Studying in Oxford

Oxford Location – United Kingdom

Oxford - Transport Links

The distance from London to Oxford is about 60 miles (∼96 km)

Oxford – The City of Dreaming Spires

Oxford – Environs

Oxford Waterways

Oxford View – South Parks

Oxford – Environs

Cricket – University Parks

Punting – River Thames
Oxford– Cosmopolitan City

Pitt Rivers Museum

City Centre – The High Street

School of Life Sciences

Oxford– Cosmopolitan City

Bridge of Sighs

Broad Street

School of Life Sciences

Gipsy Lane Campus

School of Life Sciences

Gipsy Lane Campus

School of Life Sciences

Total student numbers 18,727

Undergraduate 73%

Postgraduate 24%

Research 2%

Cell and Molecular Biology

Environmental Biology

Human Biosciences

Lecture and associated practical programmes

School of Life Sciences

Campus Facilities

School of Life Sciences

Halls of Residence

Centre for Sport
Concepts in Sports Nutrition

Dr Roger Ramsbottom
School of Life Sciences
Oxford Brookes University

Sources of energy (ATP) supply

1) ATP (5 mmoL ATP kg⁻¹)
   ATP = ADP + Pi + free energy

2) PCr phosphocreatine
   (15 mmoL ATP kg⁻¹)
   PCr + ADP = creatine + ATP

3) glycogen (muscle) or glucose (blood) to lactate
   Glycogen or glucose + Pi + ADP = lactate + ATP

4) glycogen or glucose oxidation and free fatty acid oxidation
   Glycogen and FFA + Pi + ADP + O₂ = CO₂ + H₂O + ATP

Rates of energy (ATP) supply during exercise

- ATP 11.2 mmoL kg⁻¹ dy wt s⁻¹
- PCr 8.6 mmoL kg⁻¹ dy wt s⁻¹
- Glycogen to lactate 5.2 mmoL kg⁻¹ dy wt s⁻¹
- Glycogen to CO₂ and H₂O 2.2 mmoL kg⁻¹ dy wt s⁻¹
- Glucose to CO₂ and H₂O 0.95 mmoL kg⁻¹ dy wt s⁻¹

Estimated energy stores of fat and carbohydrate

<table>
<thead>
<tr>
<th>Substrate</th>
<th>Weight (kg)</th>
<th>Energy (kcal)</th>
<th>Energy (MJ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbohydrate</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plasma glucose</td>
<td>0.02</td>
<td>78</td>
<td>0.33</td>
</tr>
<tr>
<td>Liver glycogen</td>
<td>0.1</td>
<td>388</td>
<td>1.62</td>
</tr>
<tr>
<td>Muscle glycogen</td>
<td>0.4</td>
<td>1550</td>
<td>6.49</td>
</tr>
<tr>
<td>Total (approx.)</td>
<td>0.52</td>
<td>2000</td>
<td>8.38</td>
</tr>
<tr>
<td>Fat</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plasma fatty acid</td>
<td>0.0004</td>
<td>4</td>
<td>0.02</td>
</tr>
<tr>
<td>Plasma triglycerides</td>
<td>0.004</td>
<td>39</td>
<td>0.16</td>
</tr>
<tr>
<td>Adipose tissue</td>
<td>12.0</td>
<td>100,000</td>
<td>418.60</td>
</tr>
<tr>
<td>Intramuscular triacylglycerols</td>
<td>0.3</td>
<td>2616</td>
<td>10.95</td>
</tr>
<tr>
<td>Total (approx.)</td>
<td>12.3</td>
<td>106,500</td>
<td>445.81</td>
</tr>
</tbody>
</table>

Values given are estimates for a ‘normal’ man of 80 kg and 15% body fat and not those of an athlete, who might be leaner and have more stored glycogen.

Composition of a Normal Diet

- 55% to 60% carbohydrate (60% for physically active people, up to 70% during heavy training)
- Less than 30% fat (less than 10% saturated)
- 10% to 15% protein
Importance of a high CHO diet

- Muscle glycogen contributes 3-5 more energy compared with blood glucose during prolonged submaximal exercise.
- A CHO deficient diet rapidly depletes muscle and liver glycogen and negatively affects performance in short-term, anaerobic and prolonged high-intensity (>75% VO₂max) aerobic activities.

Muscle fibre activation during exercise

- Biopsy of the vastus lateralis muscle immediately after a 30-s all-out treadmill sprint.

Muscle fibre recruitment during intense exercise

- HLA → H⁺ + LA⁻
- NaHCO₃ → Na⁺ + HCO₃⁻
- H⁺ + HCO₃⁻ → H₂CO₃
- H₂CO₃ → H₂O + CO₂
- CH₃CO.COO⁻ + NADH + H⁺ = CH₃CH(OH)COO⁻ + NAD⁺
Comparison of fat and carbohydrate as an energy source

<table>
<thead>
<tr>
<th></th>
<th>Carbohydrate</th>
<th>Fat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy stored (approx.)</td>
<td>8 MJ</td>
<td>450 MJ</td>
</tr>
<tr>
<td>Storage medium</td>
<td>Hydrated (glycogen)</td>
<td>Dry (triglyceride)</td>
</tr>
<tr>
<td>Storage location</td>
<td>Muscle, liver</td>
<td>Adipose tissue</td>
</tr>
<tr>
<td>Energy content per gram*</td>
<td>17.3 kJ g⁻¹</td>
<td>39.3 kJ g⁻¹</td>
</tr>
<tr>
<td>Energy**</td>
<td>32 ATP</td>
<td>120 ATP</td>
</tr>
<tr>
<td>O₂ needed for complete oxidation</td>
<td>6 mol O₂ per mol of substrate</td>
<td>26 mol O₂ per mol of substrate</td>
</tr>
<tr>
<td>Mol ATP generated per mol O₂</td>
<td>6.33</td>
<td>5.65</td>
</tr>
<tr>
<td>Rate of utilisation</td>
<td>Very rapid</td>
<td>Limited</td>
</tr>
</tbody>
</table>

*mean value for CHO rich in starch and poor in sugar; mean value for average fat.
**CHO, 6 Carbon glucose molecule; fat, 18 Carbon fatty acid molecule

Dietary CHO and Glycogen Concentration

Tour du France: then and now

<table>
<thead>
<tr>
<th>Period</th>
<th>1903-1909</th>
<th>1985-2002</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance (km)</td>
<td>3695 ± 1026</td>
<td>3764 ± 297</td>
</tr>
<tr>
<td>Winning time (h)</td>
<td>137 ± 36</td>
<td>97 ± 9</td>
</tr>
<tr>
<td>No. stages</td>
<td>11 ± 4</td>
<td>21 ± 1</td>
</tr>
<tr>
<td>Speed (km h⁻¹)</td>
<td>26.9 ± 1.8</td>
<td>38.8 ± 1.2</td>
</tr>
<tr>
<td>Participants</td>
<td>91 ± 32</td>
<td>192 ± 9</td>
</tr>
<tr>
<td>Finishers (%)</td>
<td>33 ± 7</td>
<td>72 ± 8</td>
</tr>
<tr>
<td>Time difference between first and last (h)</td>
<td>84 ± 26</td>
<td>4 ± 1</td>
</tr>
</tbody>
</table>

1985 onwards introduction of modern bicycle equipment e.g. clip on pedals, aerodynamic wheels


Astrand’s Glycogen Loading Protocol

- Complete an exhaustive training bout 7 days before the event
- Eat fat and protein for next 3 days and reduce training load (increases glycogen synthase activity)
- Eat a CHO-rich diet for remaining 3 days before event and reduce training load; because of increased glycogen synthesis, more glycogen is stored
Sherman’s Glycogen Loading Protocol

- 7 days before competition:
  - Reduce training intensity
  - Eat a normal, healthy mixed diet with 55% CHO
- 3 days before competition:
  - Reduce training to daily warm-up of 10-15 minutes
  - Eat a CHO-rich diet

Glycogen Loading or ‘Supercompensation’

- Glycogen depletion (exercise)
- Glycogen restored at higher concentration than before exercise
- Glycogen levels not affected in inactive muscles
- Glycogen levels can determine endurance time
  - Direct correlation between amount of glycogen in muscle and duration of exercise.

CHO and recovery

- Goal: to replete glycogen stores
- Eat high Glycemic Index CHO containing foods
- Can be done with proper diet
  - 10g CHO/kg body weight (hard workout)
- Timing of intake
  - Immediately and every 30 min for 5 hours
    - 1-1.2g CHO/kg body weight per hour
  - 15 min post-exercise
    - 50-100g CHO, 10-20g Protein

Fat and Aerobic Training

- Aerobic training increases long-chain fatty acid oxidation, primarily fatty acids from triglycerides within active muscle, during mild to moderate intensity exercise
- Enhanced fat oxidation spares glycogen, allowing trained individuals to exercise at a higher absolute level of submaximal exercise before experiencing the fatiguing effects of glycogen depletion, compared with untrained counterparts
Effect of training on lactate release, uptake of FFA, RQ and RER

Responses at the same absolute and relative work rates in humans

Endurance exercise capacity increased by 283 minutes with training or 239%
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Undergraduate Degree Programmes in the Sport and Exercise Sciences

Exercise, Nutrition and Health
single and combined honours

Sports Science
single and combined honours

Sport and Exercise Science
single and combined honours

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Common First Year

- Human Physiology
- Cell Physiology
- Exercise Physiology and Nutrition
- Human Energy Systems
- Human Anatomy
- Science Skills
- Advanced (2nd and 3rd year) Studies

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Fundamentals of Exercise Physiology and Nutrition – Year 1

$V_{O2}$ and $Q$ (L min$^{-1}$)

Blood lactate (mmol L$^{-1}$)

Increase in exercise intensity

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Sports Science u/g Programme

First Year Core

- Sports Performance: Physiology and Assessment

Sport-related options

Physiology-related options

Advanced and Applied Honours Level Studies

Research or Practice-based

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Sports Performance: Physiology and Assessment – Year 2

Rate of glycogen depletion (mmol L$^{-1}$ kg$^{-1}$)

Exercise intensity ($V_{O2\max}$)

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Exercise, Nutrition and Health u/g Programme

First Year Core

- Physical Activity and Health

Health/Exercise Options

Applied Human Nutrition

Nutrition Options

Advanced and Applied Honours Level Studies

Research or Practice-based

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Physical Activity and Health Module - Year 2

Relative Risk

Fitness Category

Total Cholesterol (mmol/L)

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Sport and Exercise Science (years 2 and 3)

First Year Core

Sports Performance: Physiology and Assessment

Physical Activity and Health

Sport-related options

Physiology-related Options

Health/Exercise Options

Advanced and Applied Honours Level Studies: Research or Practice-based

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Sports Training Programmes – Year 3

Mesocycle Mesocycle

Technique

In season Maintenance Active rest Active rest

Spring training

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Exercise Prescription – Year 3

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Applied and Research Orientated Modules

Alpine Fieldwork in Exercise Science

Monitoring fitness, energy intake and expenditure on a 7-day mountain trek

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Project work

Comparison of ventilation thresholds in well-trained compared with recreationally active cyclists

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Common Links with Related Courses

School of Life Sciences
Features of the Programmes

• Student orientated staff
• Rigorous underpinning science
• Flexibility
• Wide variety of practical work
• Opportunities to shape an individual degree programme (e.g. by taking research or practice-based modules)
• Possibility of working with elite athletes or special populations
• Links with other Institutions

School of Life Sciences

Research Activity

Exercise Science
- Physiological adaptations to mountain walking
- Health and fitness benefits of community walks
- Effects of community exercise classes on functional ability in older people
- Rehabilitation strategies for improving gait in stroke and brain-injured patients

Sports Science
- Research and physiological monitoring in a range of sports:
  - Football
  - Rugby
  - Cricket
  - Rowing
  - Running
  - Cycling

Clinical Trials
- Exercise capacity in elderly growth hormone deficient patients
Postgraduate Degree Programme in the Sport and Exercise Sciences

Applied Sport and Exercise Nutrition
MSc / PGDip / PGCert

Fundamentals of Exercise Physiology and Nutrition – Year 1

Sports Performance: Physiology and Assessment – Year 2

Sports Training Programmes – Year 3

Exercise Prescription – Year 3


- Muscular strength and endurance, body composition, and flexibility:

- Resistance training: sufficient intensity to enhance strength, muscular endurance, and maintain fat-free mass. Progressive, individualized and providing a stimulus to all the major muscle groups. (One set of 8-10 exercises that conditions the major muscle groups, 2-3 d w-1 is recommended).

- Flexibility training: to develop and maintain range of motion.

- Static and dynamic exercises to stretch the major muscle groups (2-3 d w-1).

The primary aim of the exercise programme was to improve power in the lower limb muscles, balance and functional mobility.

Emphasis was placed on the mobility and flexibility of the pectoral and pelvic girdles and joint mobility and flexibility.

The main focus was to strengthen and develop power in the shoulder and hip abductors, adductors, flexors and extensors, and knee flexors and extensors.

Classes were held twice weekly for 24 weeks.


Non-linear analysis of cardiac autonomic control in physically active healthy young women

Roger Ramsbottom, Katie-Jane Hackett, Michael Gilder
School of Life Sciences
Oxford Brookes University

Heart Rate Variability

R-R Interval

Different Heart Rate Variability in two subjects with similar Heart Rate

SDNN: Standard deviation of the R-R interval in seconds.
Long-term control of HRV
RMSSD: Square root of the mean of the squares of successive R-R interval differences
Short-term control of HRV

Time Domain

Frequency Domain Analysis

Autoregression analysis

Poincaré plots

Quantitative measures:
SD1: Short-term HRV (SD of plot data along axis A)
SD2: Long-term HRV (SD of plot data along axis B)
SD12: (Poincaré dimension) Quantitative description of entire plot

Poincaré plots: Congestive Heart Failure

Plot shape indicates cardiac health status (Woo et al. 1992)

Plasma NA:
Normal range: 150-300 pg mL⁻¹

Normal range: 244 pg mL⁻¹

NA: 750 pg mL⁻¹

Poincaré plots: Overtraining

Plot shape indicates overtraining syndrome (Mourot et al. 2004)

Trained Overtrained 1 Overtrained 2
Subjects

- Highly active group (Competitive rowers): Physical activity on > 3 occasions a week for a duration of > 1 hour per session
- Moderately active group (Non-rowers): Physical activity at least once a week for a duration of > 30 minutes per session

<table>
<thead>
<tr>
<th>Activity level</th>
<th>n</th>
<th>Mean Supine Heart Rate (b min	extsuperscript{-1})</th>
<th>Age (years)</th>
<th>Body Mass (kg)</th>
<th>Height (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moderate</td>
<td>10</td>
<td>73 (s=10)</td>
<td>23.5 (s=1.5)</td>
<td>64.8 (s=3.9)</td>
<td>1.69 (s=0.03)</td>
</tr>
<tr>
<td>High</td>
<td>10</td>
<td>59* (s=5)</td>
<td>22.8 (s=1.5)</td>
<td>67.1 (s=2.0)</td>
<td>1.69 (s=0.01)</td>
</tr>
</tbody>
</table>

*P<0.01

Method: Measurement of Heart Rate Variability

No caffeine containing drinks and food for preceding 3 hours
No alcohol or vigorous exercise for preceding 24 hours

Results: Supine

20 minutes of supine rest

<table>
<thead>
<tr>
<th>SUPINE (mean)</th>
<th>R-R (s)</th>
<th>SDNN (s)</th>
<th>LF (n.u.)</th>
<th>HF (n.u.)</th>
<th>LF/HF</th>
<th>SD1 (ms)</th>
<th>SD2 (ms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MA</td>
<td>0.84</td>
<td>0.06</td>
<td>38.8</td>
<td>42.6</td>
<td>1.04</td>
<td>41.5</td>
<td>91.2</td>
</tr>
<tr>
<td>HA</td>
<td>1.03**</td>
<td>0.09</td>
<td>47.5</td>
<td>33.0</td>
<td>1.68</td>
<td>69.9*</td>
<td>124.6*</td>
</tr>
</tbody>
</table>

*P<0.05; **P<0.01

Results: Standing

5 minutes of standing

<table>
<thead>
<tr>
<th>STAND (mean)</th>
<th>R-R (s)</th>
<th>SDNN (s)</th>
<th>LF (n.u.)</th>
<th>HF (n.u.)</th>
<th>LF/HF</th>
<th>SD1 (ms)</th>
<th>SD2 (ms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MA</td>
<td>0.66</td>
<td>0.05</td>
<td>59.3</td>
<td>25.0</td>
<td>3.9</td>
<td>20.2</td>
<td>76.6</td>
</tr>
<tr>
<td>HA</td>
<td>0.86*</td>
<td>0.08*</td>
<td>59.0</td>
<td>26.8</td>
<td>8.1</td>
<td>43.6*</td>
<td>126.9**</td>
</tr>
</tbody>
</table>

*P<0.05; **P<0.01

Conclusion

- Differences in Heart Rate Variability may exist between women possessing different levels of physical activity
- Poincaré analysis may provide an alternative technique for investigating HRV compared with time domain and frequency domain analysis


Future work

- Better quantitative descriptors of the qualitative non-linear Poincaré plot are required (Brennan et al., 2001).

Acknowledgements

HRV Analysis Software

Biomedical Analysis and Medical Imaging Group
Professor Pasi Karjalainen
Juha-Pekka Niskanen
Poincaré plots

"[Autonomic control of HRV] may behave as a nonlinear system and give rise to complex phenomena that superficially appear to be random and may elude detection by linear analytic techniques.

The nonlinear technique of Poincaré plot analysis can indicate levels of organisation not readily apparent from standard deviation or spectral methods of heart rate variability analysis"

Woo et al. 1992

Poincaré plots: Overtraining

Altered Poincaré plot shape in overtrained athletes (Mourot et al. 2004)