Nutrition and Metabolism in Sport

SSS-2-993

Level 2

FACULTY OF SCIENCE, ENGINEERING AND BUILT ENVIRONMENT

2004/2005
Semester 2

CONTENTS

Unit Title	Nutrition and Metabolism in Sport
Reference Number	SSS-2-993
Level of Study	2
Credit Value	1
Semester	1
Subject Area	SAS4 Human and Exercise Science
Student Study Hours	150 hours, of which 45 will be direct class contact time and the remainder private study
Pre-Requisite Units	Introduction to Nutrition (Level 1)
Assessment Method	60% examination, 40% coursework
Unit Co-ordinator	Dr Mike Hibbs
Teaching team	Gavin Sandercock, Dr Vassiliki Costarelli
Courses	BSc (Hons) Sports and Exercise Science

Contact Details

Name	Room	Phone	e-mail
Gavin Sandercock			gsande01@bcuc.ac.uk
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1. Introduction

The unit will provide an understanding of the metabolic process involved in physical training. Emphasis will be given to the application of the core principles of nutrition and metabolic biochemistry to health, fitness, sport and exercise.

2. Aims

- To introduce the students to the metabolic processes of energy provision in the body and to illustrate the effects of different types of training on these processes.
- To develop an appreciation of the important links between exercise, energy needs and organ-specific energy generation and utilization.
- To introduce the methods available for the measurement of body composition and nutritional status and how these may be applied in sport, exercise and health.
- To review nutrient intake methodologies and the use of dietary standards and their relevance to nutritional support in sport.
- To investigate the relationships between nutrition, lifestyle, exercise, health and risk of disease.

3. Learning Outcomes

- Demonstrate a clear understanding of the relationship between cellular nutrition, energy balance and fuel utilization during exercise.
- Devise suitable regimens and strategies for the assessment of nutritional status of different groups and individuals.
- Demonstrate practical skills in the measurement of energy balance and body composition in health, fitness and exercise.
- Evaluate the role of nutrition in, and recommend strategies for the promotion of good health through the right combination of adequate nutrition and exercise.
- Demonstrate an understanding of the concepts required in order to appreciate the nutritional needs of athletes.

4. Key and Cognitive Skills

During this unit, students will be given the opportunity to improve their laboratory, IT, numeracy and communication skills, both written and verbal. In addition they should be able to critically evaluate the current research methodologies used in the field of sports nutrition.

5. Teaching and Learning Patterns

This unit will consist of a 2 hour lecture weekly and one-hour weekly student-led seminar/tutorial sessions. Three sessions of practicals, of three hours duration, will support the theoretical program.

6. End of Unit Review – your feedback is valuable.

It is University policy to obtain student feedback at the end of each unit. This is carried out using a standard form that should be completed and returned in a way that should maintain your anonymity. The results of the tick-box responses and any additional commentary are presented and discussed at the Subject Area Review & Planning Meetings that are held twice per year. Should it be required, members of staff at these meetings agree to modify aspects of unit delivery and assessment for the next time that the unit will be presented (usually for the following year).

7. Weekly Teaching and Learning Programme

Summary of weekly lecture programme (Fridays from 14.00-17.00pm)

Week no.	Date	Room	Topic	Lecturer
19	04/02/05	B466	Introduction to the Unit Introduction to Bioenergetics	Gavin Sandercock
20	11/02/05	B466	Energy Metabolism	Gavin Sandercock
21	18/02/05	B466	Catabolism: Carbohydrate, Fat and Protein Metabolism	Gavin Sandercock
22	25/02/05	B466	Anabolism: Carbohydrate, Fat and Protein Metabolism	Gavin Sandercock
23	04/03/05	B466	Body Composition and Nutritional Status Measurement of nutrient intake and energy requirements	Vassiliki Costarelli
24	11/03/05	B466	Energy Balance Measurement of energy expenditure	Gavin Sandercock
25	18/03/05	B466	Metabolism during and in Recovery from Exercise	Gavin Sandercock
29	15/04/05	B466	Metabolic adaptations to training	Gavin Sandercock
30	22/04/05	B466	Macronutrient and Energy Requirements for Optimal Sports Performance	Gavin Sandercock
31	29/04/05	B466	Micronutrient and Fluid Requirements for Optimal Sports Performance	Gavin Sandercock
32	06/05/05	B466	Nutrition, Physical Activity and "The Health of the Nation"	Gavin Sandercock
33	13/05/05	B466	Workshop: Nutrition, lifestyle, physical activity, fitness and performance	Gavin Sandercock
34	20/05/05	B466	Revision Tutorial	Gavin Sandercock
35			Exams	
36			Exams	

Week 19 **Introduction to the unit; Introduction to bioenergetics**

Learning Mode

Lecture

Content

- Review of the unit – aims and learning outcomes, approaches to teaching and learning, introduction to the teaching team.
- Revision of last year's lecture on energy (Introduction to Nutrition, level 1).
- Energetics – Free energy, ATP, coupled reactions, biological energy and its transformation.

Follow-up reading

- Houston ME (1995) *Biochemistry Primer for Exercise Science* Human Kinetics (Chapter 6).
- Powers SK & Howley ET (1990) *Exercise Physiology: Theory and Application to Fitness and Performance* WC Brown (Chapter 3).
- Robergs, R.A.and Roberts, S.O. *Exercise Physiology* Mosby (Chapter 2)

Preparation for week 2

Revise lecture notes on energy metabolism from "Introduction to Nutrition" level 1

Week 20 **Energy Metabolism**

Learning Mode

Lecture and tutorial support

Content

- glycolysis
- TCA cycle
- oxidative phosphorylation.

Students will not be expected to memorize the full chemical structures of metabolic intermediates and coenzymes.

Follow-up reading

- Houston ME (1995) *Biochemistry Primer for Exercise Science* Human Kinetics (Chapters 8,9).
- Robergs, R.A.and Roberts, S.O. *Exercise Physiology* Mosby (p 59 – 84)

Preparation for week 3

- Robergs, R.A.and Roberts, S.O. *Exercise Physiology* Mosby (Chapter 4)

Week 21 **Catabolism: Carbohydrate, Fat and Protein Metabolism**

Learning Mode

Lecture and tutorial support

Content

- Pathways of carbohydrate metabolism
- Glycemic index
- Fat catabolism, □-oxidation, ketone body formation
- Protein breakdown, amino acid catabolism: transamination & anaplerosis

Students will not be expected to memorize the full chemical structures of metabolic intermediates and coenzymes.

Follow-up reading

- Houston ME (1995) *Biochemistry Primer for Exercise Science* Human Kinetics ().
- Powers SK & Howley ET (1990*) Exercise Physiology: Theory and Application to Fitness and Performance* WC Brown ().
- Robergs, R.A.and Roberts, S.O. *Exercise Physiology* Mosby (Chapter 4)

Preparation for week 4

Robergs, R.A. and Roberts, S.O. *Exercise Physiology.* Mosby (Chapter 5)

Week 22 **Anabolism: Carbohydrate, Fat and Protein Metabolism**

Learning Mode

Lecture and tutorial support

Content

- Hepatic and skeletal muscle glycogen synthesis
- Lipogenesis, fat deposition
- Protein synthesis, transcription and translation

Follow-up reading

Robergs, R.A. and Roberts, S.O. *Exercise Physiology.* Mosby (Chapter 5)

Preparation for week 5

Garrow, J.S. and James, W.P.T. (1993). *Nutrition and Dietetics* Churchill and Livingstone (Chapter 2)

Thomas Brion, BDA (1994) Manual of Dietetics in Practice Blackwell Science Ltd (Chapters 1.2, 1.3 and 1.6).

Week 23 **Body composition and nutritional status**
Measurement of Nutrient Intake and Energy Requirement

Learning Mode

Lecture and tutorial support

Content

- Definitions of body composition and nutritional status
- Methods available for the estimation of body composition
- Does body composition affect sports performance?
- Dietary survey methodologies; recall methods, diet histories, inventory methods, diet computation.

Follow-up reading

- Powers SK & Howley ET (1990) *Exercise Physiology: Theory and Application to Fitness and Performance* WC Brown (Chapters 3,4).
- Katch FI & McArdle WD (1993) *Introduction to Nutrition, Exercise and Health* Lea and Febiger (Chapters 4,5,6).
- Roche AF, Heymsfield SB, Lohman TG (1996). *Human Body Composition.* Human Kinetics (Chapters 11,12,13).
- Garrow JS and James WPT (1993). *Nutrition and Dietetics* Churchill and Livingstone (Chapter 2)

Preparation for week 6

- McArdle WD, Katch FR, Katch VL (1996). *Exercise Physiology* Williams and Wilkins (Chapter 18)

Week 24 Energy Balance

Measurement of energy expenditure

Content

- Calorie content of foods.
- Energy balance
- Regulation of energy intake: glucostatic theory, leptin
- Energy requirements during exercise
- Direct and indirect calorimetry, basal metabolic rate, prediction equations.

Follow-up reading

- Houston ME (1995) *Biochemistry Primer for Exercise Science* Human Kinetics (Chapters 10,13).
- Powers SK & Howley ET (1990) *Exercise Physiology: Theory and Application to Fitness and Performance* WC Brown (Chapters 3,4).
- Katch FI & McArdle WD (1993) *Introduction to Nutrition, Exercise and Health* Lea & Febigen (Chapters 4,5,6).
- Roche AF, Heymsfield SB, Lohman TG (1996). Human Body Composition. Human Kinetics (Chapters 11,12,13).
- Garrow JS and James WPT (1993). *Nutrition and Dietetics* .Churchill and Livingstone (Chapter 3)

Preparation for week 7

- Robergs, R.A.and Roberts, S.O. *Exercise Physiology* Mosby (Chapter 10)

Week 25 Metabolism during and in Recovery from Exercise

Learning Mode

Lecture and tutorial support

Content

- Energy sources during exercise: effect of duration and intensity of exercise
- Recovery processes: glycogen resynthesis, rehydration, remodeling
- Effect of nutrition

Follow-up reading

- Houston ME (1995) *Biochemistry Primer for Exercise Science* Juman Kinetics (Chapters 10,13).
- Powers SK & Howley ET (1990) *Exercise Physiology: Theory and Application to Fitness and Performance* WC Brown (Chapters 3,4).
- Katch FI & McArdle WD (1993) *Introduction to Nutrition, Exercise and Health* Lea and Febigen (Chapters 4,5,6).

Further reading for ambitious students:

- Maughan R, Gleeson M, Greenhatt PL (1997) *Biochemistry for Exercise Training* Oxford University Press (Chapters: 1.1, 1.2)
- Maughan, R.J. (2000) *Nutrition in Sport*. London, Blackwell Science Ltd. (Chapter 2)

Preparation for week 8

- Wilmore JK, Costill DL (1994). *Physiology of Sport and Exercise* Human Kinetics (Chapter 7).
- Robergs, R.A.and Roberts, S.O. *Exercise Physiology* Mosby (Chapter 10)

Week 26 Metabolic Adaptations to Training

Learning Mode

Lecture and tutorial support

Content

- Effect of endurance training upon metabolism:
- Muscle fibre type
- Capillarisation
- Fuel selection and utilization.
- Organ specific substrate utilization during exercise.
- Role of hormones/adrenaline.

Follow-up reading

- Houston ME (1995) *Biochemistry Primer for Exercise Science* Human Kinetics (Chapters 7,12).
- Powers SK & Howley ET (1990) *Exercise Physiology: Theory and Application to Fitness and Performance* WC Brown (Chapters 3,4).
- Katch FI & McArdle WD (1993) *Introduction to Nutrition, Exercise and Health* Lea & Febigen (Chapters 4,5,6).

Further reading for ambitious students:

- Maughan R, Gleeson M, Greenhatt PL (1997) *Biochemistry for Exercise Training* Oxford University Press (Chapters: 1.9)

Preparation for week 9

- Brouns F (1993): *Nutritional Needs of the Athlete* John Wiley (Chapter 3,4)
- Robergs, R.A.and Roberts, S.O. *Exercise Physiology* Mosby (Chapter 17)

Week 27 Macronutrient and Energy Requirements for Optimal Sports Performance

Learning Mode

Lecture and tutorial support

Content

- Carbohydrate, protein and fat requirements
- Effect of training upon macronutrient requirements
- Optimising performance with nutrition

Follow-up reading

- Department of Health (1991). *Dietary Reference Values* No. 41 HMSO.
- Bean Anita (1996). *The Complete Guide to Sports Nutrition* BLACK(Chapter 2,3,7).
- McArdle WD, Katch FR, Katch VL (1996). *Exercise Physiology* Williams and Wilkins (Chapter 1).
- Williams C and Devlin JT (1992). *Food, Nutrition and Sports Performance* (Chapter 2,3).

Preparation for week 10

- Maughan, R.J. (2000) *Nutrition in Sport*. London, Blackwell Science Ltd. (Chapters 15 – 17, 20 – 25)
- Robergs, R.A.and Roberts, S.O. *Exercise Physiology* Mosby (Chapter 17)

Week 28 **Micronutrient and Fluid Requirements for Optimal Sports Performance**

Learning Mode

Lecture and tutorial support

Content

- Biochemical roles of vitamins and minerals.
- Vitamin and mineral requirements for athletes
- Is there an ergogenic role for vitamins and minerals?
- Fluid balance

Follow-up reading

- Maughan, R.J. (2000) *Nutrition in Sport*. London, Blackwell Science Ltd. (Chapters 15 – 17, 20 – 25)
- Robergs, R.A.and Roberts, S.O. *Exercise Physiology* Mosby (Chapter 17).

Preparation for week 11

- Department of Health (1998). *Our Healthier Nation* HMSO
- Department of Health (1999). Saving Lives: Our Healthier Nation *HMSO*, London
- McArdle WD, Katch FR, Katch VL (1996). *Exercise Physiology* Williams and Wilkins (Chapter 29,30)

Week 32 Nutrition, Physical Activity and "The Health of the Nation"

Learning Mode

Lecture and tutorial support

Content

- "Health of the Nation's" objectives and targets
- Determinants of risk of coronary heart disease, obesity, diabetes mellitus, osteoporosis.
- The role of an active life style in achieving the "Health of the Nation's" targets.

Follow-up reading

- Department of Health (1998). *Our Healthier Nation* HMSO
- Department of Health (1999). Saving Lives: Our Healthier Nation *HMSO*, London
- McArdle WD, Katch FR, Katch VL (1996). *Exercise Physiology* Williams and Wilkins (Chapter 29,30)

Preparation for week 12

- Powers SK & Howley ET (1990) *Exercise Physiology: Theory and Application to Fitness and Performance* WC Brown (Chapters 16,17).
- Katch FI & McArdle WD (1993) *Introduction to Nutrition, Exercise and Health* Lea and Febigen (Chapters 14-17).

Week 33 Workshop: Nutrition, lifestyle, physical activity, fitness and performance

Learning Mode

Whole group discussion facilitated by lecturer

Content

- Links between body composition and health and fitness
- Discuss ways by which sports scientists can help the community to meet "The Health of the Nation's" targets.

Follow-up reading

Revise lecture notes from weeks 9,10,11

Week 34 Revision Tutorial

Review of the unit.

The layout of the exam paper will be discussed.

Some model questions and answers will be discussed

EXAMS

8. Summary of practical program (Mondays from 14.00-17.00pm)

Week no	Date	Practical Group	Title of practical activity
20	07/02/04	Room: J212	Anthropometry
22	21/02/04	Room : J212	Energy Expenditure
24	07/03/04	Room : E252	Diet Computation

9. Assessment

Assessment will be on the basis of **60% unit examination** and **40% practical reports**. Satisfactory attendance at practical sessions will be required.

Coursework

This will be an extended laboratory report (2000 words) chosen from one of the first 2 practicals. The coursework is to be submitted word processed. See Practicals pamphlet for more details.

Coursework must be submitted to Dr Hibbs via the Faculty Office (J200) by **Friday 15th April 2005.**

Examination

The examination will be a 2-hour written paper.

- Section A (30 marks)

There will be 6 compulsory short-answer questions. Each question carries 5 marks.

- Section B (70 marks)

You will have to answer 2 out of 4 essay-type questions. Each question carries 35 marks.

All examination questions will be aimed at addressing the learning outcomes of the unit.

A student must achieve a minimum mark of 35% in each element of assessment and 40% overall to pass the unit.

10. Academic misconduct

Students are referred to the University's Student Handbook Section 10.12 Academic misconduct, which summarises Chapter 13 of the academic regulations. The full version of the regulations is available from the registry (situated in the Technopark building).

Sections taken from 10.12 Academic misconduct section of student handbook:

Academic misconduct is defined as 'any attempt to gain unfair advantage in assessment, or to help another student gain unfair advantage, by deception or fraudulent means.'

Some examples of academic misconduct include:

Assisting another student to gain unfair advantage - for example by allowing another student to copy your work, or use an electronic copy of your work.

Syndication: The submission of pieces of work, which are substantially similar, by two or more students. This may apply within the same institution or in a number of institutions, either at the same time or at different times.

Plagiarism To 'take and use another person's thoughts, writings, inventions as one's own.' Representing another person's work as your own, without acknowledging the source. Examples of this are provided in your student handbook (10.12, d).

Collusion: Representing as your own piece of work, which two or more students have undertaken together, without permission to do so.

Bribery: Offering payment or other inducement to another person in order to gain improper advantage in assessment or to falsify the result of assessment.

Commission: Commissioning another person to undertake all or part of an assignment presented as your own work, or knowingly undertaking work for another student to present as his or her own work.

N.B. Students are referred to Section 12 of this unit guide for guidance on Journal of Sports Sciences' format.

11. Reading and Other Source Materials

CORE TEXTS

Department of Health (1991) Dietary Reference Values No. 41 HMSO London

Katch FI & McArdle WD (1993) Introduction to Nutrition, Exercise and Health. 4th Ed. Lea & Feibiger. Philadelphia/London.

Lee DC, Nieman RD (1993) Nutritional Assessment. Brown & Benchmark

Maughan R, Gleeson M, Greenhaff PL (1997) Biochemistry for Exercise Training. Open University Press

Powers SK & Howley ET (1990) Exercise Physiology: Theory and Application to Fitness and Performance. 2nd Ed. Brown & Benchmark.

Robergs, R.A. & Roberts, S.O. (1997) Exercise Physiology. Exercise, Performance, and Clinical Applications. Mosby – Year Book Inc, London.

Houston, ME (1995) Biochemistry Primer for Exercise Science. Human Kinetics.

BACKGROUND READING

McArdle, W.D., Katch, F.I., Katch V.L. (1996) Exercise Physiology. 4th Edition, Williams & Wilkins, London.

Maughan, R.J. (1999) Nutrition in Sport. Blackwell Science, Oxford.

Brouns, F. (1993) Nutritional Needs of the Athlete. John Wiley

Department of Health (1991) The Health of the Nation. HMSO. London

Department of Health (1998) Our Healthier Nation. HMSO, London.

Garrow JS and James WPT (1993) Nutrition and Dietetics 9th Edition Churchill Livingstone.

Roche, A.F., Heymsfield, S.B., Lohman, T.G. (1996). Human Body Composition. Human Kinetics.

Department of Health (1999) Saving Lives: Our Healthier Nation. HMSO London

Flatt, J.P. Carbohydrate balance and body weight regulation. Proc. Nutr. Soc. (1996) 55: 449 – 465.

Havel P.J. Role of adipose tissue in body-weight regulation: mechanism regulating leptin production and energy balance. Pric. Nutr. Soc. (2000) 59: 359 – 371.

Ingjer et al. Effects of endurance training on muscle fibre ATPase activity, capillary supply and mitochondrial content in man Journal of Physiology (1979) 294: 419 – 432.

Ivy, J.L. Muscle glycogen synthesis before and after exercise. Sports Medicine (1991) 11(1): 6 – 19.

Kiens et al. Skeletal muscle substrate utilization during sub-maximal exercise in man: effect of endurance training. Journal of Physiology (1993) 469: 459 – 478.

Kiens et al. Utilization of skeletal muscle triacylglycerol during postexercise recovery in humans. American Journal of Physiology. (1998) 275: E332 – E337.

King, N.A. What processes are involved in the appetite response to moderate increases in exercise-induced energy expenditure? Proc.Nutr.Soc. (1999) 58: 107 – 113.

Martinez, J.A. Body-weight regulation: causes of obesity. Proc. Nutr. Soc. (2000) 337 – 345.

Moore, M.S. Interactions between physical activity and diet in the regulation of body weight. Proc.Nutr.Soc. (2000) 59: 193 – 198.

Stubbs, R.J. Dietary macronutrients and glucostatic control of feeding. Proc. Nutr. Soc. (1996) 55: 467 – 483.

Tremblay, A., Doucet, E. Influence of intense physical activity on energy balance and body fatness. Proc.Nutr.Soc. (1999) 58: 99 – 105.

OPTIONAL READING

Hargreaves, M. Exercise Metabolism. (1995) Human Kinetics, Leeds.

Useful Internet Addresses:

- http://www.nsmi.org.uk/1snf.html — SPORTS NUTRITION FOUNDATION
- http://www.gssiweb.com:80/home.html — GATORADE SPORTS SCIENCE INSTITUTE
- http://www.nutrition.org/ — AMERICAN SOCIETY FOR NUTRITIONAL SCIENCES
- http://www.nal.usda.gov/fnic/ — FOOD AND NUTRITION INFORMATION CENTRE
- http://www.nutrition.org.uk — BRITISH NUTRITION FOUNDATION
- http://www.bhf.org — BRITISH HEART FOUNDATION
- http://www.humankinetics.com/infok/journals/ijsn/intro.htm — INTERNATIONAL JOURNAL OF SPORT NUTRITION
- http://jap.physiology.org/ — JOURNAL OF APPLIED PHYSIOLOGY
- http://www.nejm.ogr/ — THE NEW ENGLAND JOURNAL OF MEDICINE
- http://www.bmj.com/index.stml/ — BRITISH MEDICAL JOURNAL (BMJ)
- http://www.nature.com/ — NATURE
- http://www.newscientist.com/ — NEWSCIENTIST
- http://www.sugar-bureau-sis.co.uk/ — THE SUGAR BUREAU
- http://www.faseb.org/ascn/ — AMERICAN SOCIETY OF CLINICALNUTRITION
- http://www.eatright.org/ — THE AMERICAN DIETETIC ASSOCIATION
- http://www.bda.uk.com/ — BRITISH DIETETIC ASSOCIATION
- http://www.roysocmed.ac.uk/ — THE ROYAL SOCIETY OF MEDICINE
- http://www.doh.gov.uk/ — DEPARTMENT OF HEALTH
- http://www.ifrn.bbsrc.ac.uk/ — INSTITUTE OF FOOD RESEARCH
- http://www.medwebplus.com/ — MedWeb NUTRITION
- http://www.milk.co.uk/ — NATIONAL DIARY COUNCIL
- http://www.physoc.org — PHYSIOLOGICAL SOCIETY
- http://www.bmn.com — BIOMEDNET
- http://www.biology.arizona.edu/biochemistry/biochemistry.html — learning resource
- http://esg-www.mit.edu:8001/esgbio/glycolysis/dir.html — learning resource

- http://www1.pitt.edu/~pahnet/ Physical Activity and Health Network
- http://wos.mimas.ac.uk/ Web of Science: search for papers

12. Guide to Journal of Sports Sciences Referencing:

Source: http://www.tandf.co.uk/journals/authors/t-authors/jspauth.html

References

The Journal uses one of several variations of the Harvard system. The following examples should make clear the most important points. References in the text are cited as follows: Smith (1985) . . . or (Brown and Green, 1996) . . . or, if there are more than two authors, as Jones *et al.* (1993) . . . or (Jones *et al.*, 1993). Citations of different publications by the same author(s) are differentiated as Green (1993a) . . . (Brown *et al.*, 1995b); the a, b, c, etc., are normally in order of citation in the text. Multiple citations are listed in ascending chronological order. Within a year, they are organised in alphabetical sequence of the first author. Examples: Smith (1995), Brown and Green (1996), Jones *et al.*, (1996); or (Smith, 1995; Brown and Green, 1996; Jones *et al.*, 1996). The following should make clear how multiple publications by the same authors are treated in such lists: Smith (1991, 1995), Brown and Green (1992, 1993), Jones *et al.* (1993, 1996a,b); or (Smith, 1991, 1995; Brown and Green, 1992, 1993; Jones *et al.*, 1993, 1996a,b).

A list of all cited references should be collected at the end of the paper in alphabetical order by, in the first instant, the first author's surname. Where the name of the first author appears more than once, the order is determined by: first, the number of co-authors (zero, one, or more than one); secondly, for one co-author, the first co-author's surname then the year; for two or more co-authors, year then order as dictated by the use of 1990a,b,c (for example) in the citations. The following is an example of how references would be ordered in the reference list: Brown (1980), Brown (1990), Brown and Jones (1977), Brown and Smith (1973), Brown and Smith (1975), Brown, Smith and Jones (1990a), Brown, Jones, Smith, Jones and Brown (1990b), Brown, Jones and Smith (1990c). Note that the last three examples would all have been cited as Brown *et al.* in the text, with the a, b and c relating to the order of citation. The names and initials of all authors should be given in the list of references. The style should follow the examples below:

Books

Zatsiorsky. V.M. (1995). *Science and Practice of Strength Training.* Champaign, IL: Human Kinetics.

Journals (Papers or Abstracts)

Elliott, B., Marshall, R. and Noffal, G. (1996). The role of upper limb segment rotations in the development of racket-head speed in the squash forehand. *Journal of Sports Sciences*, **14**, 159-165.

Chapters in Books

Stephenson, D.G., Lamb, G.D., Stephenson, G.M.M. and Fryer, M.W. (1996). Mechanisms of excitation-contraction coupling relevant to skeletal muscle fatigue. In *Fatigue: Neural and Muscular Mechanisms* (edited by S.C. Gandavia, R.M. Enoka, A.J. McManus, D.G. Stuart and C.K. Thomas), pp. 45-56. New York: Plenum Press.

Chapters in Published Books of Conference Proceedings or Abstracts

Howe, B.L. and Bell, G.J. (1986). Mood states and motivation of triathletes. In *Sports Science: Proceedings of the VII Commonwealth and International Conference on Sport, Physical Education, Dance, Recreation and Health* (edited by J. Watkins, T. Reilly and L. Burwitz), pp. 273-278. London: E & FN Spon.

The issue number of a journal should be included only to avoid confusion, as when for example the pagination starts from 1 in each issue rather than being continuous across a volume; in such cases use 16(4), etc. Authors should seek to minimize references to non-published material, including collections of conference abstracts that are not generally available through libraries or electronic databases. When it is absolutely necessary to reference unpublished material, this must be done within the citation in the body of the paper, for example (Bartlett and Bremble, unpublished data); the material must not be included in the list of references. Secondary references should be avoided if at all possible; if not, the reference should be listed as, for example: Full reference (cited in Zatsiorsky, V.M., 1995, *Science and Practice of Strength Training.* Champaign, IL: H