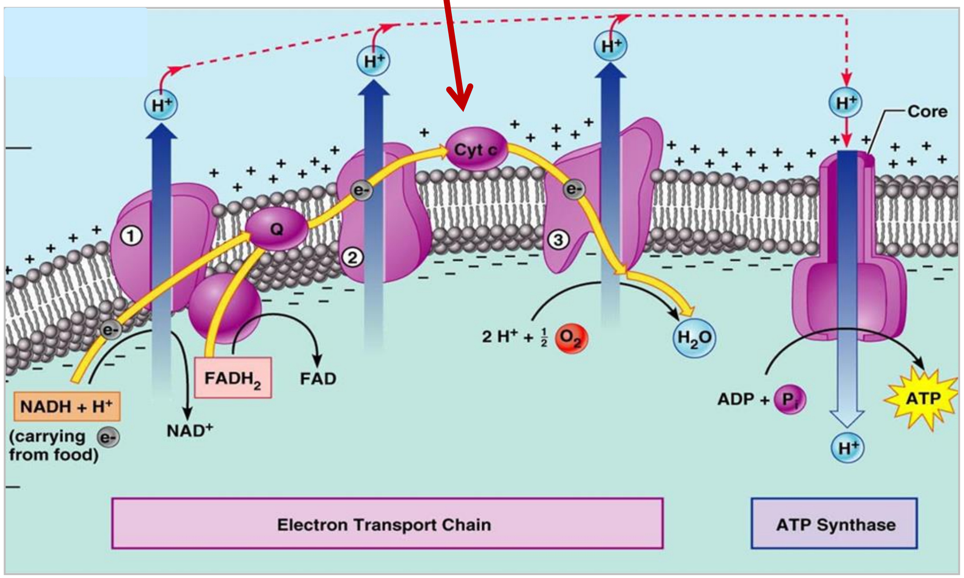
IRON SUPPLEMENTATION

Hemoglobin





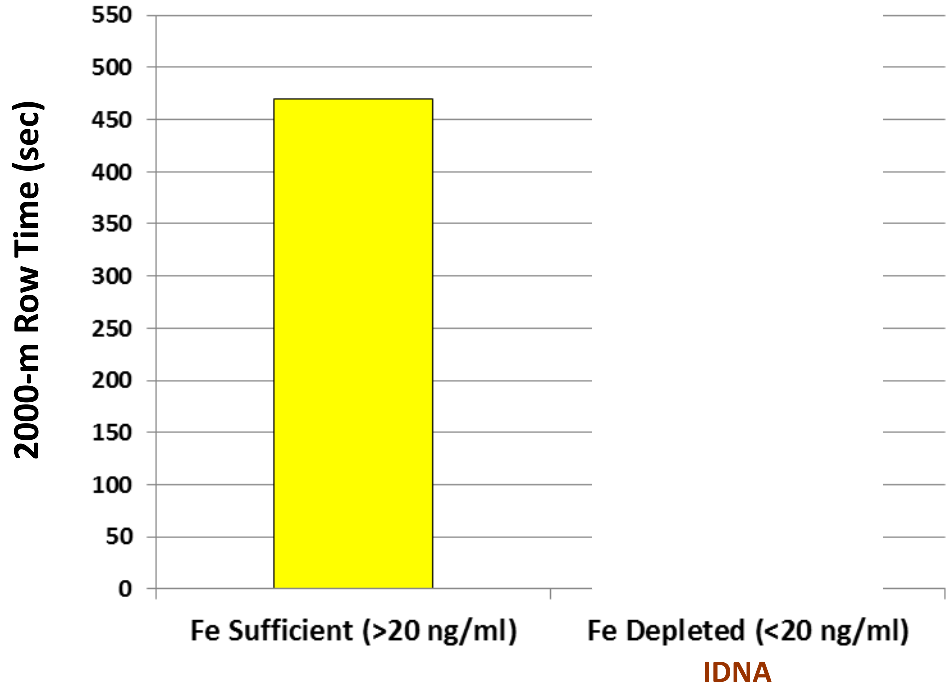
Cytochrome-c Oxidase

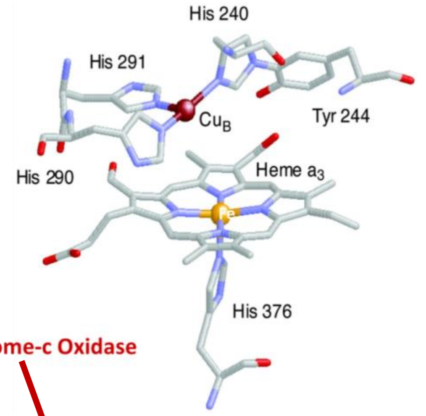


Impact of Iron Depletion Without Anemia on Performance in Trained Endurance Athletes at the Beginning of a Training Season: A Study of Female Collegiate Rowers

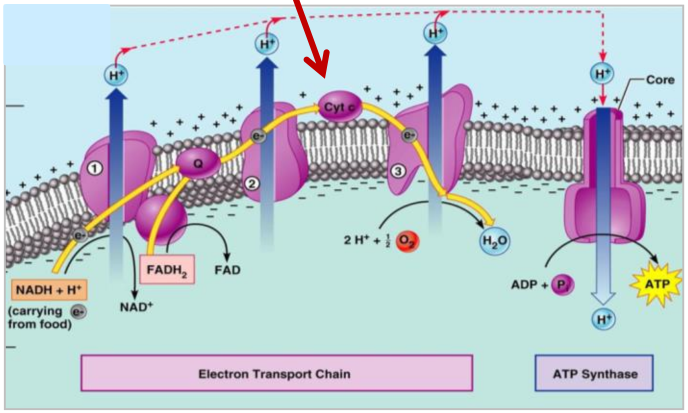
Diane M. DellaValle and Jere D. Haas

International Journal of Sport Nutrition and Exercise Metabolism, 2011, 21, 501-506





Cytochrome-c Oxidase



THE JUNIOR ELITE ATHLETE:
Physiological Characteristics and Training Considerations

- Introduction / Physiology 101
- ➡ From Childhood to Adolescence to Adulthood
- Increased Risk of Injury
- Training Considerations
- Overtraining
- Summary and Q/A

From CHILDHOOD to ADOLESCENCE to ADULTHOOD

Pre-Puberty

Age 6-10

A slow and balanced development when the function of some organs becomes more efficient.

Puberty

Age 11-13

Fast growth and development in height, weight, and the efficiency of some organs. Sexual maturation with change in interests and behaviors.

Post-Puberty / Adolescence

Age 14-18

A slow, balanced and proportional development with functional maturation.

Young Adulthood

Age 19-25

Full growth and maturation of physiological and physical traits. Athletic and psychological potentials are maximized.

From CHILDHOOD to ADOLESCENCE to ADULTHOOD ♂

Pre-Puberty
Age 7-11

A slow and balanced development when the function of some organs becomes more efficient.

Puberty
Age 12-14

Fast growth and development in height, weight, and the efficiency of some organs. Sexual maturation with change in interests and behaviors.

Post-Puberty / Adolescence
Age 15-18

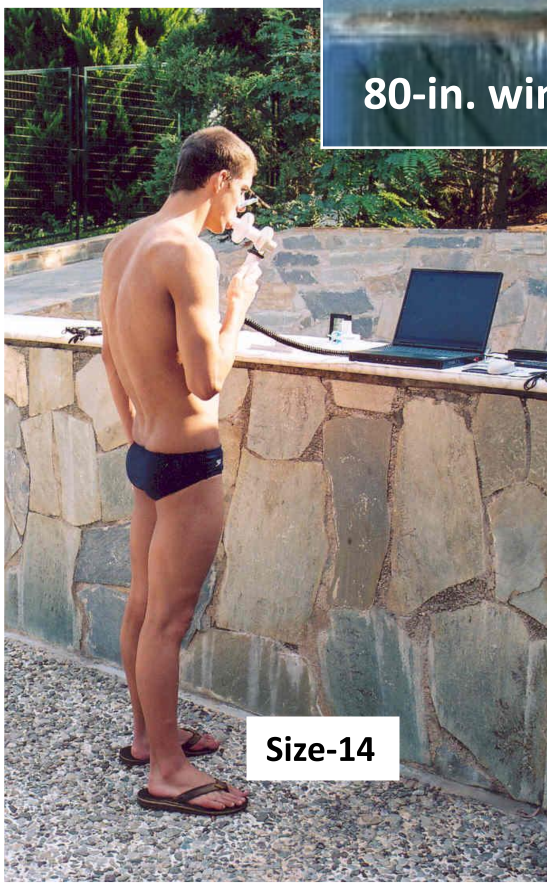
A slow, balanced and proportional development with functional maturation.

Young Adulthood
Age 19-25

Full growth and maturation of physiological and physical traits. Athletic and psychological potentials are maximized.

Talent ID + Development

Stage 1: Age-Group Competition



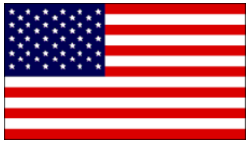
Michael Phelps (20 yr)

Coach Bob Bowman

Michael Phelps (10 yr)

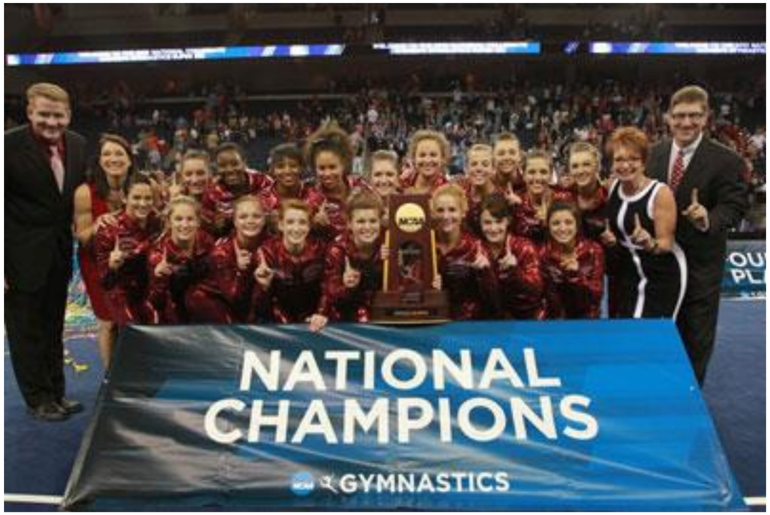
Talent ID + Development

Stage 2: High School (13-17 yr)



Talent ID + Development

Stage 3: University (17-21 yr)



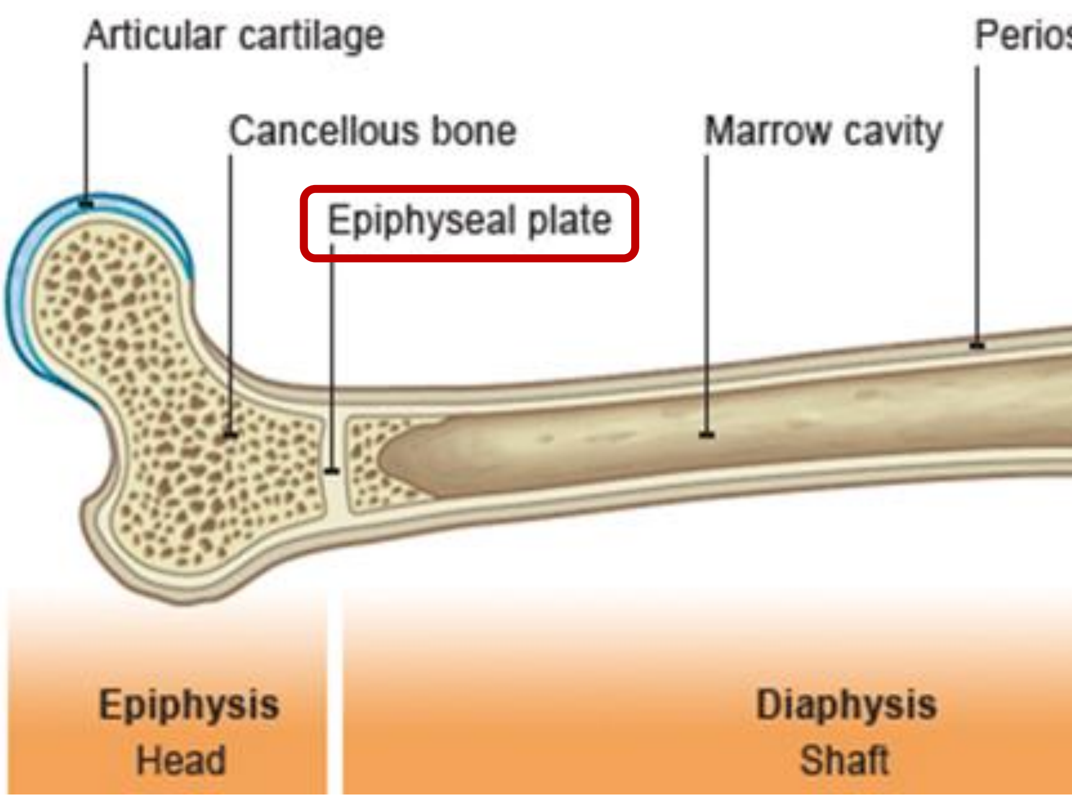
Talent ID + Development

Stage 4: Post-University & Professional (22+ yr)

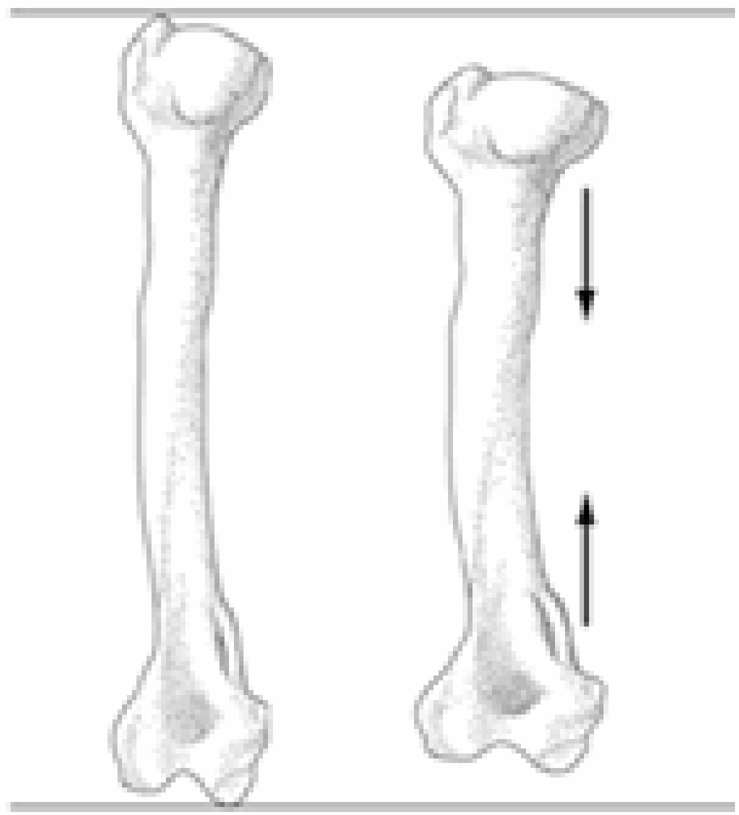
THE JUNIOR ELITE ATHLETE:
Physiological Characteristics and Training Considerations

- Introduction / Physiology 101
- From Childhood to Adolescence to Adulthood
- Increased Risk of Injury →
  - Skeletal (Stress Fracture)
  - Female-Specific (Female AT)
  - Psychological (Early Drop Out)
- Training Considerations
- Overtraining
- Summary and Q/A

INCREASED RISK of INJURY: Skeletal (Stress Fracture)

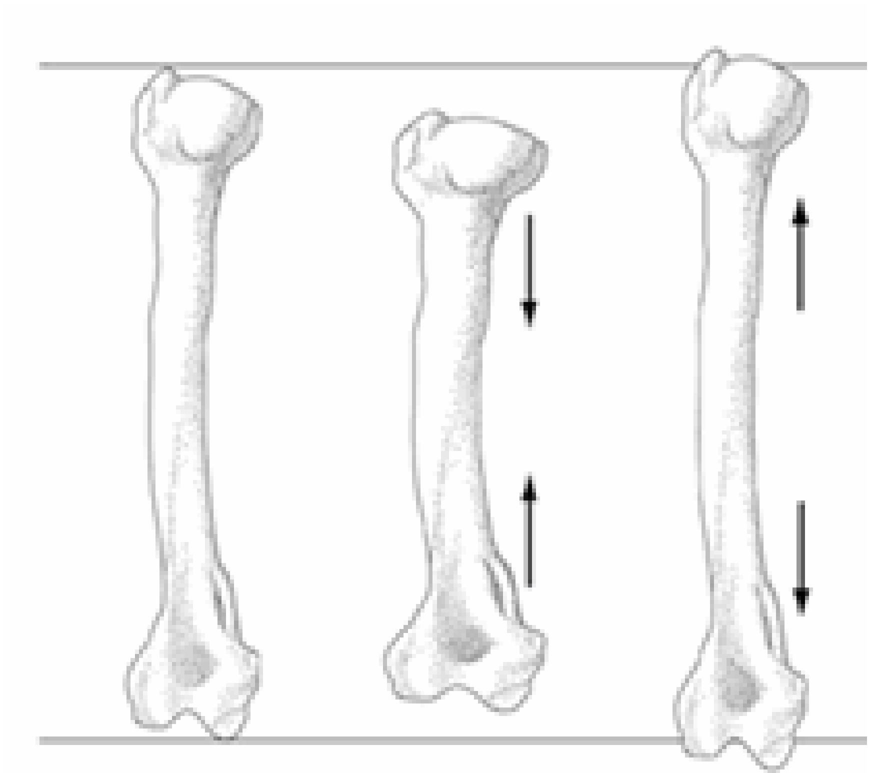


INCREASED RISK of INJURY: Skeletal (Stress Fracture)

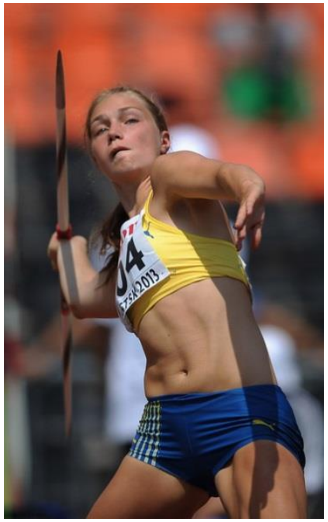


COMPRESSION

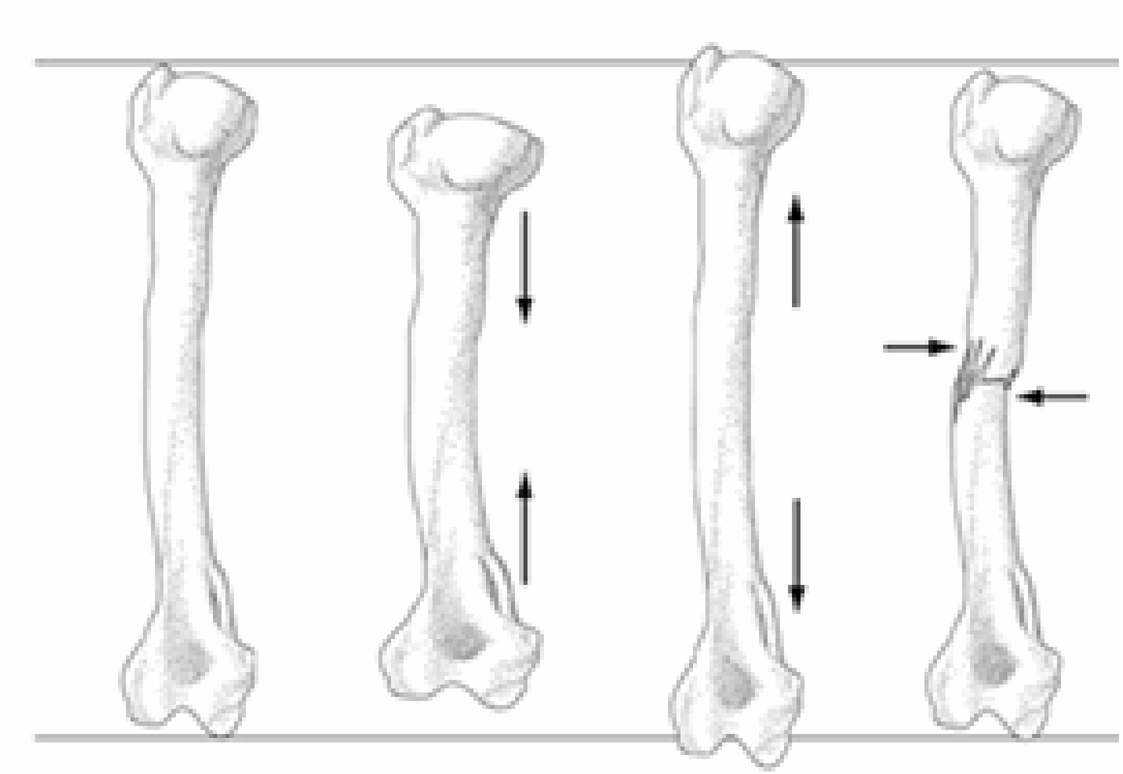
INCREASED RISK of INJURY: Skeletal (Stress Fracture)



COMPRESSION TENSION

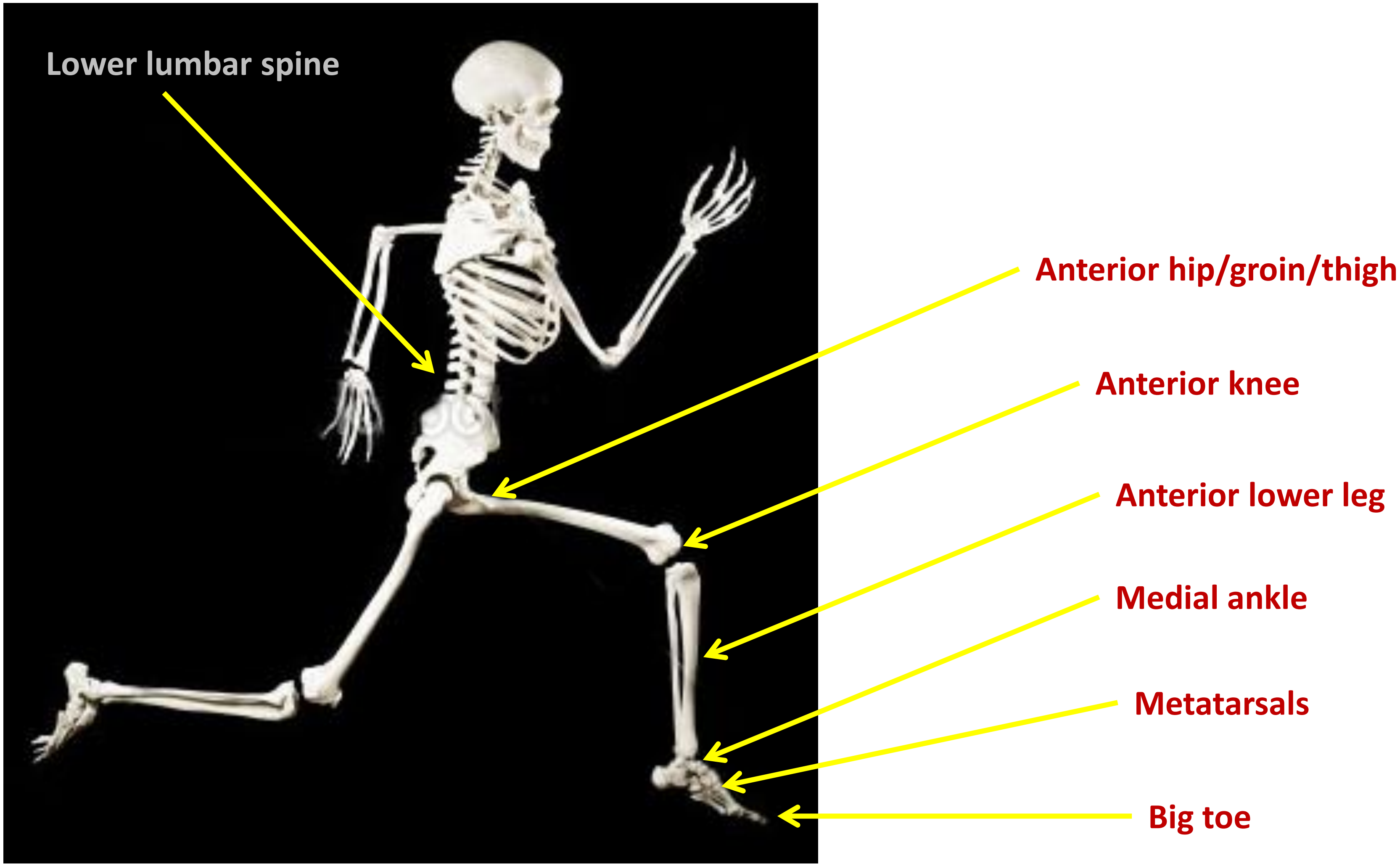


INCREASED RISK of INJURY: Skeletal (Stress Fracture)

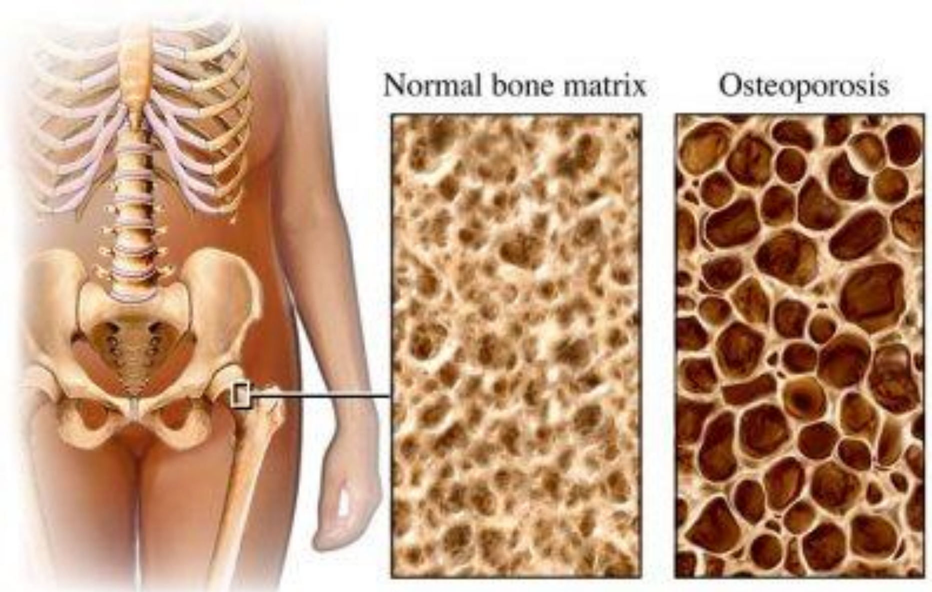


COMPRESSION TENSION SHEAR

INCREASED RISK of INJURY: Skeletal (Stress Fracture)



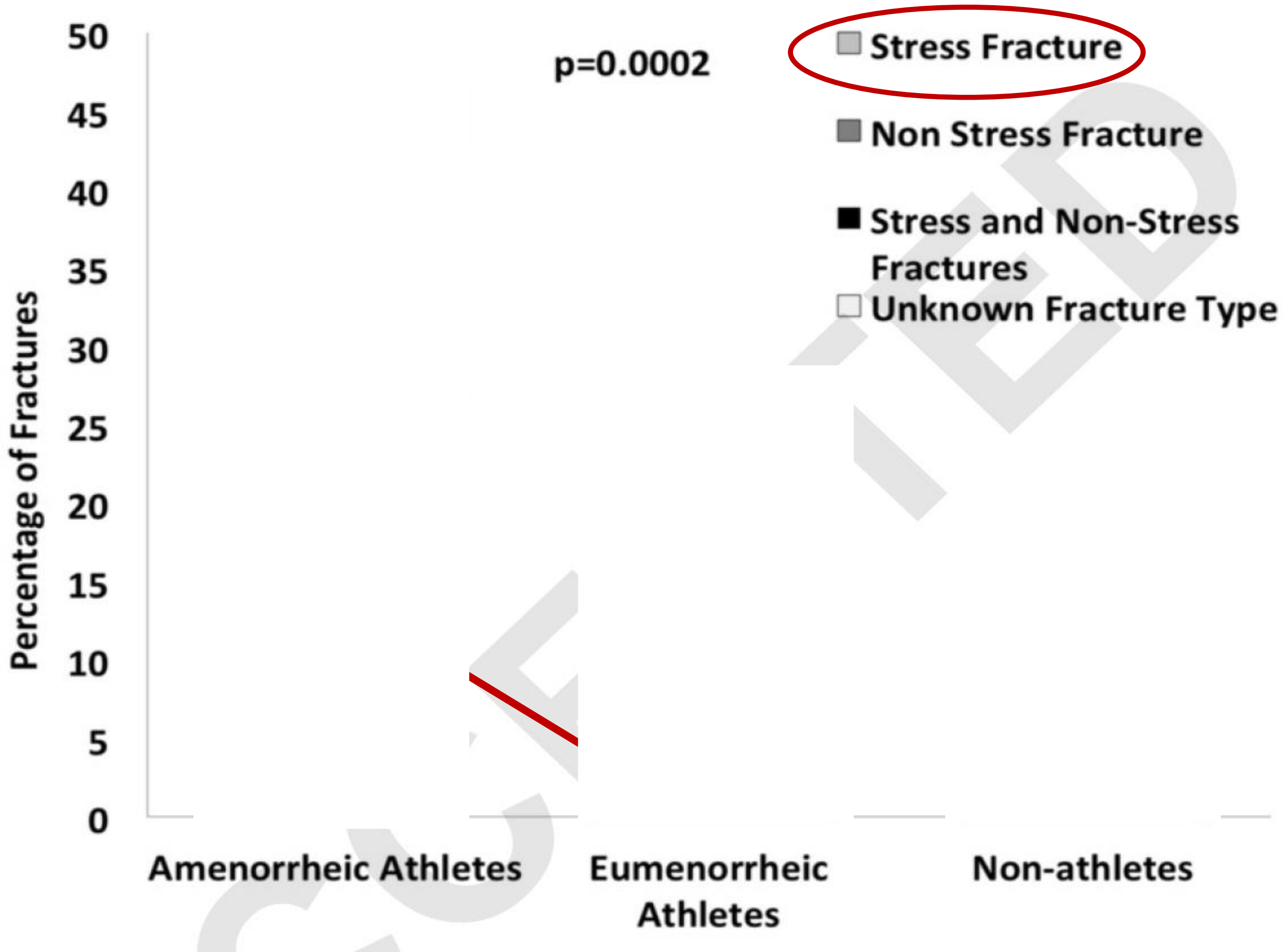
INCREASED RISK of INJURY: Female-Specific



Fractures in Relation to Menstrual Status and Bone Parameters in Young Athletes

Kathryn E. Ackerman, Natalia Cano Sokoloff, Giovanna De Nardo Maffazioli, Hannah Clark, Hang Lee, and Madhusmita Misra

Medicine and Science in Sports and Exercise, 2014.



INCREASED RISK of INJURY: Psychological

SPORT SPECIALIZATION

↓

Extremely high training load (adult level)
Extremely high time demands
Frequent competition and travel
High/Unrealistic performance expectations from coach/parents
Perfectionist personality

Injury and/or **Burnout**

↓

"I used to really like this sport . . . but I don't want to do it anymore!"

INCREASED RISK of INJURY: Prevention

Conservative Training Load
(Volume, Intensity, # D/W)

Don't Overschedule Meets
(or # Events in Meet)

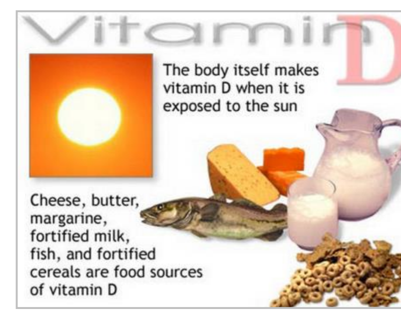
Soft Surface Training

Aquatic Training

Resistance Training

Be Knowledgeable of Symptoms

Orthotics / Arch Supports



Vitamin D Health

THE JUNIOR ELITE ATHLETE:
Physiological Characteristics and Training Considerations

- Introduction / Physiology 101
- From Childhood to Adolescence to Adulthood
- Increased Risk of Injury
- Training Considerations
  - "Windows of Opportunity"
  - Specialization vs Diversification
  - Thermoregulation
  - Sleep
- Overtraining
- Summary and Q/A

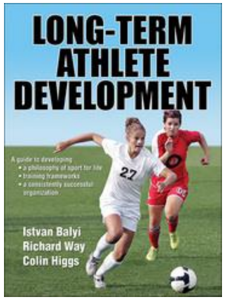
IAAF World Youth Championships CALI 2015

"WINDOWS OF OPPORTUNITY"

Sport Diversification — **Sport Specialization**

CHILD	**ADOLESCENT**	**ADOLESCENT**	**YOUNG ADULT**
Pre-Puberty	Puberty	Post-Puberty	Maturity
Age 6-10	Age 11-14	Age 15-18	Age 19-25

Speed 1: Central Nervous System (quickness, change of direction, segmental speed, agility)
Speed 2: Anaerobic power + Anaerobic capacity (interval training)



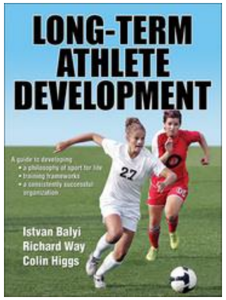
"WINDOWS OF OPPORTUNITY"

Sport Diversification (Child, Adolescent – Puberty, Adolescent – Post-Puberty)

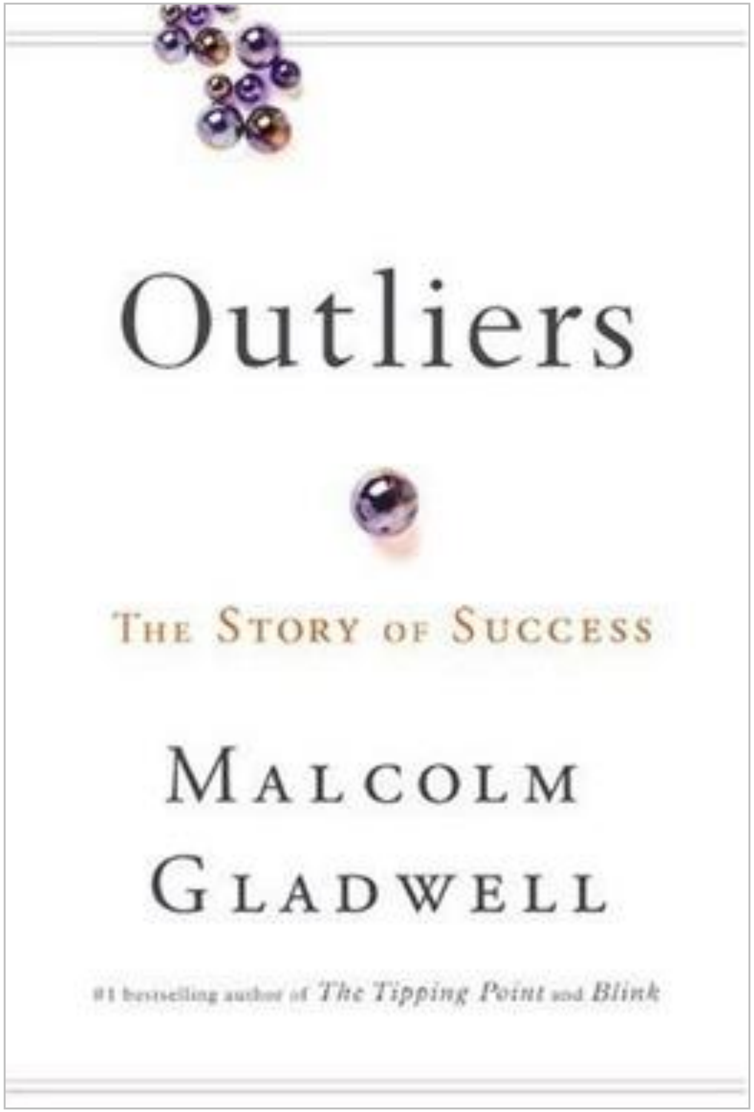
Sport Specialization (Young Adult)

CHILD	ADOLESCENT	ADOLESCENT	YOUNG ADULT
Pre-Puberty	Puberty	Post-Puberty	Maturity
Age 7-11	Age 12-13	Age 13-18	Age 19-25

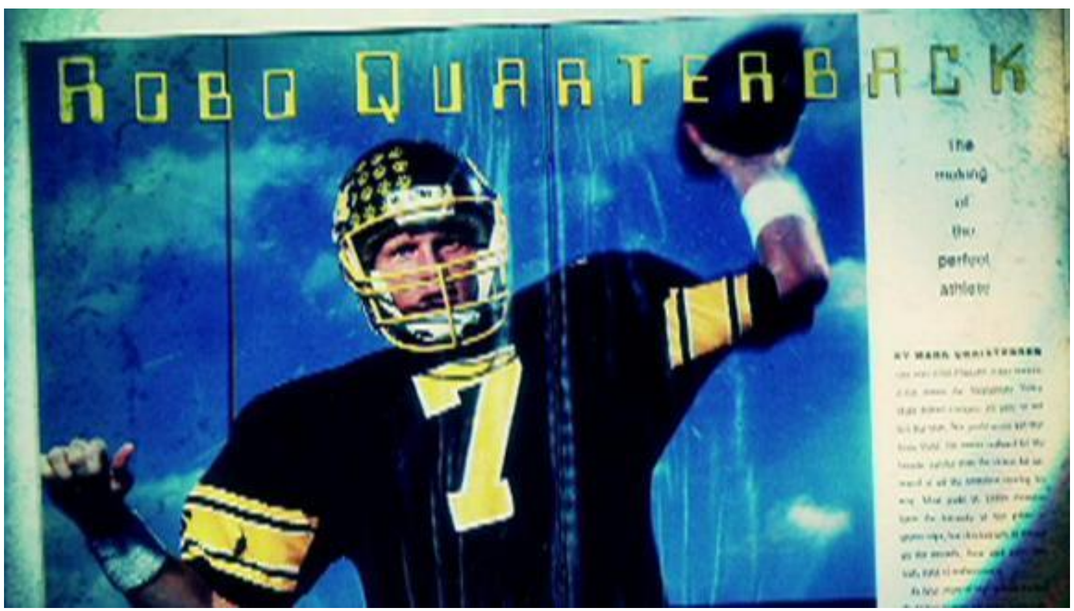
Speed 1: Central Nervous System (quickness, change of direction, segmental speed, agility)
Speed 2: Anaerobic power + Anaerobic capacity (interval training)



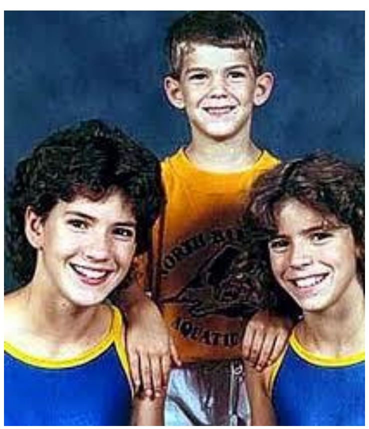
SPECIALIZATION vs DIVERSIFICATION

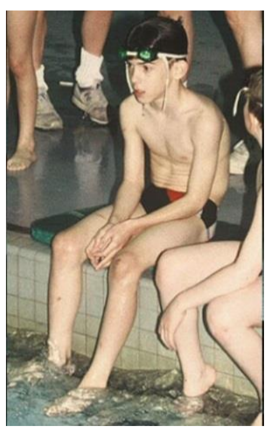


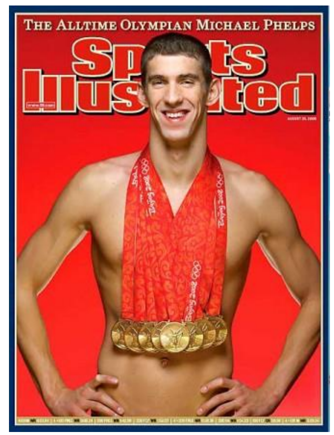
SPECIALIZATION vs DIVERSIFICATION



SPECIALIZATION vs DIVERSIFICATION







1st US Olympic Team: age 15

1st Olympic Medal: age 19

Beijing 2008 london Rio2016

SPECIALIZATION vs DIVERSIFICATION

Team USA swimmers who specialized early (< 12 yr) spent less time on the US National/Olympic Team than swimmers who specialized later (> 16 yr).

Team USA swimmers who specialized early (< 12 yr) retired from the sport significantly earlier than swimmers who specialized later (> 16 yr).

Sports-Specialized Intensive Training and the Risk of Injury in Young Athletes

Am J Sports Med 43:794-801, 2015

Neeru A. Jayanthi,*† MD, Cynthia R. LaBella,‡§ MD, Daniel Fischer,† Jacqueline Pasulka,‡ and Lara R. Dugas,† PhD, MPH

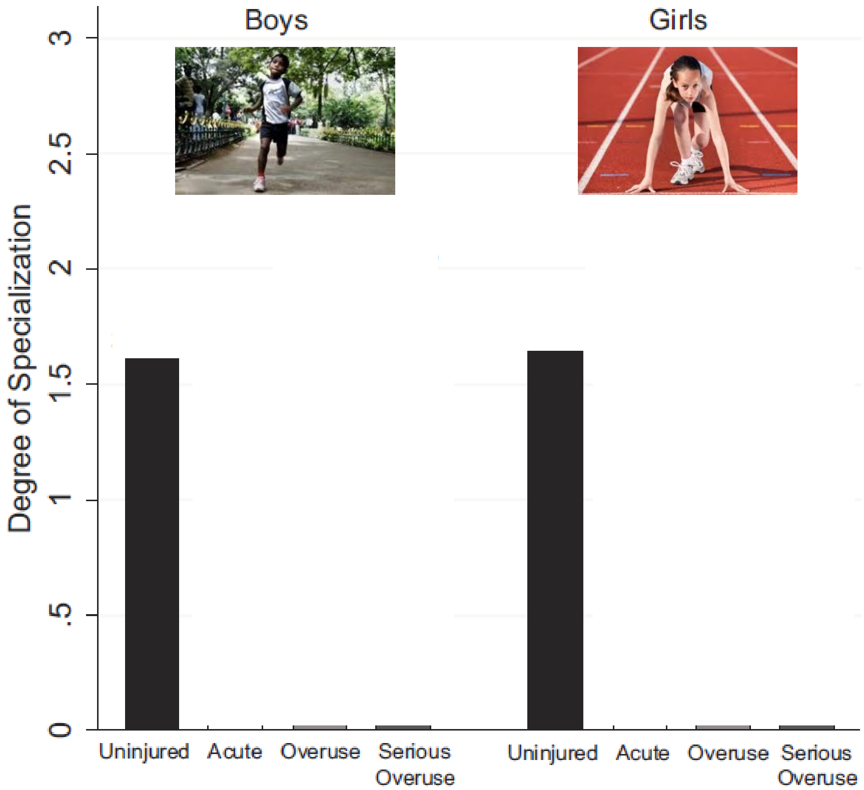
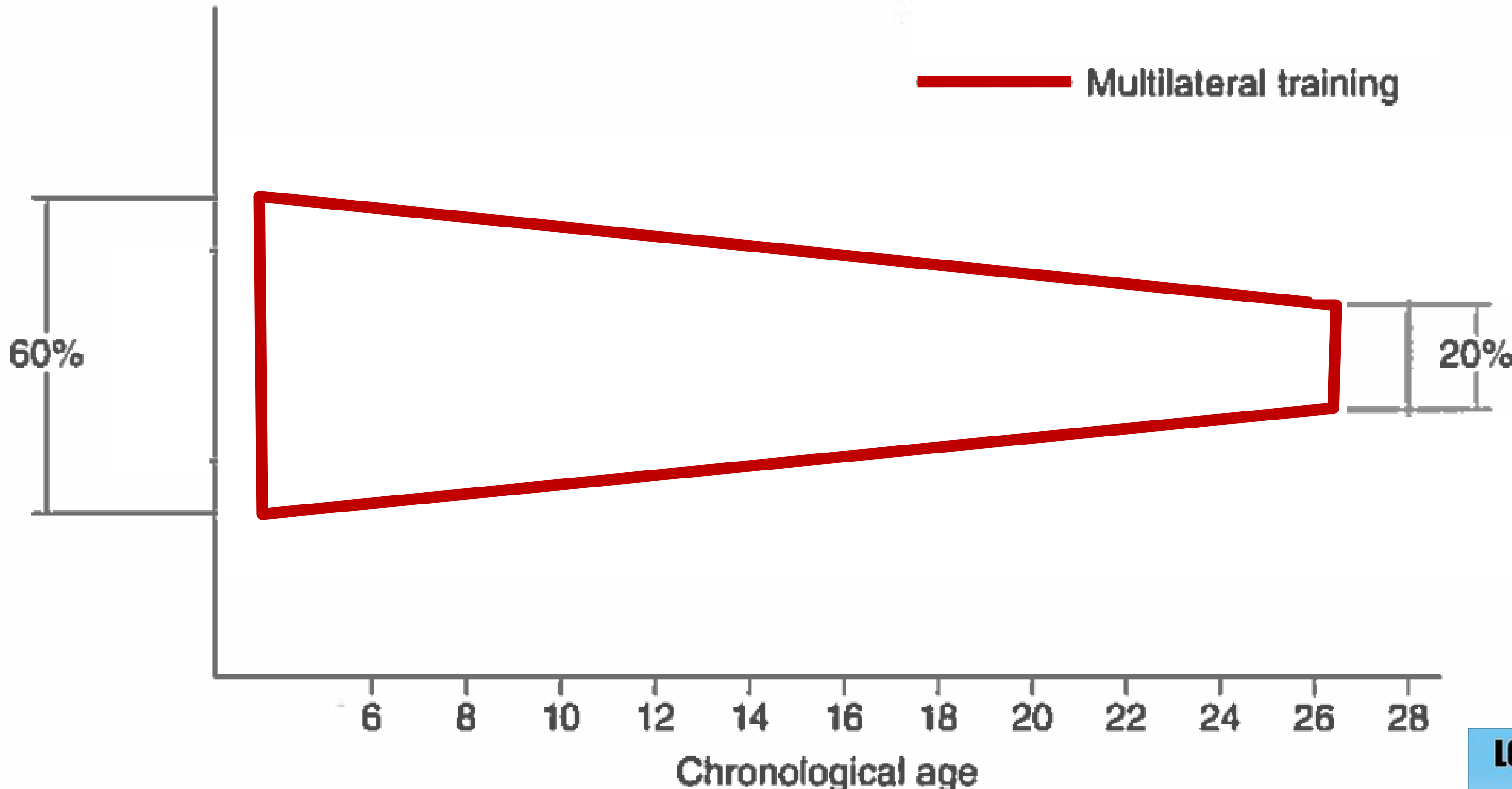
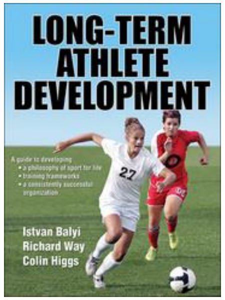


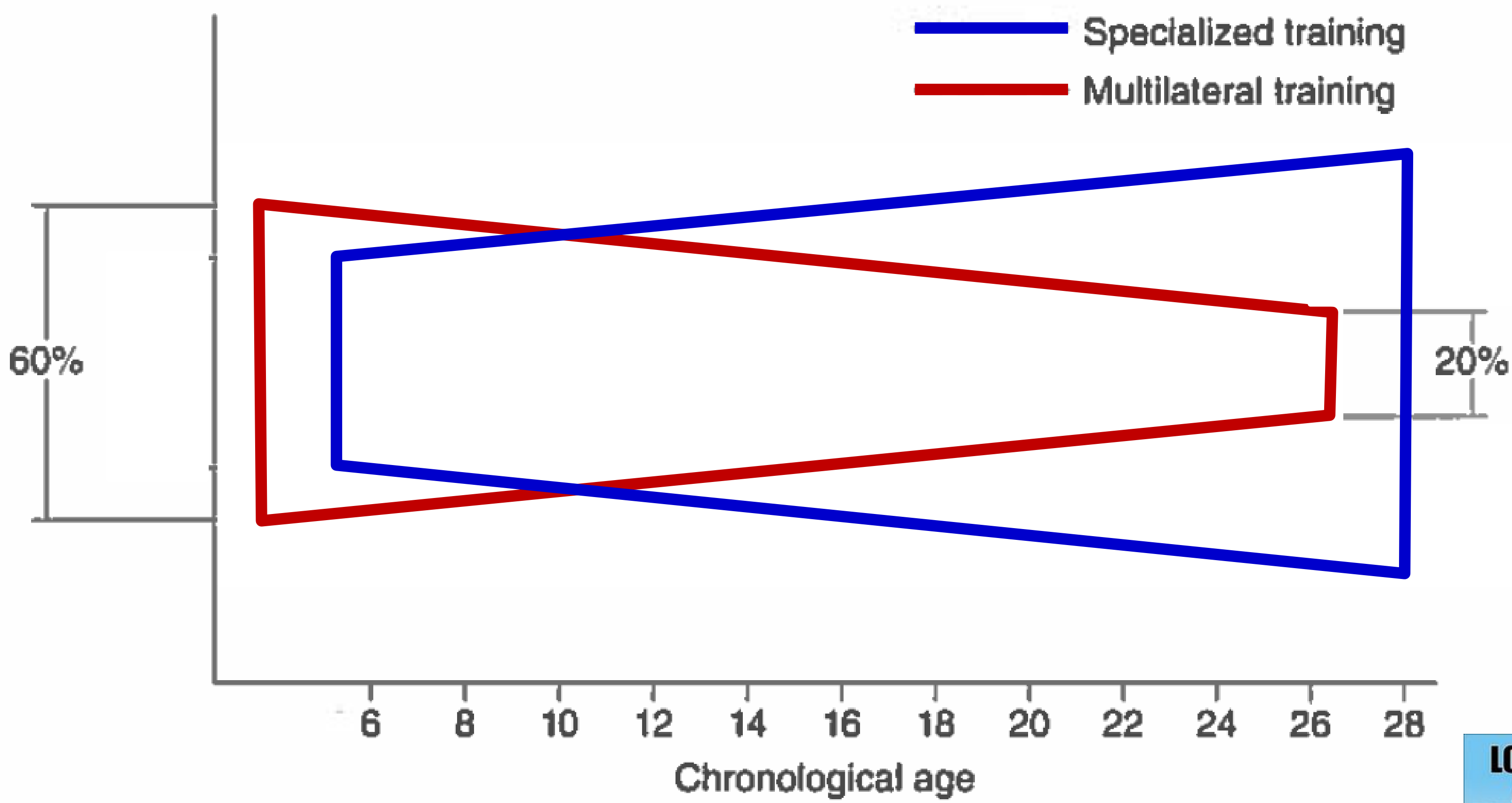
Figure 2. Degree of sports specialization by injury type and sex.

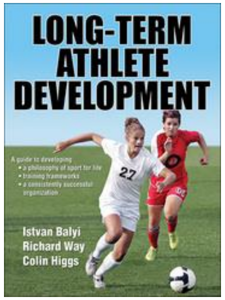
SPECIALIZATION vs DIVERSIFICATION



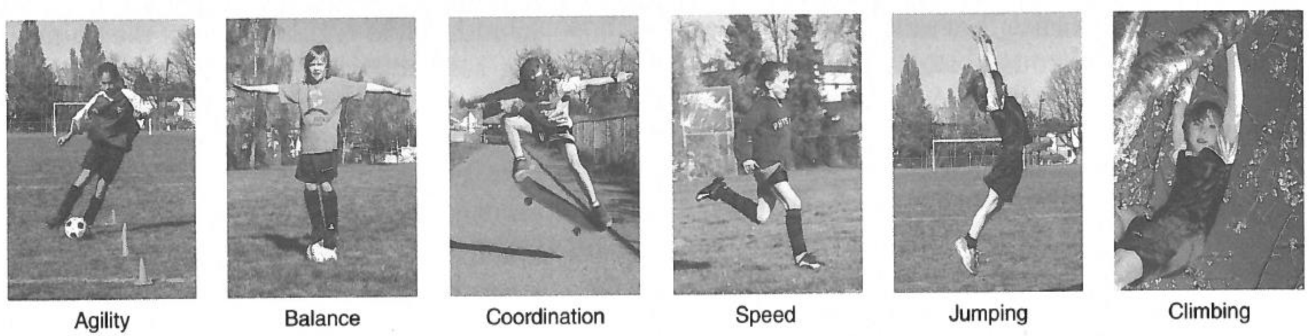


SPECIALIZATION vs DIVERSIFICATION



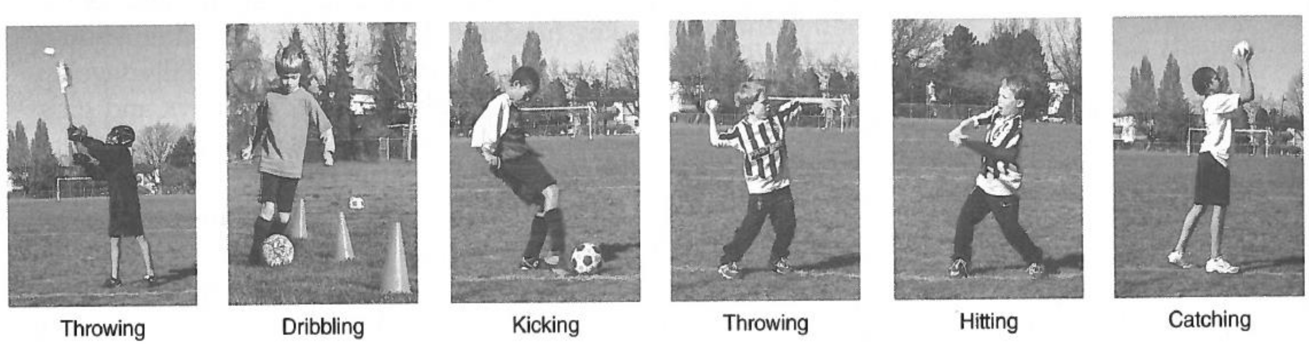


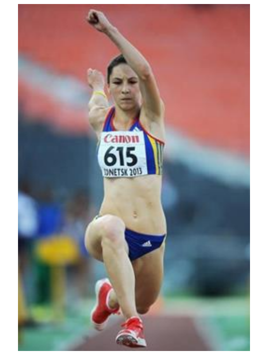
SPECIALIZATION vs DIVERSIFICATION

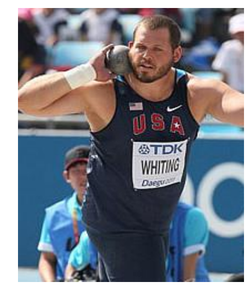


"Diversified sports training during early and middle adolescence appears to be a more effective strategy in ultimately developing elite-level skills in a specific sport/event *due to a positive transfer of physical and mental skills*.

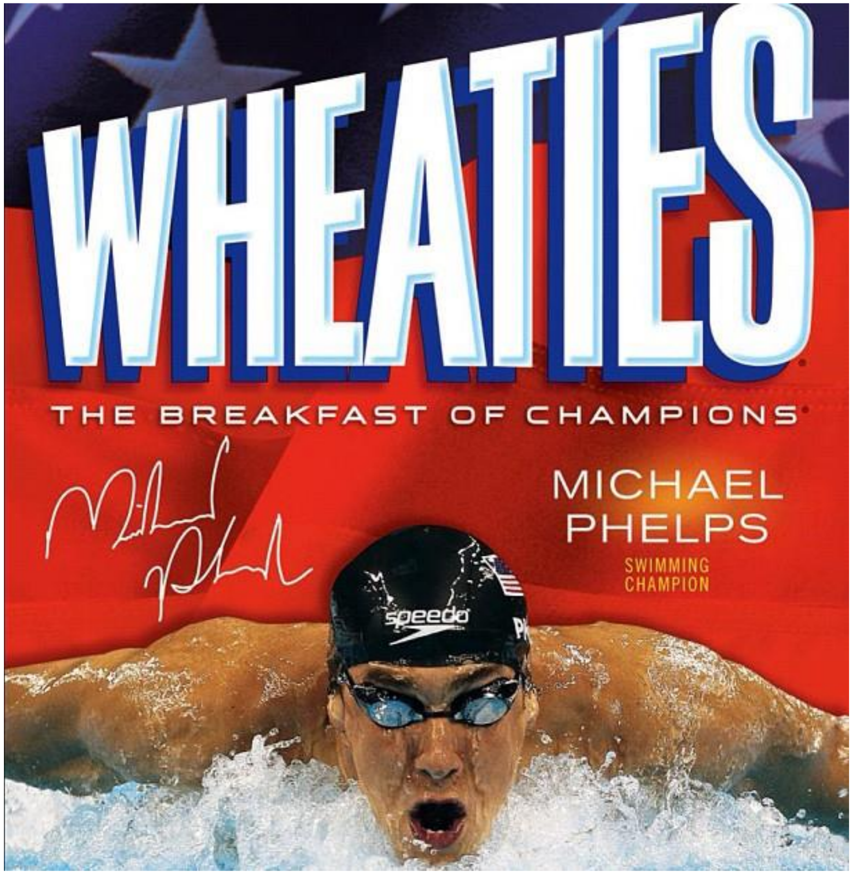
Overuse injuries and burnout in youth sports. DiFiori et al. Clin J Sport Med 24: 3-20, 2014.





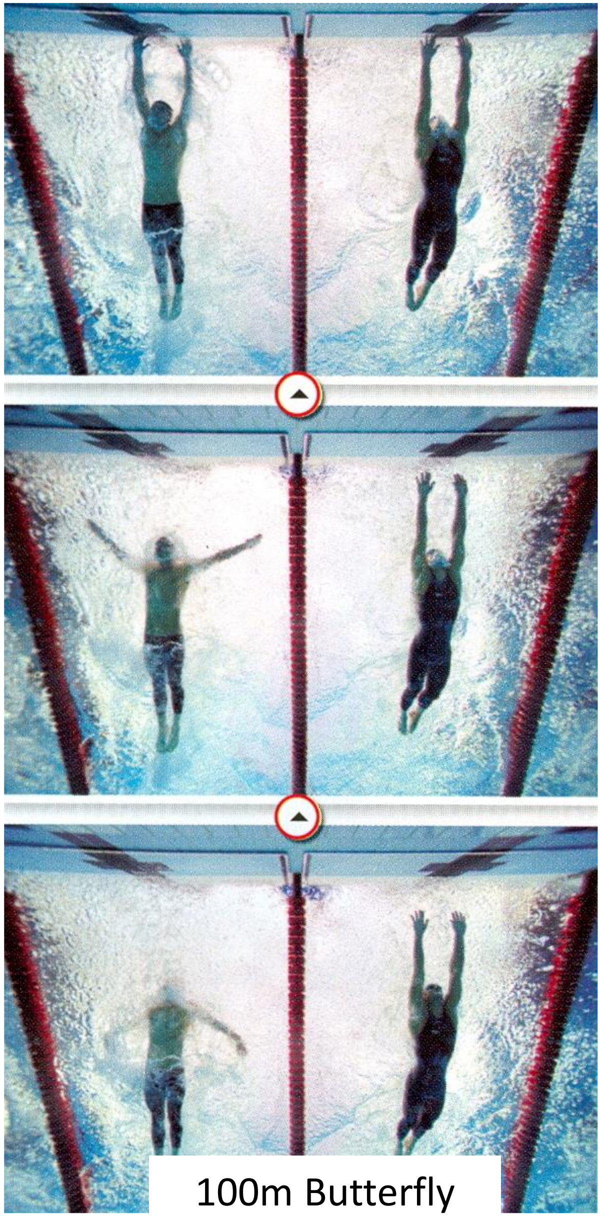


"The difference between being on the Wheaties box . . . and eating from one!"



Michael Phelps (USA) 50.58

Milorad Cavic (SER) 50.59



100m Butterfly

SPECIALIZATION vs DIVERSIFICATION

TALENT

TRANSFER

SPECIALIZATION vs DIVERSIFICATION

Average Age = 26
(20-31)

Average Age = 28
(25-30)

Average Age = 27
(22-31)

EVENT	WOMEN	Nation	Performance	Age
100	Fraser-Pryce	JAM	10.75	25
200	Felix	USA	21.88	26
400	Richards-Ross	USA	49.55	27
800	Savinova	RUS	1:56.19	27
1500	Cakir Alptekin	TUR	4:10.23	27
3000 SC	Zaripova	RUS	9:06.72	26
5000	Defar	ETH	15:04.25	28
10,000	Dibaba	ETH	30:20.75	27
100 H	Pearson	AUS	12.35	25
400 H	Antyukh	RUS	52.70	31
Marathon	Gelana	ETH	2:23:07	24
20 km RW	Lashmanova	RUS	1:25:02	20
LJ	Reese	USA	7.12	25
TJ	Rypakova	KAZ	14.98	27
HJ	Chicherova	RUS	2.05	30
PV	Suhr	USA	4.75	30
SP	Adams	NZL	20.70	27
D	Perkovic	CRO	69.11	22
J	Spotakova	CZE	69.55	31
HT	Lysenko	RUS	78.18	28
Heptathlon	Ennis	GBR	6955	26

SPECIALIZATION vs DIVERSIFICATION

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SPECIALIZATION vs DIVERSIFICATION

Average Age = 27
(19-34)

Average Age = 25
22-26

Average Age = 27
19-30

EVENT	MEN	Nation	Performance	Age
100	Bolt	JAM	9.63	26
200	Bolt	JAM	19.32	26
400	James	GRN	43.94	19
800	Rudisha	KEN	1:40.91	23
1500	Makhloufi	ALG	3:34.08	24
3000 SC	Kemboi	KEN	8:18.56	30
5000	Farah	GBR	13:41.66	30
10,000	Farah	GBR	27:30.42	30
100 H	Merritt	USA	12.92	27
400 H	Sanchez	DOM	47.63	34
Marathon	Kiprotich	UGA	2:08:01	23
20 km RW	Chen	CHN	1:18:46	20
50 km RW	Kirdyapkin	RUS	3:35:59	32
LJ	Rutherford	GBR	8.31	25
TJ	Taylor	USA	17.81	22
HJ	Ukhov	RUS	2.38	26
PV	Lavillenie	FRA	5.97	25
SP	Majewski	POL	21.89	30
D	Harting	GER	69.11	27
J	Walcott	TRI	84.58	19
HT	Pars	HUN	80.59	30
Decathlon	Eaton	USA	8869	24

SPECIALIZATION vs DIVERSIFICATION

EVENT	MEN	Nation	Performance	Age
100	Bolt	JAM	9.63	26
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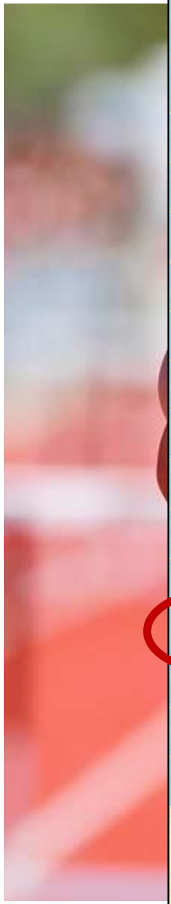
TRAINING CONSIDERATIONS: Thermoregulation



The Heat Index

Air Temp (°F)	Relative Humidity (percentage) 0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
135°	120	126																			
130°	117	122	131																		
125°	111	116	123	131	141																
120°	107	111	116	123	130	139	148														
115°	105	107	111	115	120	127	135	143	151												
110°	99	102	105	108	112	117	123	130	137	143	150										
105°	95	97	100	102	105	109	113	118	123	129	135	142	149								
100°	91	93	95	97	99	101	104	107	110	115	120	126	132	138	144	150					
95°	87	88	90	91	93	94	96	98	101	104	107	110	114	119	124	130	136	140	150		
90°	83	84	85	86	87	88	90	91	93	95	96	98	100	102	106	109	113	117	122	126	131
85°	78	79	80	81	82	83	84	85	86	87	88	89	90	91	93	95	97	99	102	105	108
80°	73	74	75	76	77	77	78	79	79	80	81	81	82	83	84	85	86	87	88	89	90
75°	69	69	70	71	72	72	73	73	74	74	75	75	76	76	77	77	78	78	79	79	80
70°	64	64	65	65	66	66	67	67	68	68	69	69	70	70	70	70	71	71	71	71	72

= Heatstroke risk extremely high

= Heat exhaustion likely, heatstroke possible

= Heat exhaustion possible

= Fatigue possible

TRAINING CONSIDERATIONS: Thermoregulation

Cooling Strategies: Hydration for Training/Competition < 1hr

Example: **Sprints, Hurdles, Jumps, Throws**

Exercise intensity: **80 – 130% VO_{2max}**

Primary concern: **Fluid:**

1. to negate the rise in core temp
2. to replace H_2O lost via sweat

Fluid ingestion:

Pre = 1 x 8-10 oz. CHO-E

During / After = 2 x 8-10 oz. H_2O (or CHO-E)

CHO-E = Carbohydrate-Electrolyte drink (eg, Gatorade, Powerade)

TRAINING CONSIDERATIONS: Thermoregulation
Cooling Strategies: Hydration for Training/Competition 1-3+ hr

Example: **Middle distance, Long distance**

Exercise intensity: **60 – 90% VO_{2max}**

Primary concerns:

Fluid:
1. to negate the rise in core temp
2. to replace H_2O lost via sweat

Electrolytes:
1. to replace Na^+, CL^-, K^+ lost via sweat

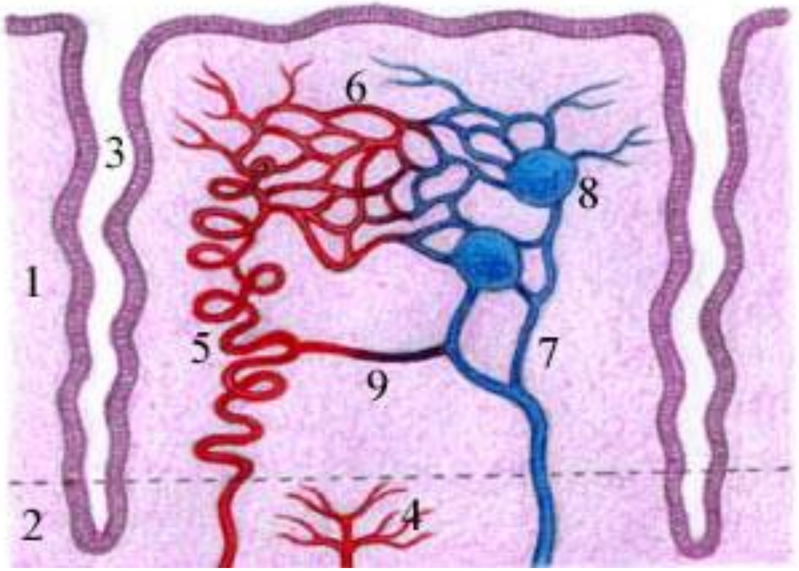
CHO:
1. to maintain blood Glucose for immediate energy
2. to replenish liver/muscle glycogen post-exercise

Fluid ingestion:

Pre = 1 x 8-10 oz. CHO-E ~ 30-60 min pre
During = 2 x 8-10 oz. CHO-E per hour
After = 1-2 x 8-10 oz. CHO-E-PRO within 30-60 min post

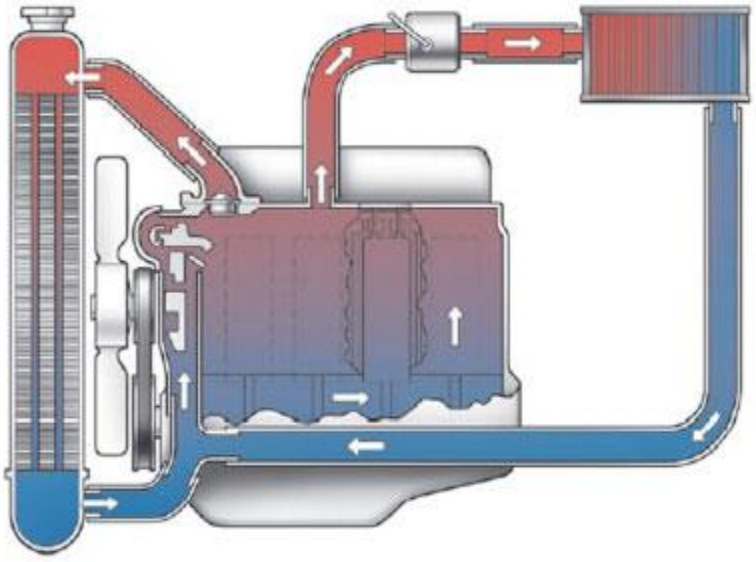
CHO-E-PRO = Carbohydrate-Electrolyte-Protein drink (eg, Gatorade, Powerade, LF chocolate milk)

TRAINING CONSIDERATIONS: Thermoregulation

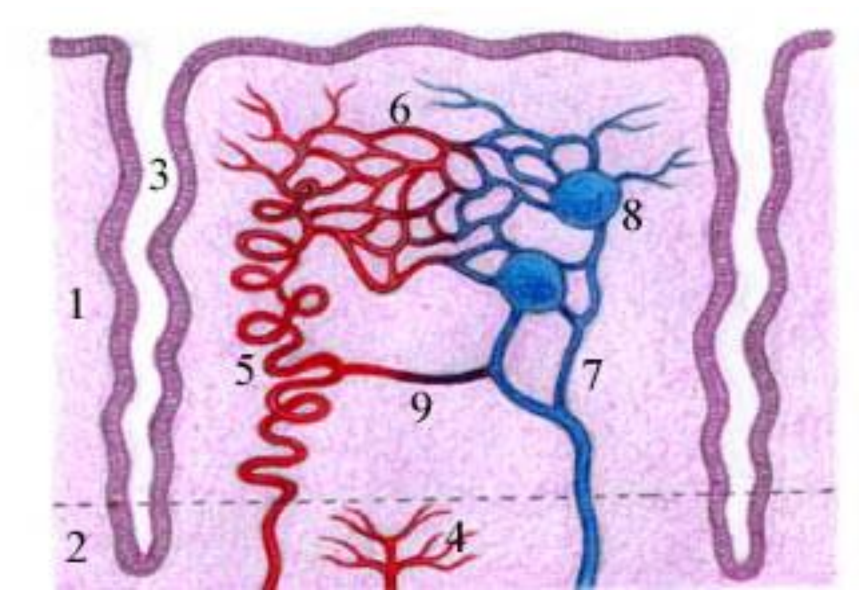


Arterio-venous anastomoses (AVAs)

Automobile cooling system

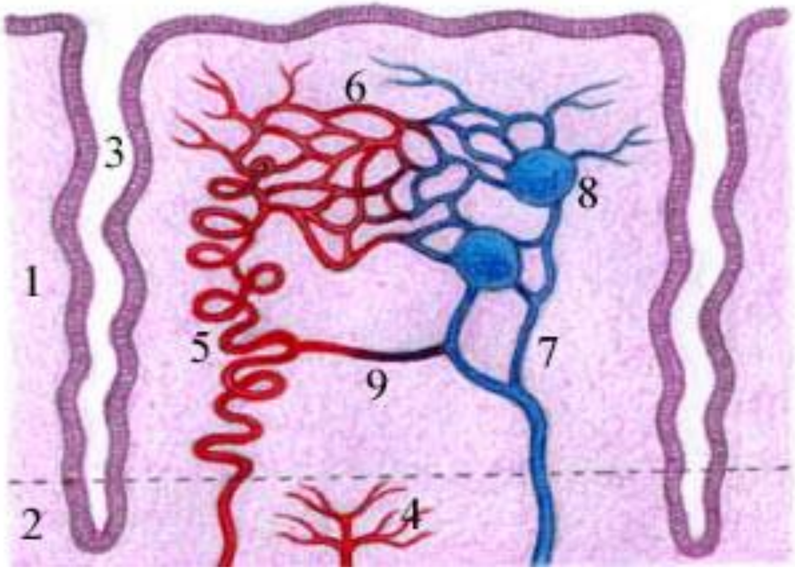


TRAINING CONSIDERATIONS: Thermoregulation

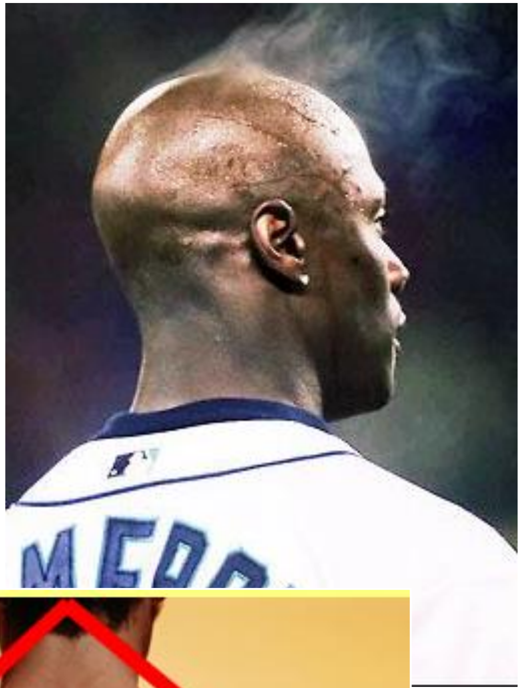


Arterio-venous anastomoses (AVAs)

TRAINING CONSIDERATIONS: Thermoregulation



Arterio-venous anastomoses (AVAs)



TRAINING CONSIDERATIONS: Thermoregulation

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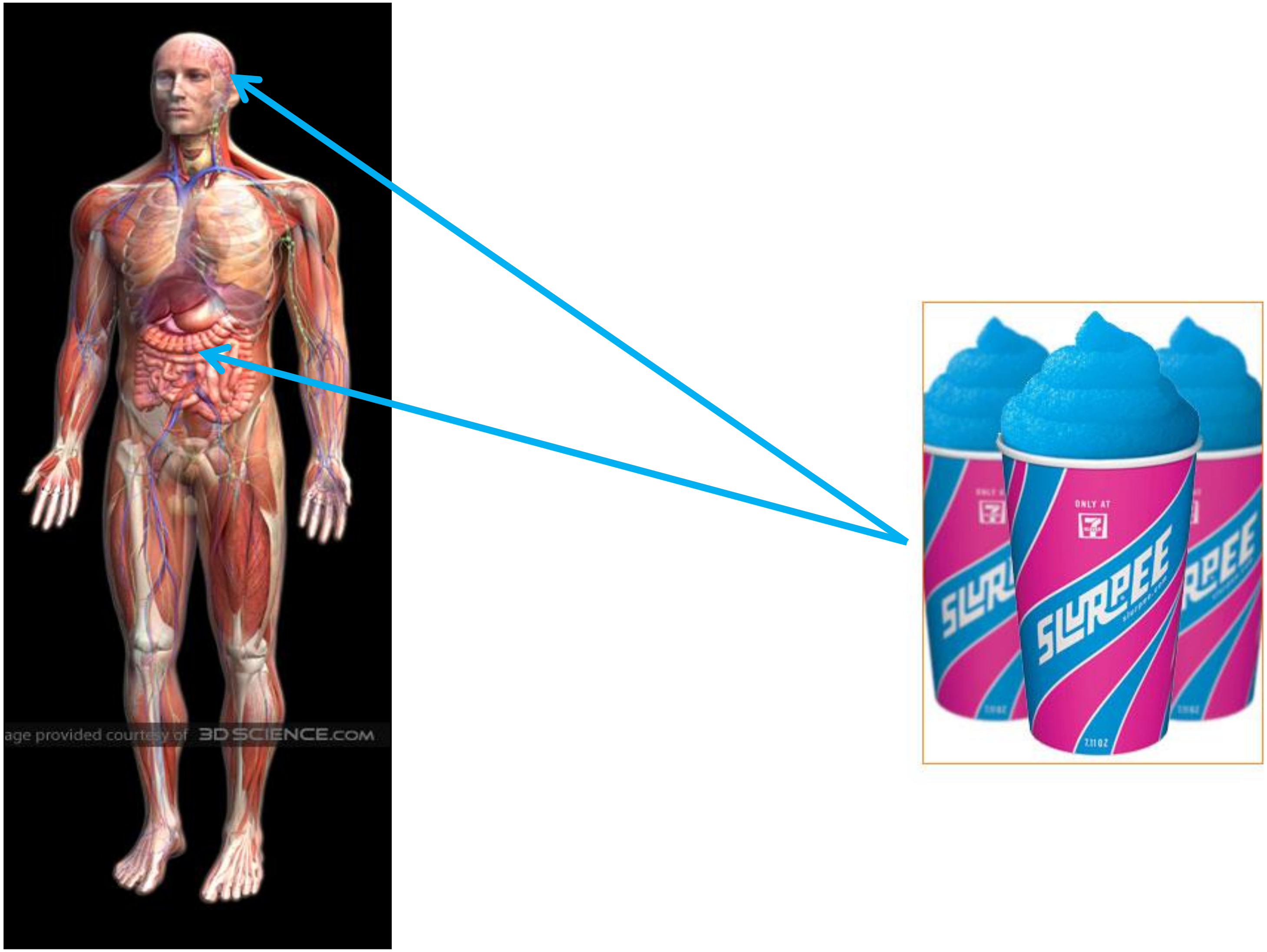


TRAINING CONSIDERATIONS: Thermoregulation

Ice Slurry Ingestion Increases Core Temperature Capacity and Running Time in the Heat

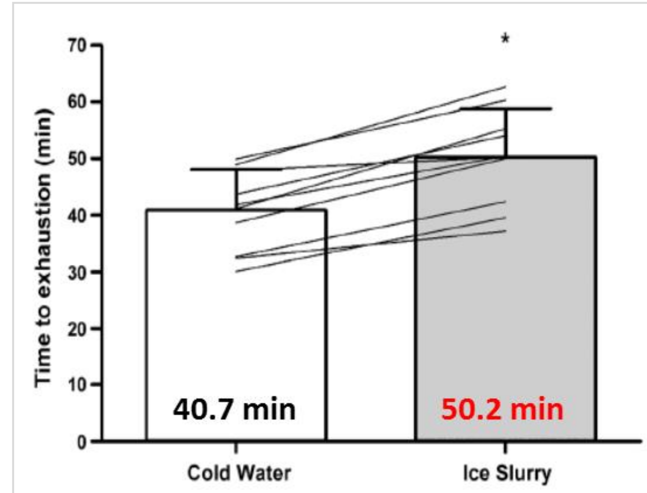
Med Sci Sports Exerc 4:717-725, 2010

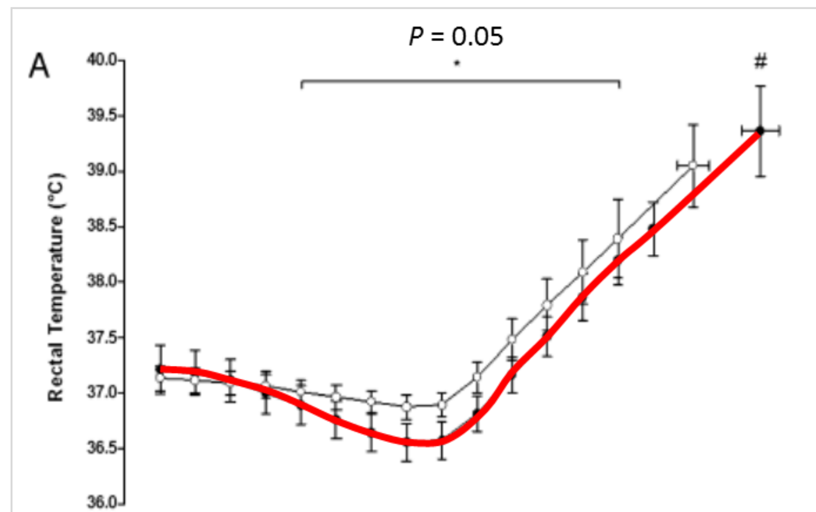
SLURPEE = 7.5 g/kg TBM

Ingested equally over 30 min prior to run

Run to exhaustion @ VT1

93º F / 55% RH





TRAINING CONSIDERATIONS: Thermoregulation

Arctic Heat®

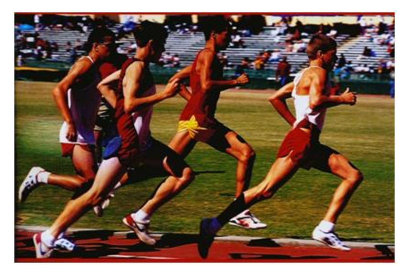
$200

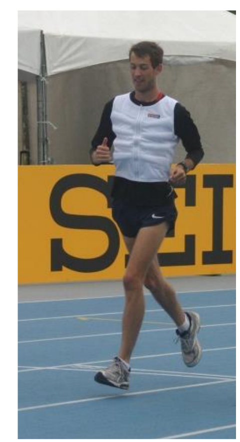
XS, S, M, L, XL

Freezer
~3 hr

Transport and keep frozen in ice chest

Wear during warmup and cooldown
Stays frozen 30-60 min





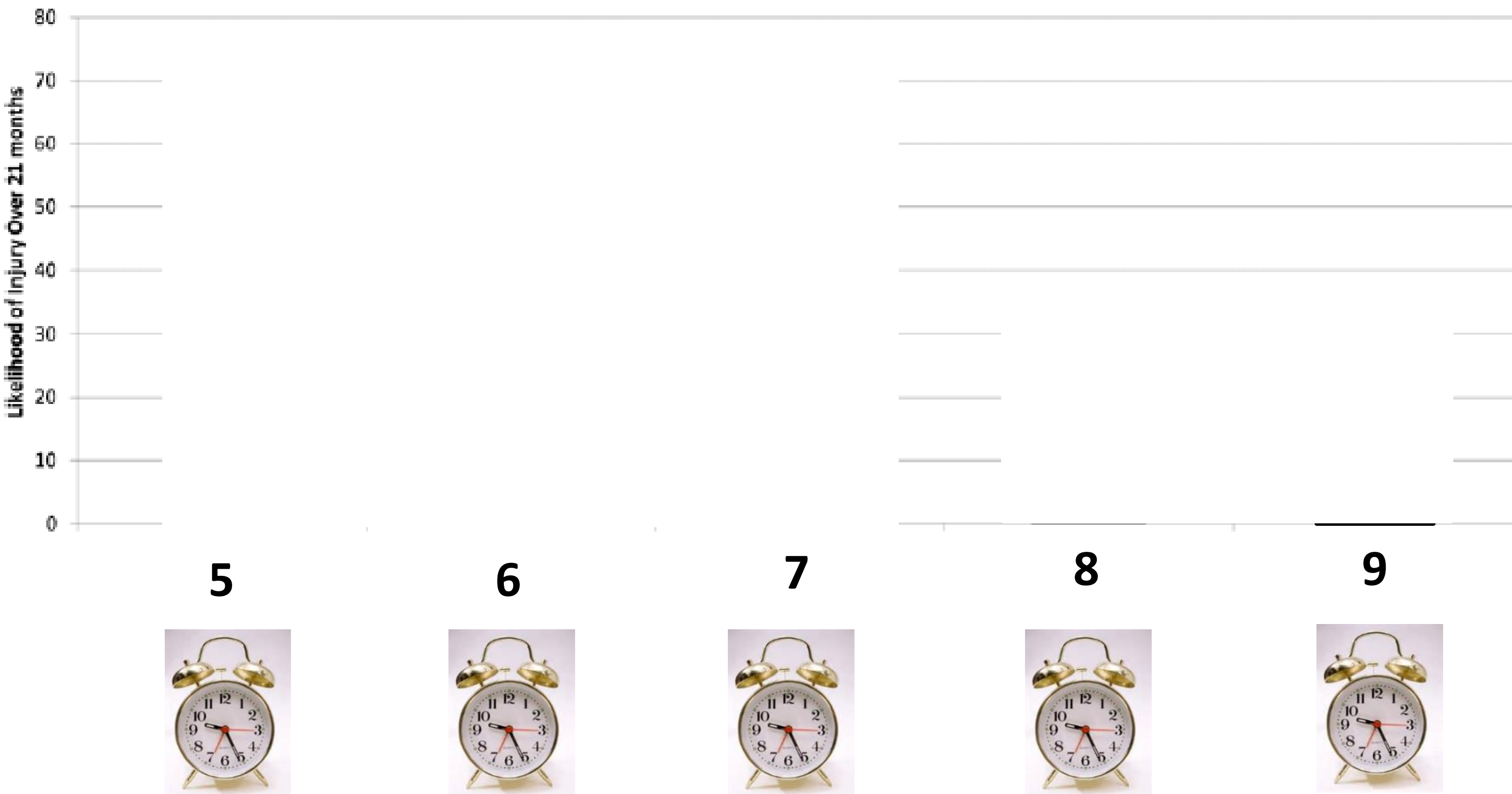
TRAINING CONSIDERATIONS: Sleep

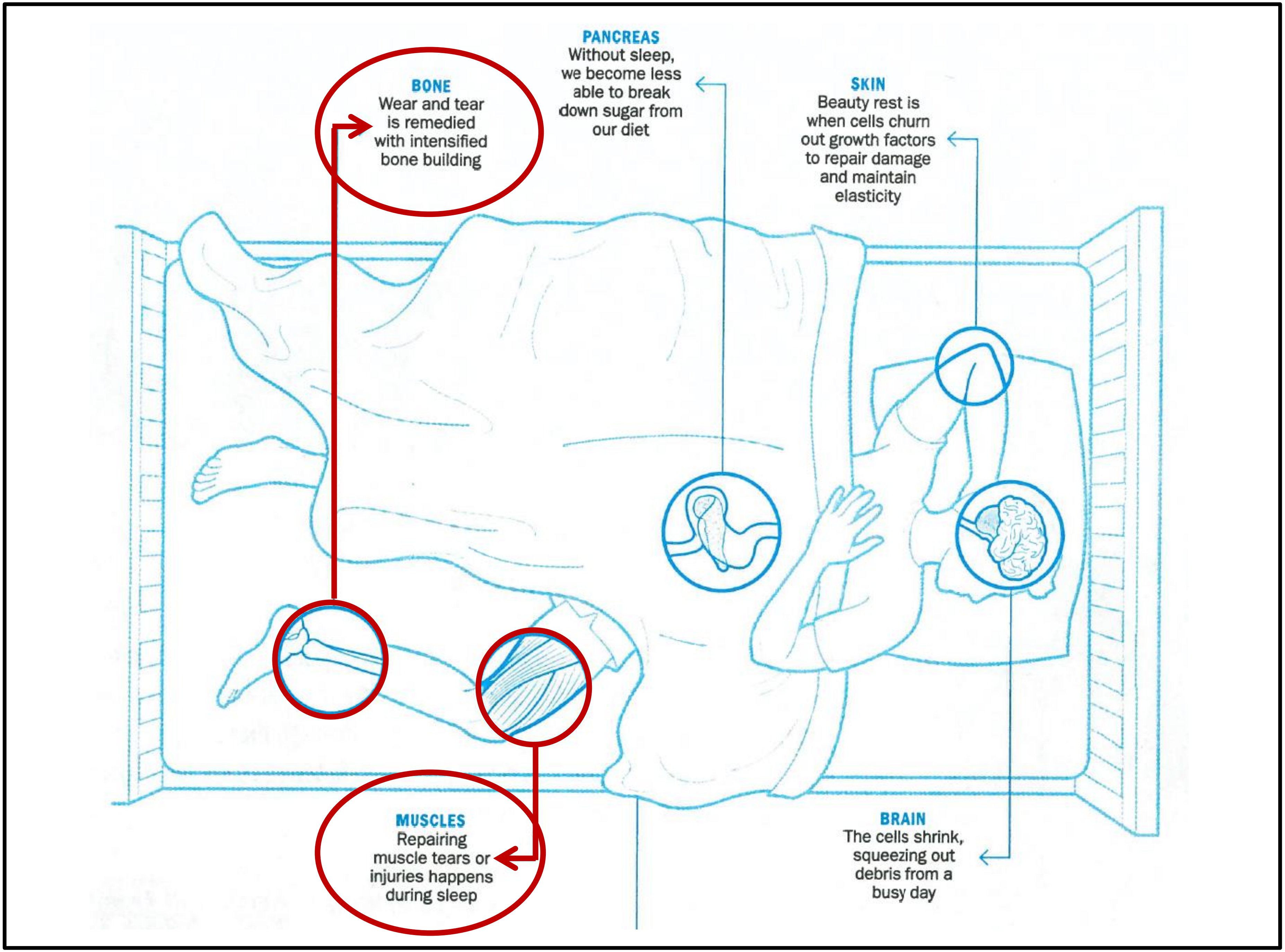
Chronic Lack of Sleep is Associated With Increased Sports Injuries in Adolescent Athletes

Matthew D. Milewski, MD, David L. Skaggs, MD, MMM,† Gregory A. Bishop, MS,‡ J. Lee Pace, MD,† David A. Ibrahim, MD,† Tishya A.L. Wren, PhD,† and Audrius Barzdukas, MEd‡*

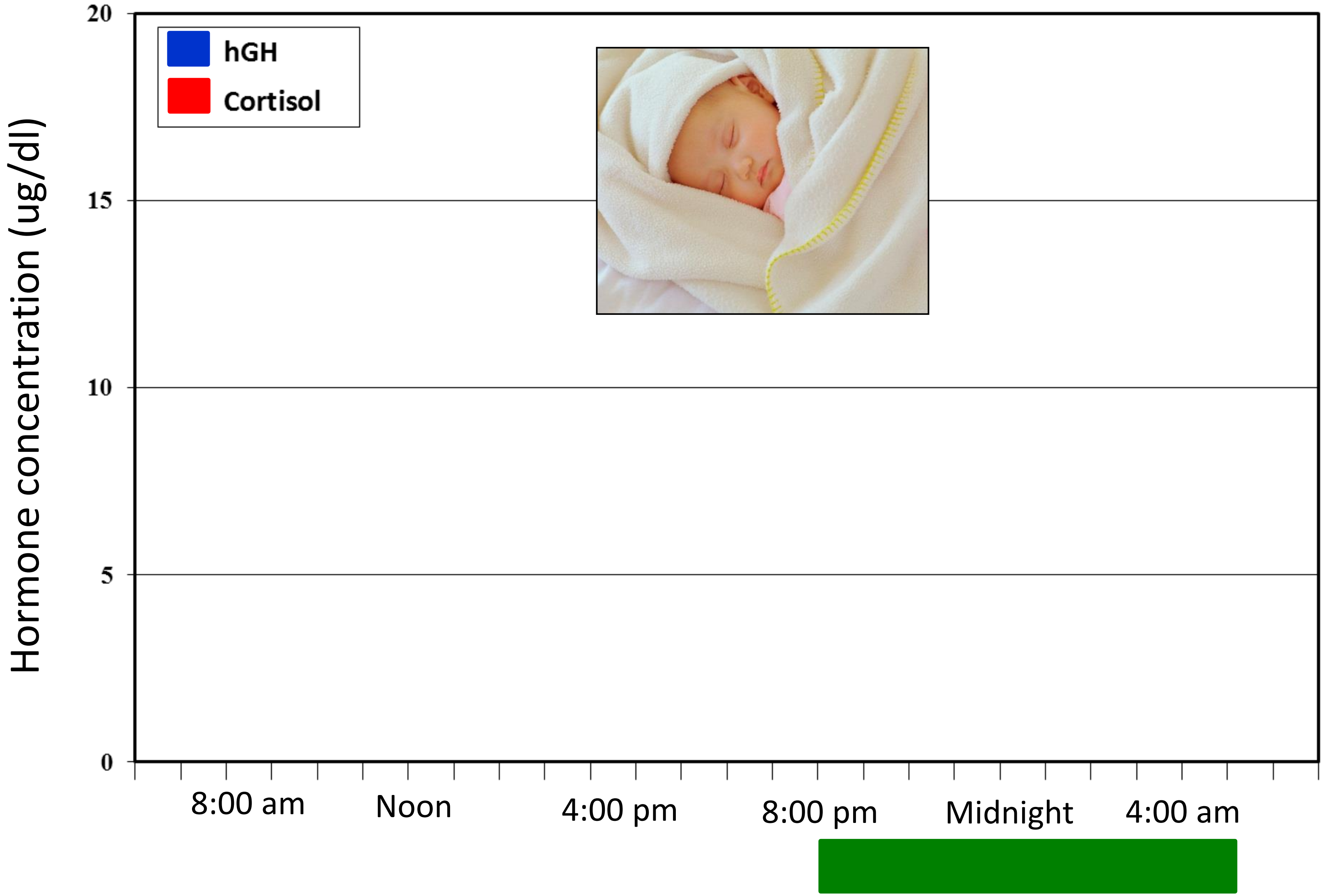
J Pediatr Orthop 34: 129-133, 2014

Likelihood of Injury Based on Hours of Sleep per Night

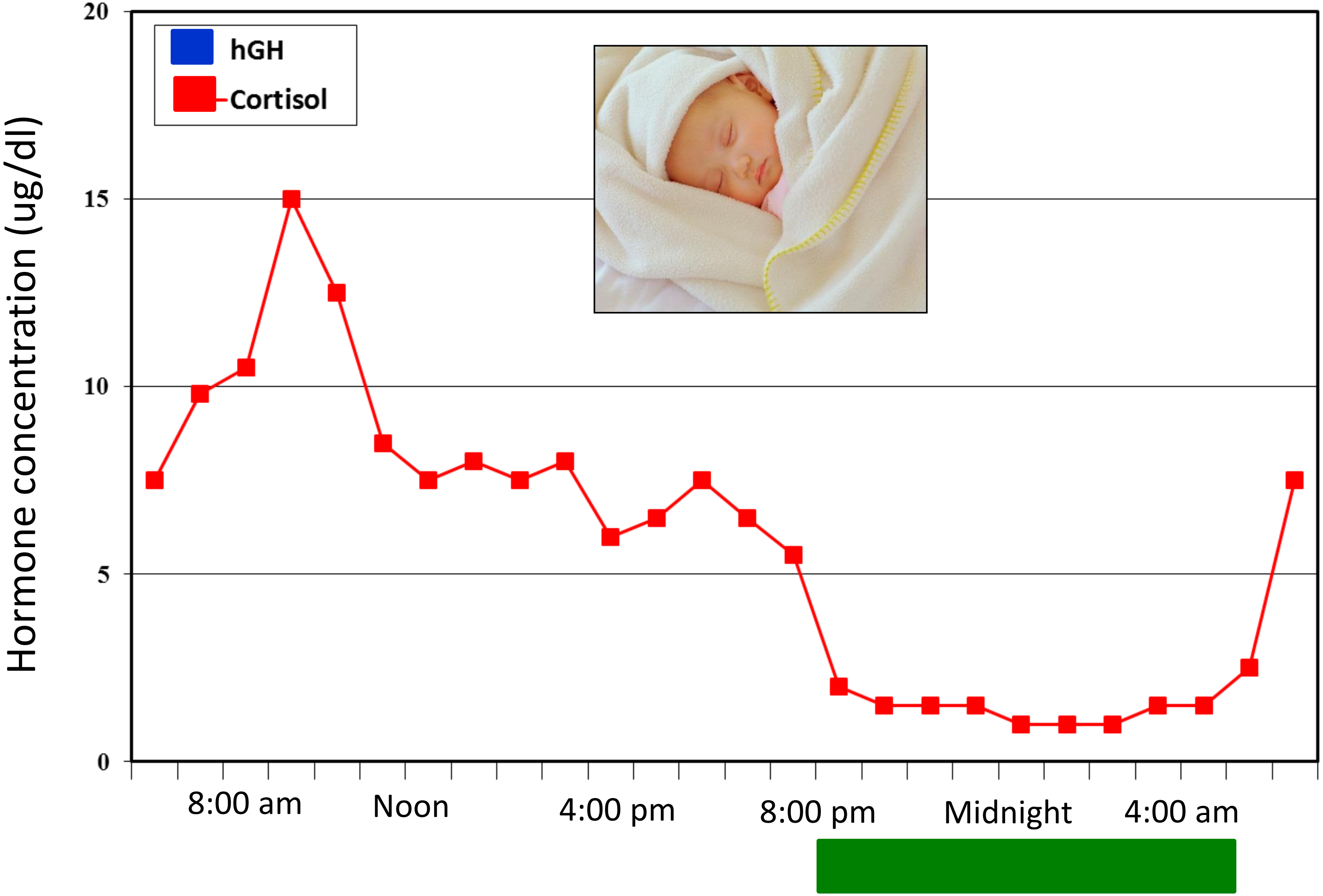




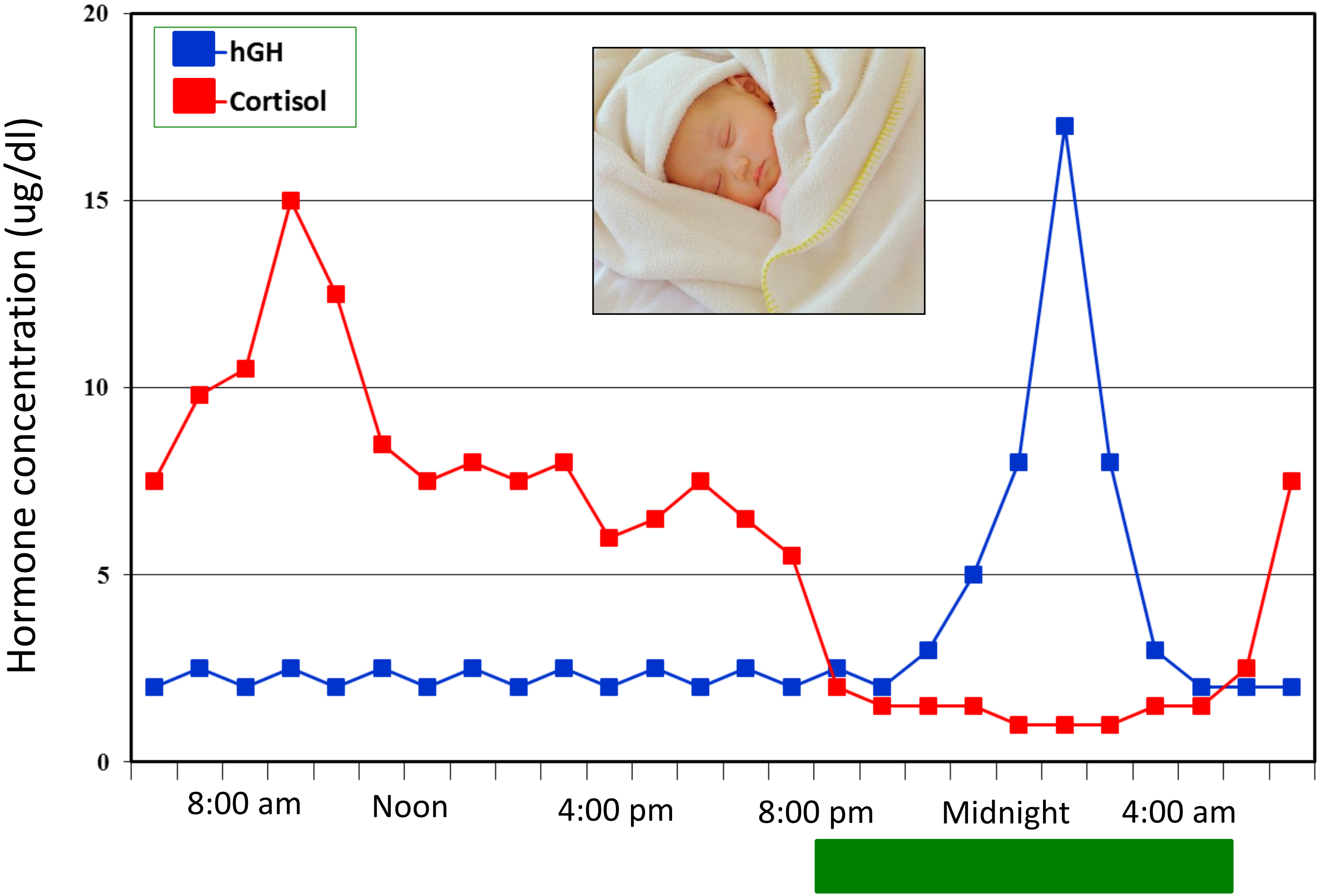
PANCREAS
Without sleep, we become less able to break down sugar from our diet
BONE
Wear and tear is remedied with intensified bone building
SKIN
Beauty rest is when cells churn out growth factors to repair damage and maintain elasticity
MUSCLES
Repairing muscle tears or injuries happens during sleep
BRAIN
The cells shrink, squeezing out debris from a busy day



Stone et al. in review



Stone et al. in review



Stone et al. in review


123RF
TRAINING

=

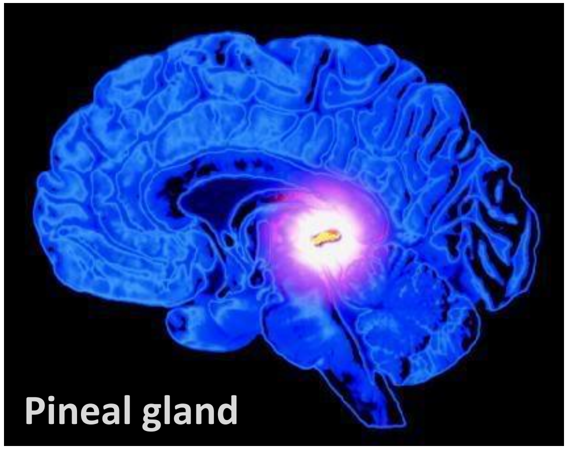

RECOVERY
+
REFUELING

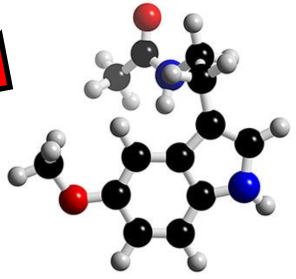
=


Miracle-Gro
All Purpose
Plant Food

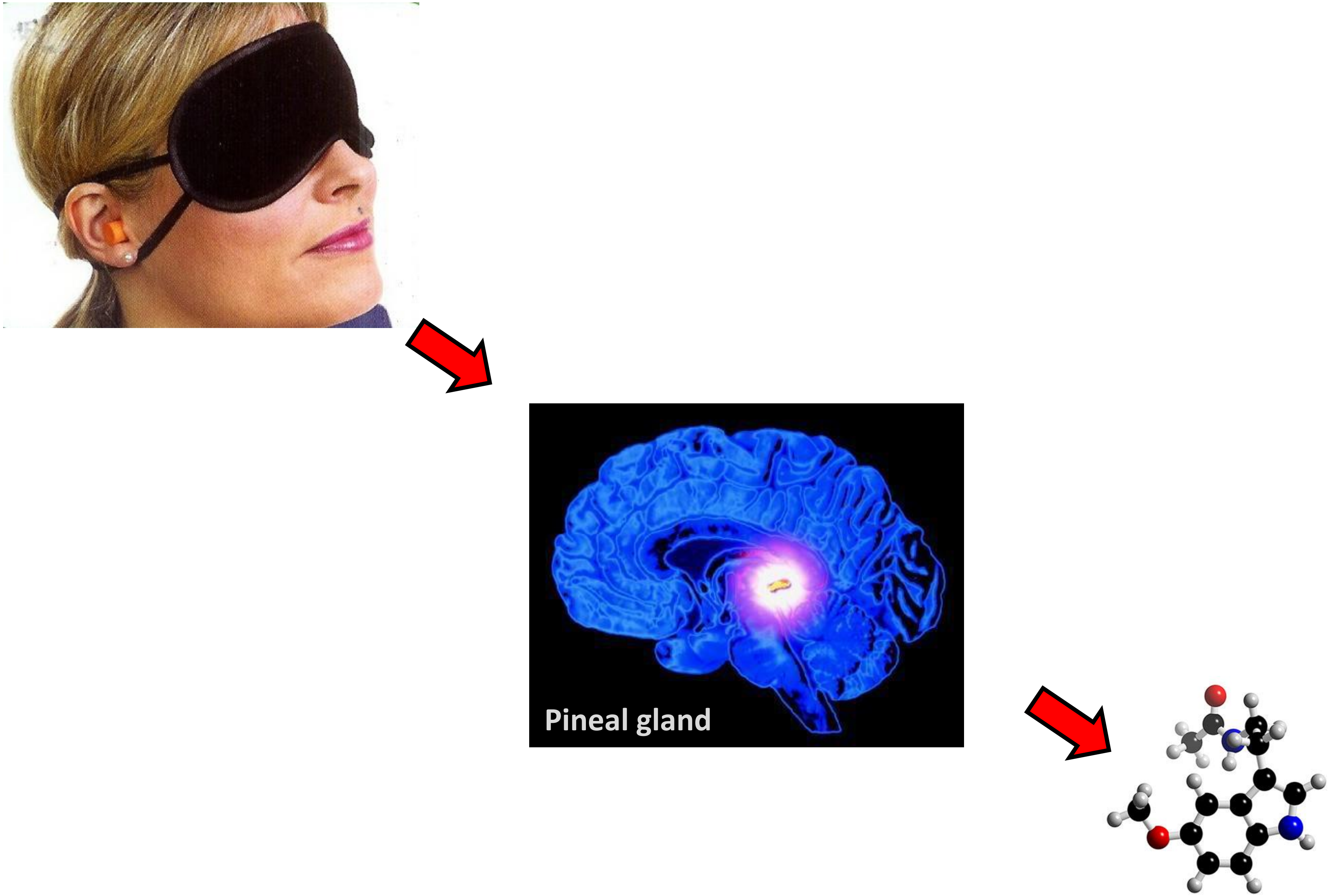

SLEEP

=



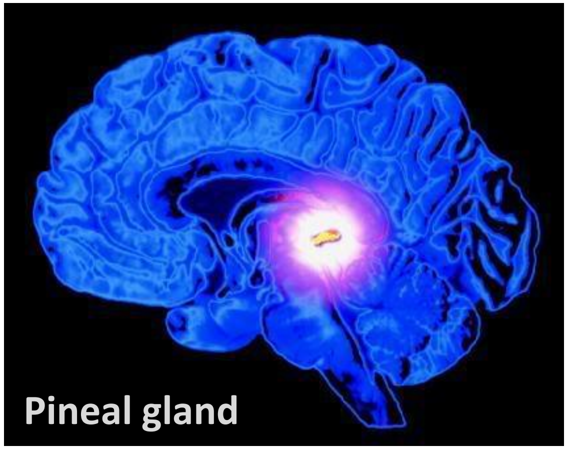


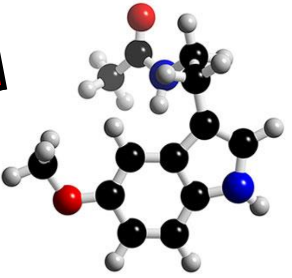
Melatonin



Melatonin


Organic
TART
Cherry
Juice
Concentrate
7.5 FL OZ 222mL


Pineal gland

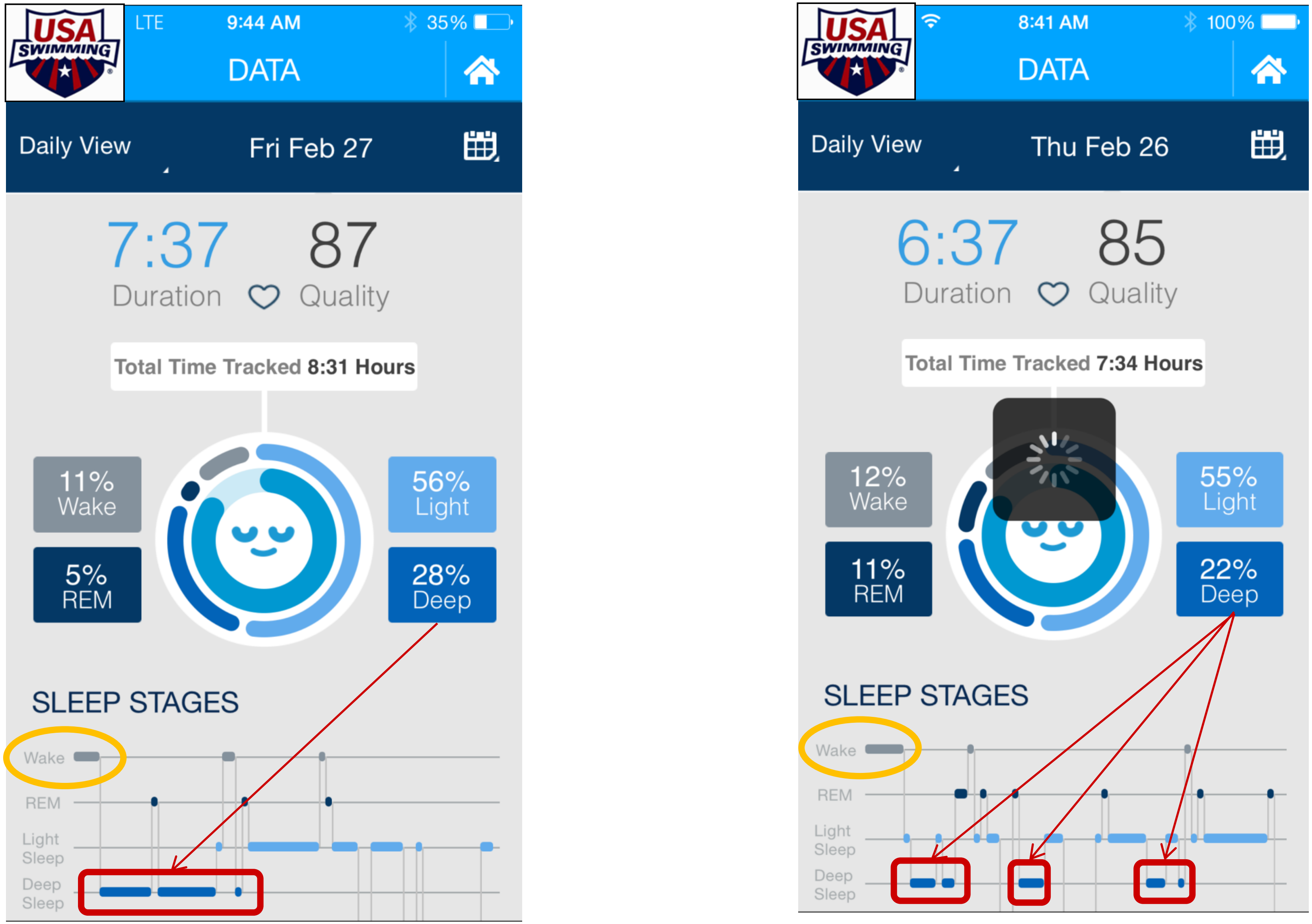


Melatonin


Start
ASUS


STARBUCKS
COFFEE

Hormone concentration (ug/dl)
20
15
10
5
0
hGH
Cortisol
8:00 am
Noon
4:00 pm
8:00 pm
Midnight
4:00 am
No SIM
17:50
DATA
Daily View
6:55
Duration
92%
Quality
Total time in bed 7:36 hr
9% Wake
13% REM
49% Light
29% Deep


USA SWIMMING
LTE
9:44 AM
35%
DATA
Daily View
Fri Feb 27
7:37
Duration
87
Quality
Total Time Tracked 8:31 Hours
11% Wake
5% REM
56% Light
28% Deep
SLEEP STAGES
Wake
REM
Light Sleep
Deep Sleep
USA SWIMMING
8:41 AM
100%
DATA
Daily View
Thu Feb 26
6:37
Duration
85
Quality
Total Time Tracked 7:34 Hours
12% Wake
11% REM
55% Light
22% Deep
SLEEP STAGES
Wake
REM
Light Sleep
Deep Sleep

The Effects of Sleep Extension on the Athletic Performance of Collegiate Basketball Players

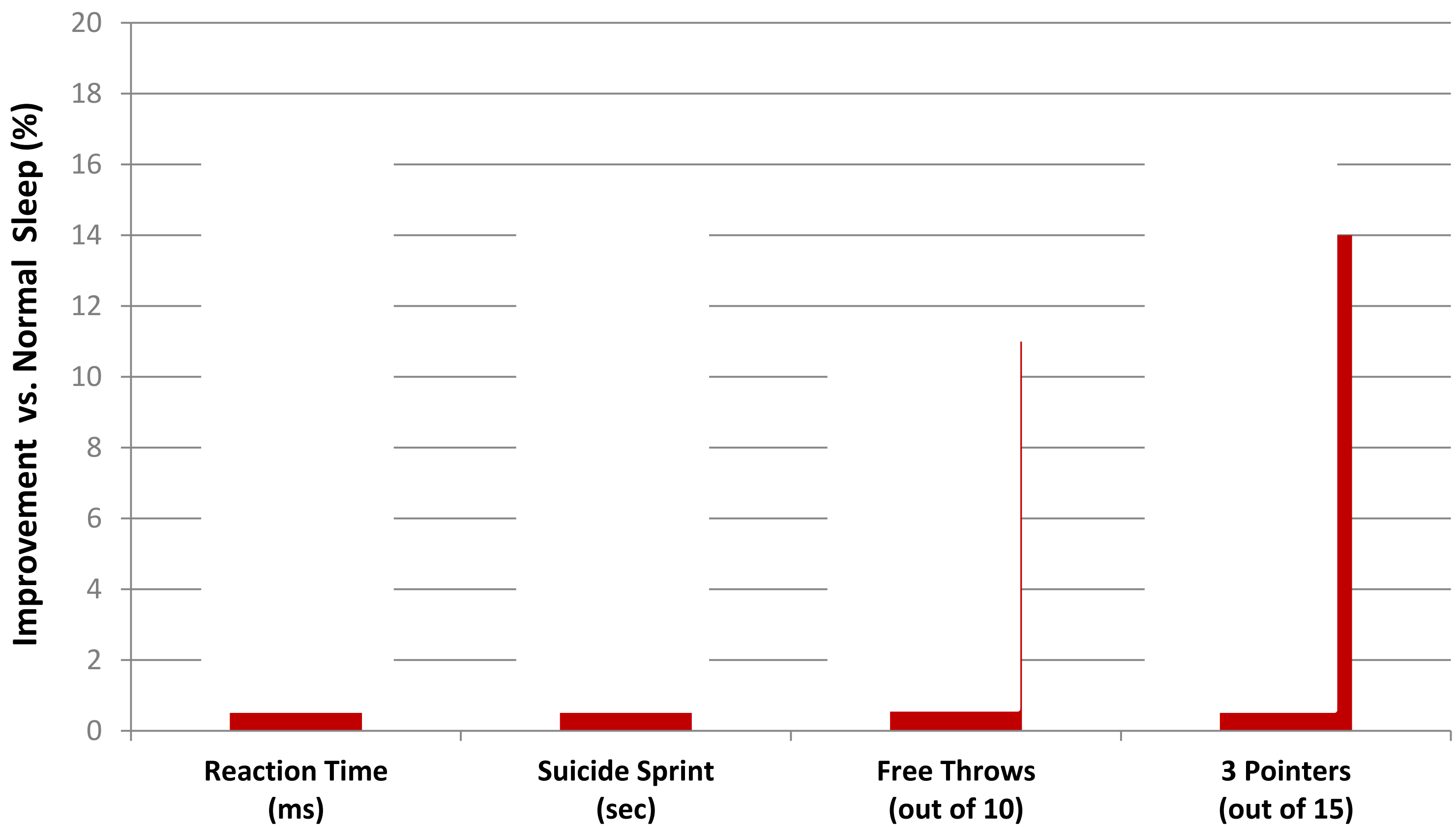
Cheri D. Mah, MS[1]; Kenneth E. Mah, MD, MS[1]; Eric J. Kezirian, MD, MPH[2]; William C. Dement, MD, PhD[1]

Sleep 34: 943-950, 2011

Normal Sleep
[2-4 weeks]
AVG = 6 hr: 41 min

→

Sleep Supplementation
[5-7 weeks]
AVG = 8 hr: 27 min

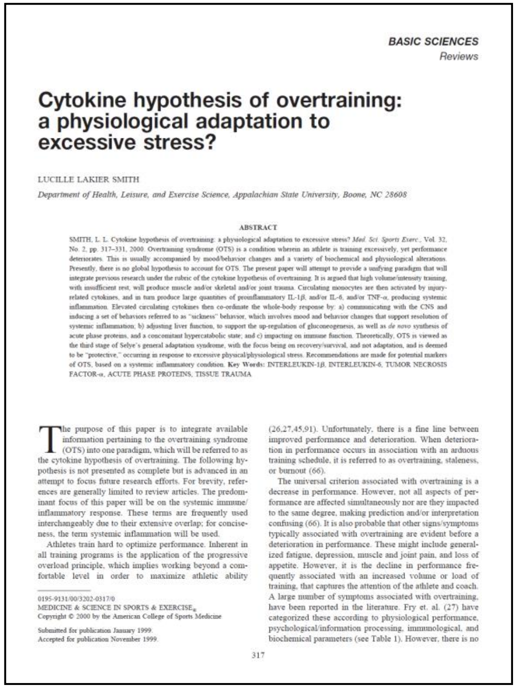


THE JUNIOR ELITE ATHLETE:
Physiological Characteristics and Training Considerations

- Introduction / Physiology 101
- From Childhood to Adolescence to Adulthood
- Increased Risk of Injury
- Training Considerations
- ➡ Overtraining
- Summary and Q/A

Cytokine Hypothesis of Overtraining / Under-Performance

Dr. Lucille Lakier Smith

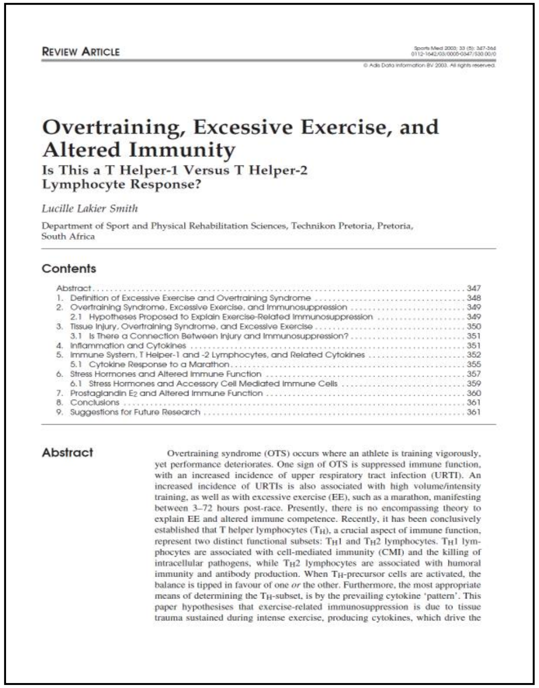

BASIC SCIENCES
Reviews

Cytokine hypothesis of overtraining: a physiological adaptation to excessive stress?

LUCILLE LAKIER SMITH

Department of Health, Leisure, and Exercise Science, Appalachian State University, Boone, NC 28608

MSSE 32: 317-331, 2000


REVIEW ARTICLE

Overtraining, Excessive Exercise, and Altered Immunity
Is This a T Helper-1 Versus T Helper-2 Lymphocyte Response?

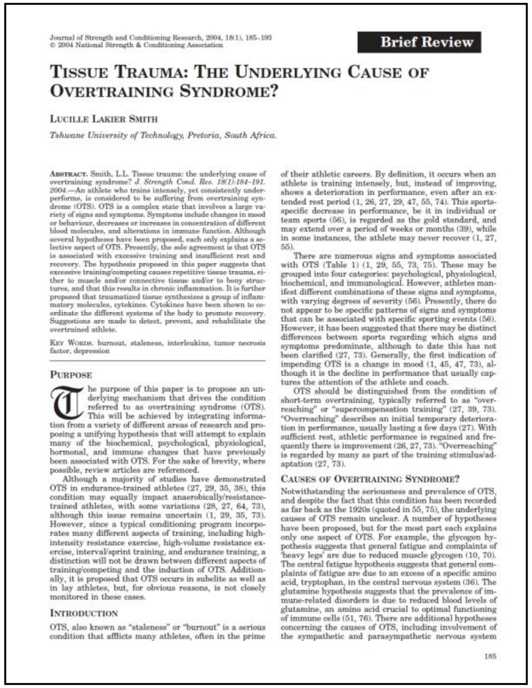
Lucille Lakier Smith

Department of Sport and Physical Rehabilitation Sciences, Technikon Pretoria, Pretoria, South Africa

Contents

Abstract

Sports Med 33: 347-364, 2003

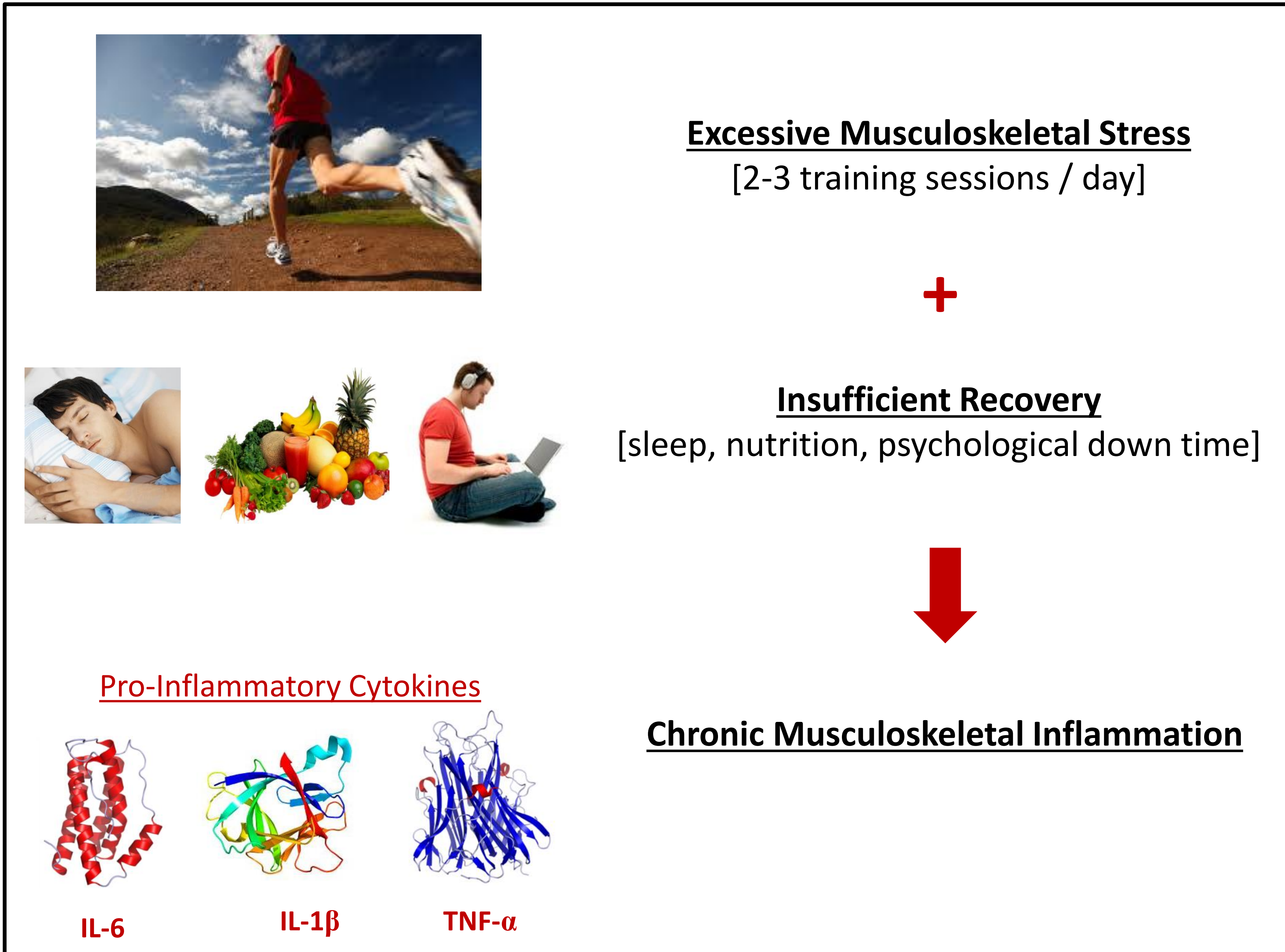

Brief Review

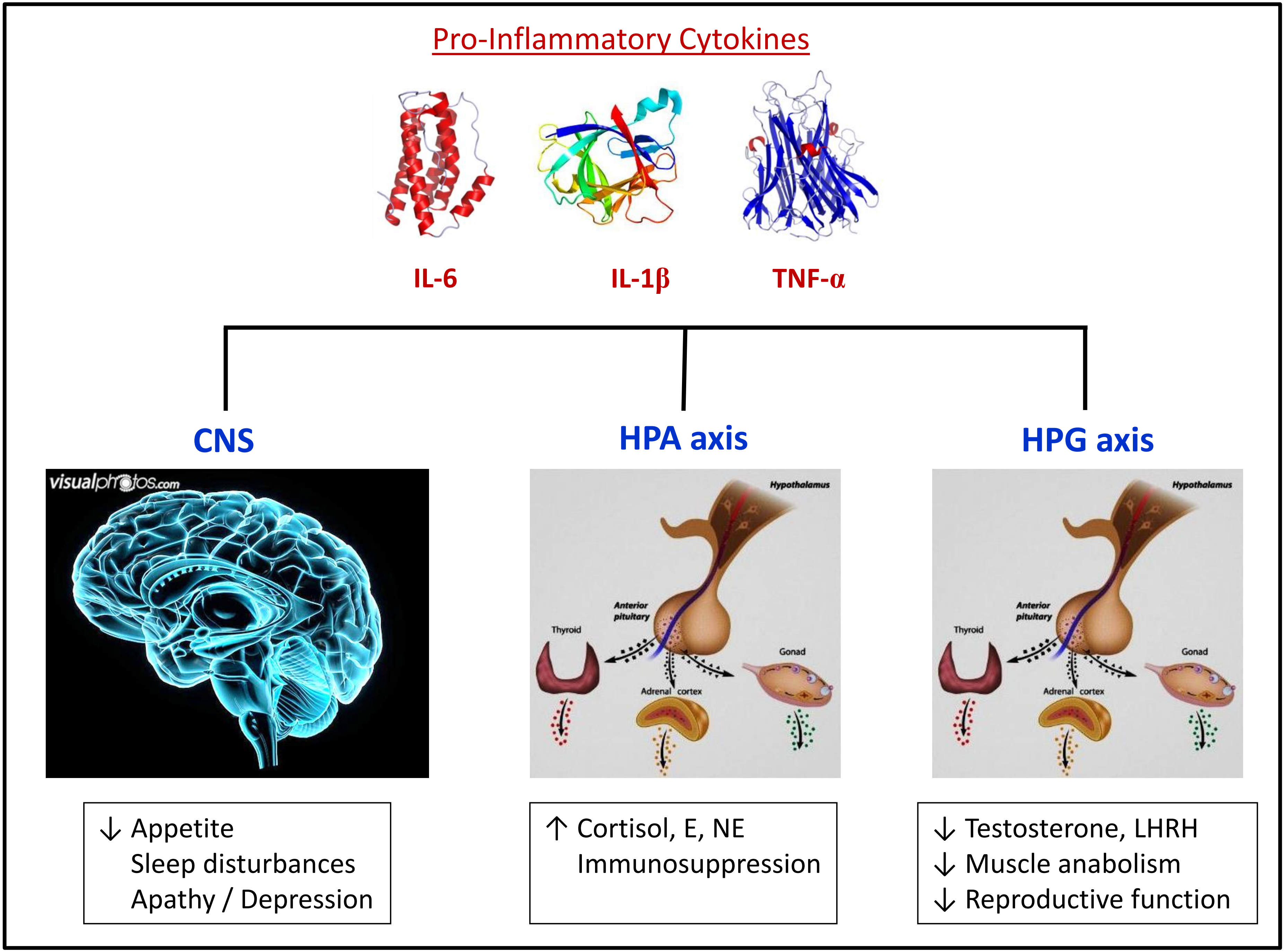
TISSUE TRAUMA: THE UNDERLYING CAUSE OF OVERTRAINING SYNDROME?

LUCILLE LAKIER SMITH

Tshwane University of Technology, Pretoria, South Africa.

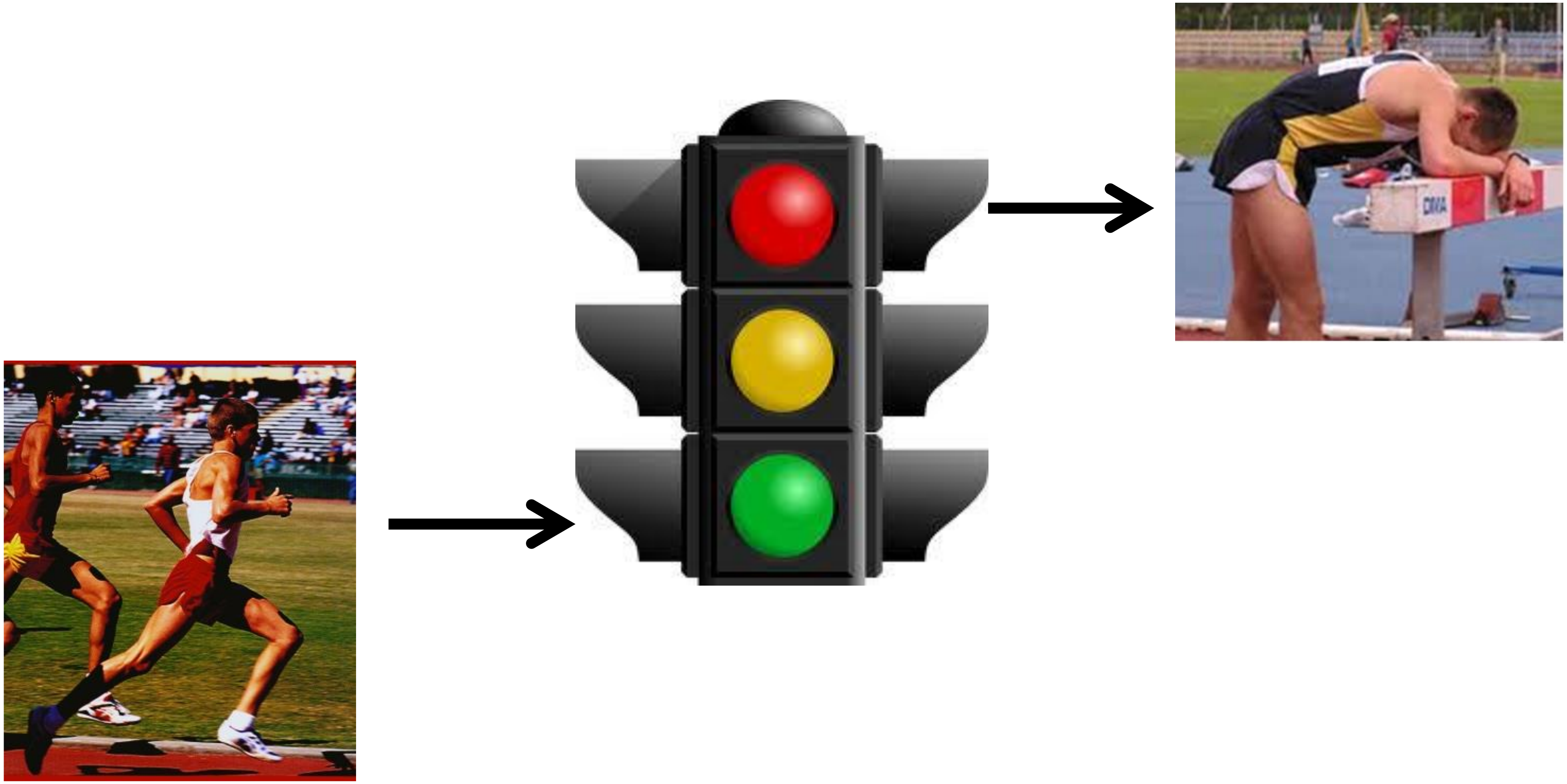
JSCR 18: 185-193, 2004

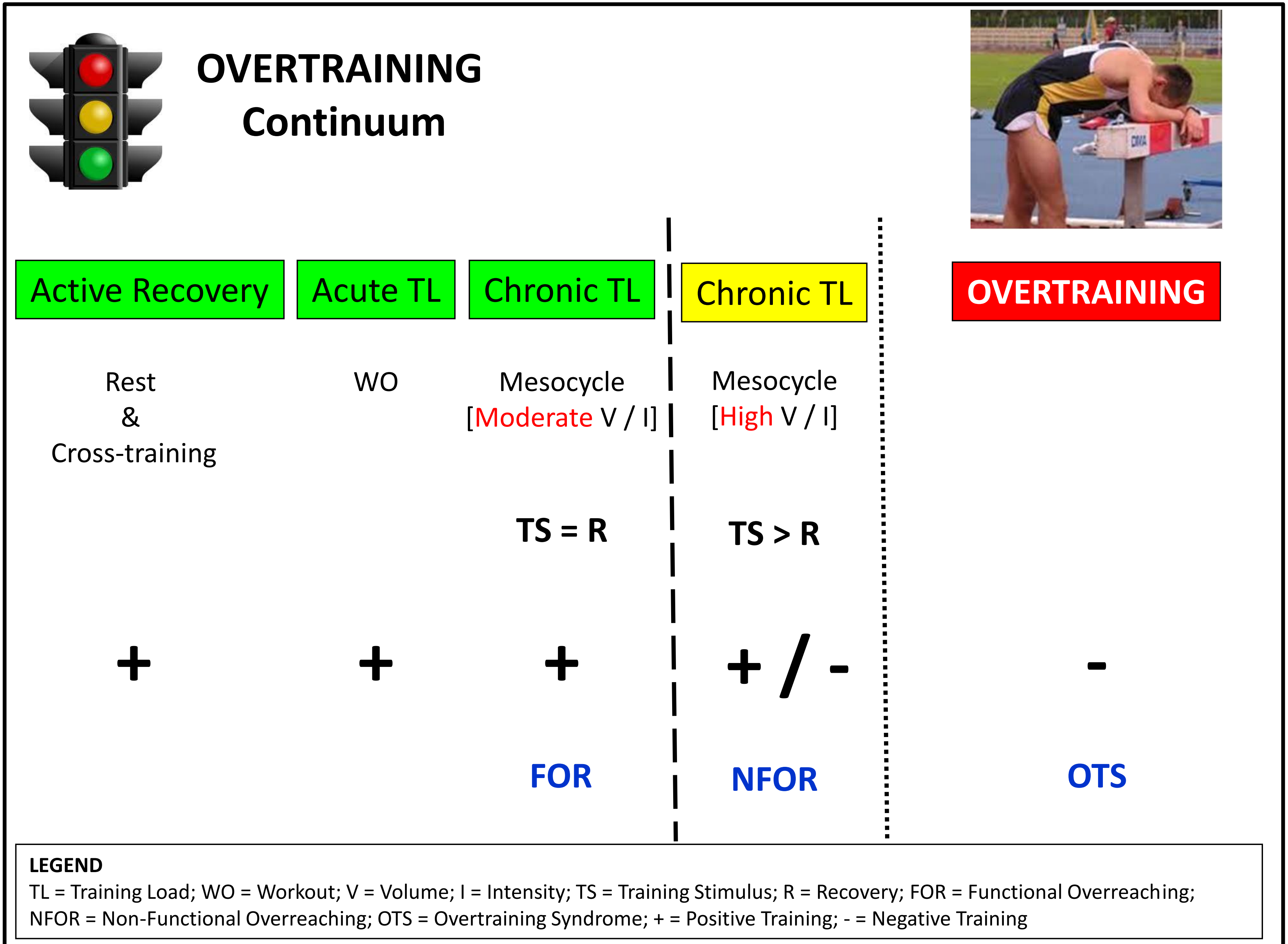

Excessive Musculoskeletal Stress
[2-3 training sessions / day]
+
Insufficient Recovery
[sleep, nutrition, psychological down time]
Chronic Musculoskeletal Inflammation
Pro-Inflammatory Cytokines
IL-6
IL-1β
TNF-α



Pro-Inflammatory Cytokines
IL-6
IL-1β
TNF-α
CNS
HPA axis
HPG axis
visualphotos.com
Hypothalamus
Anterior pituitary
Thyroid
Gonad
Adrenal cortex
Hypothalamus
Anterior pituitary
Thyroid
Gonad
Adrenal cortex
↓ Appetite
Sleep disturbances
Apathy / Depression
↑ Cortisol, E, NE
Immunosuppression
↓ Testosterone, LHRH
↓ Muscle anabolism
↓ Reproductive function

OVERTRAINING
Continuum




OVERTRAINING
Continuum
Active Recovery
Acute TL
Chronic TL
Chronic TL
OVERTRAINING
Rest
&
Cross-training
WO
Mesocycle
[Moderate V / I]
Mesocycle
[High V / I]
TS = R
TS > R
+
+
+
+ / -
-
FOR
NFOR
OTS
LEGEND
TL = Training Load; WO = Workout; V = Volume; I = Intensity; TS = Training Stimulus; R = Recovery; FOR = Functional Overreaching;
NFOR = Non-Functional Overreaching; OTS = Overtraining Syndrome; + = Positive Training; - = Negative Training

SCENARIO 1

"I'm currently under-performing . . . what can I do to get back to 100% before the 2015 season ends?"

ACTION PLAN = Reactive / Therapeutic

1. Comprehensive Health Screen
2. Modify training back to "Active Recovery" Phase
3. Monitor conservative progression from "Active Recovery" back to "Chronic TL"
4. Retroactive inspection of Training Log

SCENARIO 2

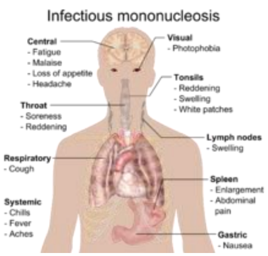
"I think I might have overtrained in 2014 . . . how can I prevent that from happening again in the 2015 season?"

ACTION PLAN = Proactive / Preventive

1. Recognition of OT "risk factors"
2. Robust DB to monitor negative response to "Chronic TL"
3. Meticulous attention to Recovery
4. Execute a scientifically-based taper

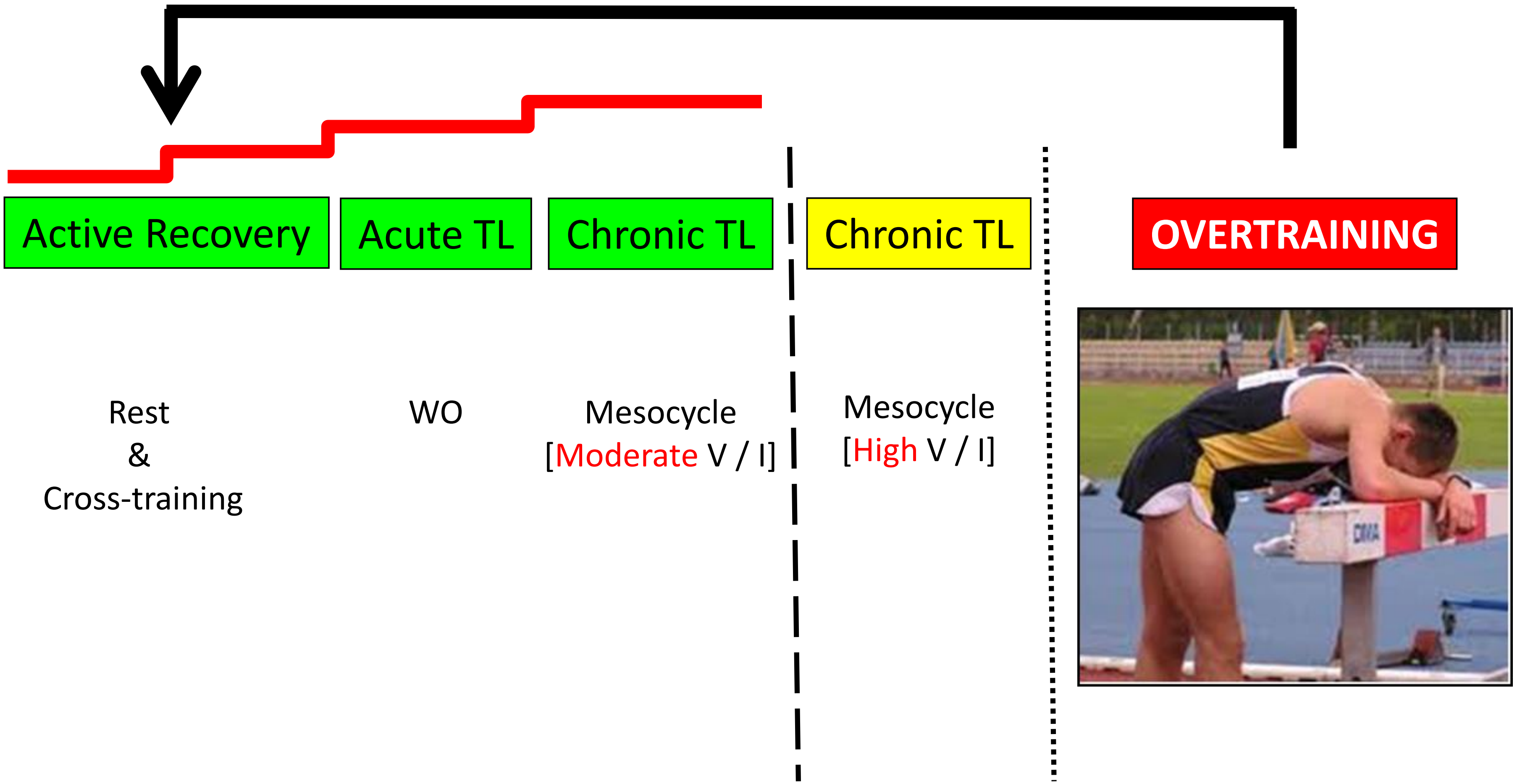
2012

<u>January</u>
Chronic "under performance" reported by Coach and Athlete



<u>February</u>
Diagnosed with IM

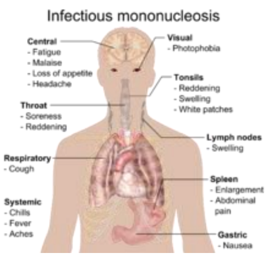
Female
20 yr
2008 Olympian
Modern Pentathlon



Active Recovery
Acute TL
Chronic TL
Chronic TL
OVERTRAINING
Rest
&
Cross-training
WO
Mesocycle
[Moderate V / I]
Mesocycle
[High V / I]

2012

<u>January</u>
Chronic "under performance" reported by Coach and Athlete



<u>February</u>
Diagnosed with IM

<u>June</u>
Resumed normal training

<u>August</u>
4th Place (<1 sec out of Bronze)

<u>September</u>
Junior World Champion: INDIVIDUAL
Junior World Champion: TEAM

Female
20 yr
2008 Olympian
Modern Pentathlon

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IAAF World Youth Championships CALI 2015

SUMMARY

1. Diversification . . . not Specialization

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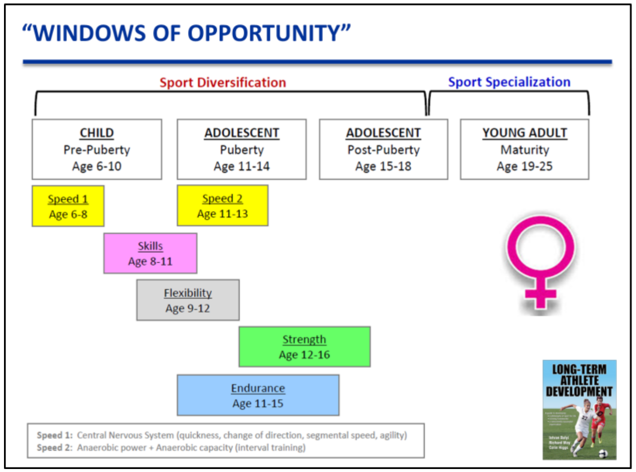
2. Conservative training load (volume, intensity, # days per week)

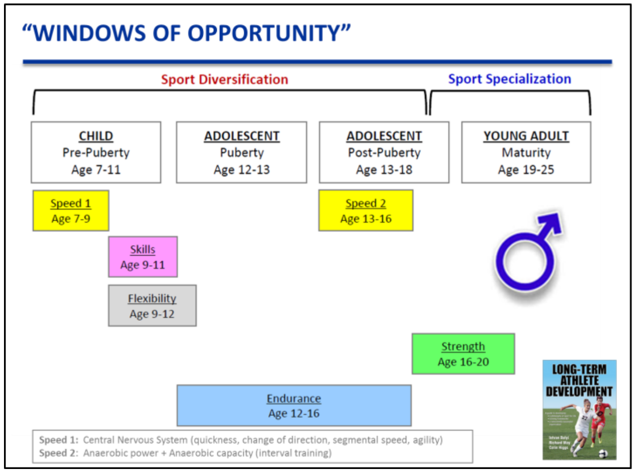
SUMMARY

1. Diversification . . . not Specialization

2. Conservative training load (volume, intensity, # days per week)

3. Female vs Male "windows of opportunity"





SUMMARY

1. Diversification . . . not Specialization

2. Conservative training load (volume, intensity, # days per week)

3. Female vs Male “windows of opportunity”

4. Individual variability in growth/maturation . . . “late bloomers”

SUMMARY

1. Diversification . . . not Specialization

2. Conservative training load (volume, intensity, # days per week)

3. Female vs Male "windows of opportunity"

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5. Strategies for injury prevention

SUMMARY

1. Diversification . . . not Specialization
2. Conservative training load (volume, intensity, # days per week)
3. Female vs Male "windows of opportunity"
4. Individual variability in growth/maturation . . . "late bloomers"

5. Strategies for injury prevention
6. Focus on LT skill development vs ST "instant gratification" in performance

SUMMARY

1. Diversification . . . not Spe


Coach Bob Larsen

2. Conservative training loa

3. Female vs Male “windows of opportunity”

4. Individual variability in growth/maturation . . . “late bloomers”

5. Strategies for injury prevention

6. Focus on LT skill development vs ST “instant gratification” in performance

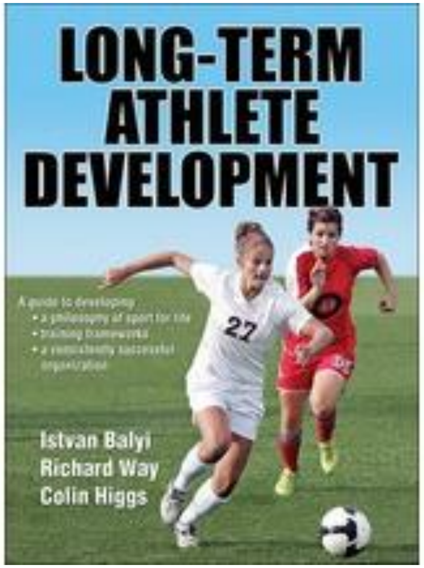
7. FUN . . . nurture that original “passion”

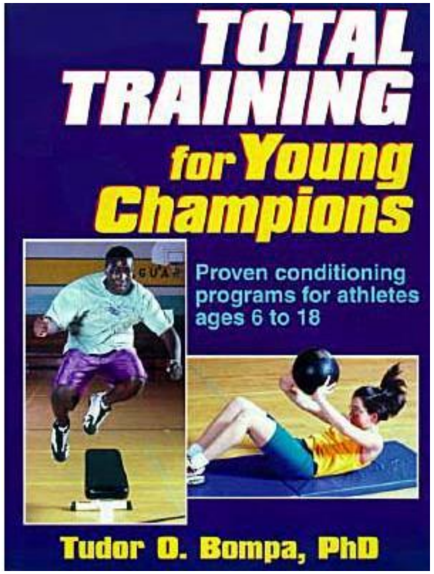

Athens 2004

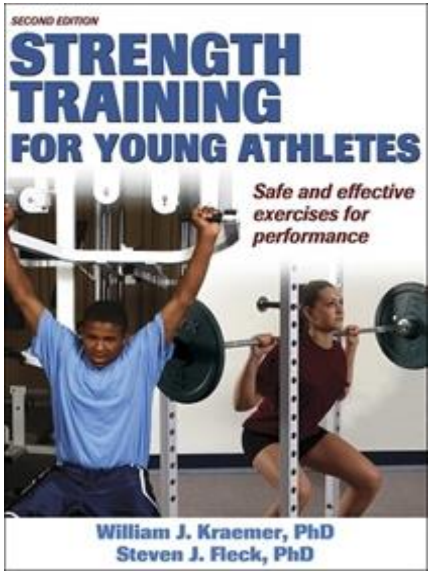

NYC 2009

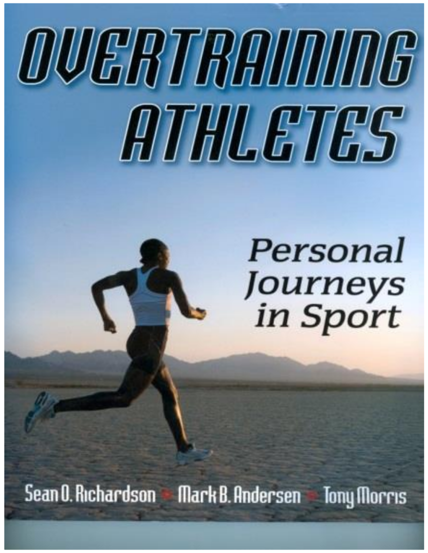

Boston 2014

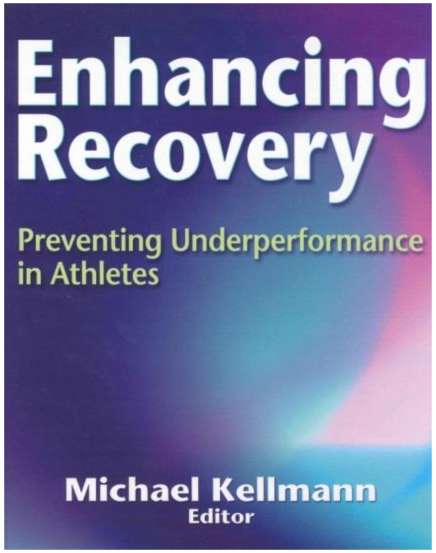
RESOURCES

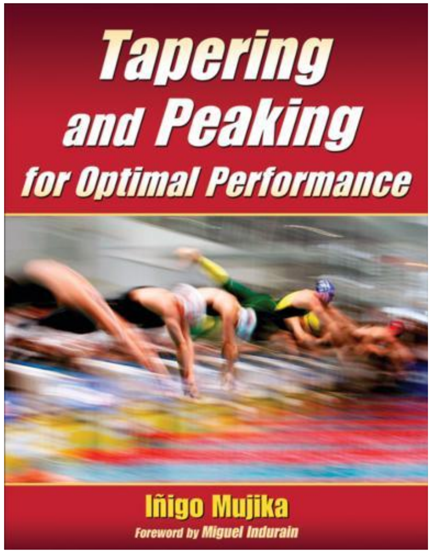

LONG-TERM ATHLETE DEVELOPMENT
Istvan Balyi
Richard Way
Colin Higgs

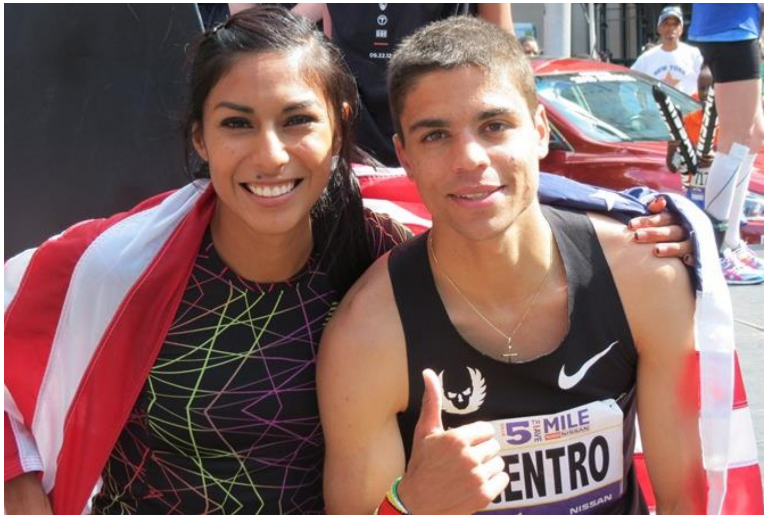

TOTAL TRAINING for Young Champions
Proven conditioning programs for athletes ages 6 to 18
Tudor O. Bompa, PhD


SECOND EDITION
STRENGTH TRAINING FOR YOUNG ATHLETES
Safe and effective exercises for performance
William J. Kraemer, PhD
Steven J. Fleck, PhD


OVERTRAINING ATHLETES
Personal Journeys in Sport
Sean O. Richardson
Mark B. Andersen
Tony Morris


Enhancing Recovery
Preventing Underperformance in Athletes
Michael Kellmann
Editor


Tapering and Peaking for Optimal Performance
Iñigo Mujika
Foreword by Miguel Indurain



QUESTIONS?

Brenda Martinez
800 m
Bronze
MOSCOW 2013

Matthew Centrowicz
1500 m
Silver
MOSCOW 2013

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