

Course Title	Advanced concepts in Exercise physiology				
Course Code	DLSEM512				
Course type	Compulsory				
Level	Master				
Year / Semester of study	1 st /1 st				
Teacher's Name	Dr Elena Papacosta & Prof. Dimitris Patikas				
ECTS	10	Lectures / week		Laboratories/week	
Course Purpose	<p>The purpose of this advanced course is to provide students with an expert-level understanding of the physiological principles that govern athletic performance. Through in-depth analysis and evaluation, students will explore advanced concepts and applications in exercise physiology, examining how various types of exercise impact body systems, the goals of sports training, and the health benefits of physical activity. The course aims to equip students with the knowledge to critically assess the functioning and adaptations of cardiovascular, respiratory, musculoskeletal, endocrine, and nervous systems during and after exercise. Additionally, students will investigate cutting-edge topics in applied ergophysiology, including hypoxic training, altitude exercise, recovery strategies, and the therapeutic use of exercise for medical conditions, ultimately fostering a thorough and sophisticated comprehension of the field.</p>				
Learning Outcomes	<p>Upon successful completion of the course, students will be able to:</p> <ul style="list-style-type: none"> • Assess the structure, function, and adaptation of the musculoskeletal system to exercise. • Evaluate the fundamental principles of neuromuscular function and its role in controlling movement and regulating exercise performance. • Analyze the complex processes of macronutrient metabolism and energy production during exercise, highlighting the role of lactic acid. • Outline the concepts of mitochondrial biogenesis and its implications for exercise performance and aesthetic adaptations. • Formulate a comprehensive evaluation of the cardiovascular and respiratory systems' complex functions during exercise, with particular emphasis on their roles in oxygen transport and carbon dioxide exchange • Examine the interaction between the endocrine and immune systems in response to exercise, emphasizing their effect on athletic performance and recovery. • Evaluate the principles of exercise environmental physiology, particularly the effects of extreme environmental conditions on the body's physiological responses and athletic performance 				

Prerequisites		Corequisites	
Course Content	Module 1 (Week 1 - 2)	Students will gain knowledge about muscle architecture, power-speed relationships, and adaptations that occur in the myotendon complex during training. In addition, they will examine the relationship between force and speed production, highlighting the mechanisms that regulate this relationship.	
	Module 2 (Week 3 - 5)	Students will gain knowledge about the function and adaptations of the neuromuscular system. Reference will be made to the composition of muscles at the level of motor units and their behavior during fatigue, but also to the immediate and chronic adaptations of the central and peripheral movement control systems.	
	Module 3 (Week 6)	Students will explore the complex functions of the body's energy systems during exercise, including the mechanisms of ATP production, the use of carbohydrates and fats for energy production, the creation and role of lactic acid in exercise, the crossover effect and its adaptations to athletic training, and mitochondrial biogenesis processes in response to different exercise volumes.	
	Module 4 (Week 7 - 9)	Students will explore the functions of the cardiovascular and respiratory systems, examining their dynamic adaptations to exercise and the factors that affect their performance, with basic references to cardiac output, and blood pressure, interpretation of the electrocardiogram, cardiovascular dynamics at different exercise intensities, autonomic nervous system function with exercise and sports training, respiratory gas exchange, pulmonary ventilation, oxygen deficit and debt, respiratory threshold, cardiopulmonary tests to assess aerobic capacity, aerobic performance and anaerobic threshold.	
	Module 5 (Week 10 - 11)	Students will examine the complex interactions between the endocrine and immune systems during and after exercise, exploring how exercise triggers a cascade of hormonal responses that affect metabolism, muscle growth and recovery, as well as how these responses affect immune system function. The module also discusses the j-shaped relationship between exercise and immune function, the role of exercise in reducing delayed muscle pain (DOMS), and the balance between pro- and anti-inflammatory responses during exercise.	
	Module 6 (Week 12)	Students will understand how the body adapts and responds to extreme environmental conditions, such as microgravity, hypo- and overweight, heat and cold. They will also learn about the physiological changes that occur in these extreme environments, the effects these changes have on athletic performance, and the strategies that can be used to mitigate these effects.	
Teaching Methodology	The course is structured and developed based on the principles of distance learning, good practices as well as the guidelines of the Evaluation Body and finally the Pedagogical Framework developed and implemented by our University. Also, through the design and development of distance learning courses, synchronous and asynchronous interaction, communication and		

	<p>collaboration are taken into account at 3 levels: 1) between instructor and student, 2) between students, and 3) between students and content. The course is taught entirely online through the electronic platform Moodle LMS. Mandatory, optional and additional bibliography (e.g. books, articles, links, open educational resources, case studies) in combination with notes, course presentations and suggestions for reading study (bibliography) are available to students through an electronic platform. Also, a variety of appropriate educational material is given through the online platform in the form of presentations with notes, presentations with narration, interactive presentations and videos, interactive learning scenarios, gamification activities, avatars, digital twins, audio files, online quizzes). Various online tools, new and emerging technologies are being exploited: communication tools (e.g. video conferencing, chat rooms), collaboration tools (e.g. discussion forums, blogs, wikis), as well as content development tools. Students are encouraged through the platform and various technological tools to interact with their fellow students and the instructor, in order to become active members of the online learning community created within the framework of the course. Finally, with the use of various technological tools, each student is expected to create his own online learning community. More information about distance learning at Frederick University, the Pedagogical Background developed and implemented, as well as the toolkit used, can be found at the following link.</p> <p>About Distance Learning - Frederick University</p>		
Bibliography	<table border="1"> <tr> <td>Module 1 (Week 1 - 2)</td><td> <p>Mandatory Bibliography</p> <p>Digital Multimedia Material</p> <ul style="list-style-type: none"> Presentations on the topics of module 1 <p>Articles/Conference Proceedings:</p> <p>Lieber, R. L., & Fridén, J. (2000). Functional and clinical significance of skeletal muscle architecture. <i>Muscle & Nerve</i>, 23(11), 1647–1666.</p> <p>Pinniger, G. J., Steele, J. R., & Cresswell, A. G. (2003). The force-velocity relationship of the human soleus muscle during submaximal voluntary lengthening actions. <i>European Journal of Applied Physiology</i>, 90, 191–198.</p> <p>Sugi, H., & Ohno, T. (2019). Physiological Significance of the Force-Velocity Relation in Skeletal Muscle and Muscle Fibers. <i>International Journal of Molecular Sciences</i>, 20(12), 3075. [doi]</p> <p>Brunello, E., & Fusi, L. (2023). Regulating Striated Muscle Contraction: Through Thick and Thin. <i>Annual Review of Physiology</i>. [doi]</p> <p>Herzog, W. (2014). The role of titin in eccentric muscle contraction. <i>Journal of Experimental Biology</i>, 217(16), 2825–2833. [doi]</p> </td></tr> </table>	Module 1 (Week 1 - 2)	<p>Mandatory Bibliography</p> <p>Digital Multimedia Material</p> <ul style="list-style-type: none"> Presentations on the topics of module 1 <p>Articles/Conference Proceedings:</p> <p>Lieber, R. L., & Fridén, J. (2000). Functional and clinical significance of skeletal muscle architecture. <i>Muscle & Nerve</i>, 23(11), 1647–1666.</p> <p>Pinniger, G. J., Steele, J. R., & Cresswell, A. G. (2003). The force-velocity relationship of the human soleus muscle during submaximal voluntary lengthening actions. <i>European Journal of Applied Physiology</i>, 90, 191–198.</p> <p>Sugi, H., & Ohno, T. (2019). Physiological Significance of the Force-Velocity Relation in Skeletal Muscle and Muscle Fibers. <i>International Journal of Molecular Sciences</i>, 20(12), 3075. [doi]</p> <p>Brunello, E., & Fusi, L. (2023). Regulating Striated Muscle Contraction: Through Thick and Thin. <i>Annual Review of Physiology</i>. [doi]</p> <p>Herzog, W. (2014). The role of titin in eccentric muscle contraction. <i>Journal of Experimental Biology</i>, 217(16), 2825–2833. [doi]</p>
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		<p>Herzog, W. (2018). The multiple roles of titin in muscle contraction and force production. <i>Biophysical Reviews</i>, 10(4), 1187–1199. [doi]</p> <p>Andersen, J. L., & Aagaard, P. (2010). Effects of strength training on muscle fiber types and size; consequences for athletes training for high-intensity sport. <i>Scandinavian Journal of Medicine & Science in Sports</i>, 20 Suppl 2, 32–38. [doi]</p> <p>Crotty, E. D., Furlong, L.-A. M., & Harrison, A. J. (2023). Ankle and Plantar Flexor Muscle-Tendon Unit Function in Sprinters: A Narrative Review. <i>Sports Medicine (Auckland, N.Z.)</i>. [doi]</p> <p>Lai, A., Schache, A. G., Lin, Y.-C., & Pandy, M. G. (2014). Tendon elastic strain energy in the human ankle plantar-flexors and its role with increased running speed. <i>Journal of Experimental Biology</i>, jeb.100826. [doi]</p> <p>D'Antona, G., Lanfranconi, F., Pellegrino, M. A., Brocca, L., Adami, R., Rossi, R., Moro, G., Miotti, D., Canepari, M., & Bottinelli, R. (2006). Skeletal muscle hypertrophy and structure and function of skeletal muscle fibres in male body builders. <i>Journal of Physiology</i>, 570(Pt 3), 611–627. [doi]</p> <p>Fitts, R. H., & Widrick, J. J. (1996). Muscle mechanics: Adaptations with exercise-training. <i>Exercise and Sport Sciences Reviews</i>, 24, 427–473.</p> <p>Malisoux, L., Francaux, M., Nielens, H., & Theisen, D. (2006). Stretch-shortening cycle exercises: An effective training paradigm to enhance power output of human single muscle fibers. <i>Journal of Applied Physiology (Bethesda, Md.: 1985)</i>, 100(3), 771–779. [doi]</p>
	<p>Module 2 (Week 3 -5)</p>	<p>Mandatory Bibliography</p> <p>Digital Multimedia Material</p> <ul style="list-style-type: none"> • Presentations on the topics of module 2 <p>Articles/Conference Proceedings:</p> <ol style="list-style-type: none"> 1. Heckman, C. J., & Enoka, R. M. (2012). Motor unit. <i>Comprehensive Physiology</i>, 2(4), 2629–2682. [doi] 2. Hug, F., Avrillon, S., Ibáñez, J., & Farina, D. (2023). Common synaptic input, synergies, and size principle:

		<p>Control of spinal motor neurons for movement generation. <i>The Journal of Physiology</i>, 601(1), 11–20. [doi]</p> <p>3. Forbes, P. A., Chen, A., & Blouin, J.-S. (2018). Chapter 4—Sensorimotor control of standing balance. In B. L. Day & S. R. Lord (Eds.), <i>Handbook of Clinical Neurology</i> (Vol. 159, pp. 61–83). Elsevier. [doi]</p> <p>4. Disselhorst-Klug, C., Schmitz-Rode, T., & Rau, G. (2009). Surface electromyography and muscle force: Limits in sEMG-force relationship and new approaches for applications. <i>Clinical Biomechanics</i> (Bristol, Avon), 24(3), 225–235. [doi]</p> <p>5. Taube, W., Leukel, C., & Gollhofer, A. (2012). How neurons make us jump: The neural control of stretch-shortening cycle movements. <i>Exercise and Sport Sciences Reviews</i>, 40(2), 106–115. [doi]</p> <p>6. Lazaridis, S. N., Bassa, E. I., Patikas, D. A., Giakas, G., Gollhofer, A., & Kotzamanidis, C. M. (2010). Neuromuscular differences between prepubescent boys and adult men during drop jump. <i>European Journal of Applied Physiology</i>, 110(1), 67–74. [doi]</p> <p>7. Gandevia, S. C. (2001). Spinal and supraspinal factors in human muscle fatigue. <i>Physiological Reviews</i>, 81(4), 1725–1789.</p> <p>8. Froyd, C., Beltrami, F. G., Millet, G. Y., & Noakes, T. D. (2016). Central regulation and neuromuscular fatigue during exercise of different durations. <i>Medicine and Science in Sports and Exercise</i>, 48(6), 1024–1032. [doi]</p> <p>9. McCrary, J. M., Ackermann, B. J., & Halaki, M. (2018). EMG amplitude, fatigue threshold, and time to task failure: A meta-analysis. <i>Journal of Science and Medicine in Sport</i>, 21(7), 736–741. [doi]</p> <p>10. Zero, A. M., & Rice, C. L. (2021). State-of-the-art review: Spinal and supraspinal responses to muscle potentiation in humans. <i>European Journal of Applied Physiology</i>, 121(5), 1271–1282. [doi]</p> <p>11. Blazeovich, A. J., & Babault, N. (2019). Post-activation potentiation versus post-activation performance enhancement in humans: Historical perspective, underlying mechanisms, and current issues. <i>Frontiers in Physiology</i>, 10, 1359. [doi]</p> <p>12. Xenofondos, A., Bassa, E. I., Vrabas, I. S., Kotzamanidis, C. M., & Patikas, D. A. (2018). Muscle twitch torque during</p>
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	<p>Module 3 (Week 6) Elena</p>	<p>Mandatory Bibliography</p> <p>Digital Multimedia Material</p> <ul style="list-style-type: none"> • Presentations on the topics in module 3 <p>Articles/Conference Proceedings:</p> <ol style="list-style-type: none"> 1. Spaulding HR, Yan Z. AMPK and the Adaptation to Exercise. <i>Annu Rev Physiol.</i> 2022 Feb 10;84:209-227. doi: 10.1146/annurev-physiol-060721-095517. PMID: 35143330; PMCID: PMC8919726. 2. Evans PL, McMillin SL, Weyrauch LA, Witczak CA. Regulation of Skeletal Muscle Glucose Transport and Glucose Metabolism by Exercise Training. <i>Nutrients.</i> 2019 Oct 12; 11(10):2432. doi: 10.3390/nu11102432. PMID: 31614762; PMCID: PMC6835691. 3. Flores-Opazo M, McGee SL, Hargreaves M. Exercise and GLUT4. <i>Exerc Sport Sci Rev.</i> 2020 Jul; 48(3):110-118. doi: 10.1249/JES.0000000000000224. PMID: 32568924. 4. Mul JD, Stanford KI, Hirshman MF, Goodyear LJ. Exercise and Regulation of Carbohydrate Metabolism. <i>Prog Mol Biol Transl Sci.</i> 2015;135:17-37. doi: 10.1016/bs.pmbts.2015.07.020. Epub 2015 Aug 20. PMID: 26477909; PMCID: PMC4727532. 5. Muscella A, Stefàno E, Lunetti P, Capobianco L, Marsigliante S. The Regulation of Fat Metabolism During Aerobic Exercise. <i>Biomolecules.</i> 2020 Dec 21; 10(12):1699. doi: 10.3390/biom10121699. PMID: 33371437; PMCID: PMC7767423. 6. Horowitz JF, Klein S. Lipid metabolism during endurance exercise. <i>Am J Clin Nutr.</i> 2000 Aug; 72(2 Suppl):558S-63S. doi: 10.1093/ajcn/72.2.558S. PMID: 10919960. 7. Purdom T, Kravitz L, Dokladny K, Mermier C. Understanding the factors that effect maximal fat oxidation. <i>J Int Soc Sports Nutr.</i> 2018 Jan 12;15:3. doi: 10.1186/s12970-018-0207-1. PMID: 29344008; PMCID: PMC5766985. 8. Brooks GA, Osmond AD, Arevalo JA, Duong JJ, Curl CC, Moreno-Santillan DD, Leija RG. Lactate as a myokine and exerkine: drivers and signals of physiology and metabolism. <i>J Appl Physiol (1985).</i> 2023 Mar 1; 134(3):529-548. doi: 10.1152/japplphysiol.00497.2022. Epub 2023 Jan 12. PMID: 36633863; PMCID: PMC9970662. 9. Cairns SP. Lactic acid and exercise performance : culprit or friend? <i>Sports Med.</i> 2006; 36(4):279-91. doi: 10.2165/00007256-200636040-00001. PMID: 16573355. 10. Lee S, Choi Y, Jeong E, Park J, Kim J, Tanaka M, Choi J. Physiological significance of elevated levels of lactate by exercise training in the brain and body. <i>J Biosci Bioeng.</i> 2023 Mar; 135(3):167-175. doi:
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	<p>Module 4 (Week 7-9)</p>	<p>Mandatory Bibliography</p> <p>Digital Multimedia Material</p> <ul style="list-style-type: none"> • Presentations on the topics in module 4 <p>Articles/Conference Proceedings:</p> <ol style="list-style-type: none"> 1. Zorzi A, Vio R, Bettella N, Corrado D. Criteria for interpretation of the athlete's ECG: A critical appraisal. Pacing Clin Electrophysiol. 2020 Aug; 43(8):882-890. doi: 10.1111/pace.14001. Epub 2020 Jul 30. PMID: 32602144. 2. Lavie CJ, Arena R, Swift DL, Johannsen NM, Sui X, Lee DC, Earnest CP, Church TS, O'Keefe JH, Milani RV, Blair SN. Exercise and the cardiovascular system: clinical science and cardiovascular outcomes. Circ Res. 2015 Jul 3; 117(2):207-19. doi: 10.1161/CIRCRESAHA.117.305205. PMID: 26139859; PMCID: PMC4493772. 3. Fu Q, Levine BD. Exercise and the autonomic nervous system. Handb Clin Neurol. 2013;117:147-60. doi: 10.1016/B978-0-444-53491-0.00013-4. PMID: 24095123. 4. Rowland T. Endurance athletes' stroke volume response to progressive exercise: a critical review. Sports Med. 2009; 39(8):687-95. doi: 10.2165/00007256-200939080-00005. PMID: 19769416. 5. Aubert AE, Seps B, Beckers F. Heart rate variability in athletes. Sports Med. 2003; 33(12):889-919. doi: 10.2165/00007256-200333120-00003. PMID: 12974657. 6. Buchheit M, Laursen PB. High-intensity interval training, solutions to the programming puzzle: Part I: cardiopulmonary emphasis. Sports Med. 2013 May; 43(5):313-38. doi: 10.1007/s40279-013-0029-x. PMID: 23539308. 7. Souissi A, Haddad M, Dergaa I, Ben Saad H, Chamari K. A new perspective on cardiovascular drift during prolonged

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Module 5 (Week 10-11)		<p>Mandatory Bibliography</p> <p>Digital Multimedia Material</p> <ul style="list-style-type: none"> • Presentations on the topics in module 5 <p>Articles/Conference Proceedings:</p> <ol style="list-style-type: none"> 1. Kraemer WJ, Ratamess NA. Hormonal responses and adaptations to resistance exercise and training. Sports Med. 2005; 35(4):339-61. doi: 10.2165/00007256-200535040-00004. PMID: 15831061. 2. Kraemer WJ, Ratamess NA, Hymer WC, Nindl BC, Fragala MS. Growth Hormone(s), Testosterone, Insulin-Like Growth Factors, and Cortisol: Roles and Integration for Cellular Development and Growth With Exercise. Front Endocrinol (Lausanne). 2020 Feb 25;11:33. doi: 10.3389/fendo.2020.00033. PMID: 32158429; PMCID: PMC7052063. 3. Neves RS, da Silva MAR, de Rezende MAC, Caldo-Silva A, Pinheiro J, Santos AMC. Salivary Markers Responses in the Post-Exercise and Recovery Period: A Systematic Review. Sports (Basel). 2023 Jul 18; 11(7):137. doi: 10.3390/sports11070137. PMID: 37505624; PMCID: PMC10386489. 4. Papacosta E., Nassis G.P. Saliva as a tool for monitoring steroid, peptide and immune markers in sport and exercise science. J. Sci. Med. Sport. 2011; 14:424–434. doi:10.1016/j.jsams.2011.03.004. 5. Severinsen MCK, Pedersen BK. Muscle-Organ Crosstalk: The Emerging Roles of Myokines. Endocr Rev. 2020 Aug 1; 41(4):594–609. doi: 10.1210/endo/bnaa016. Erratum in: Endocr Rev. 2021 Jan 28; 42(1):97-99. PMID: 32393961; PMCID: PMC7288608.

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	<p>Module 6 (Week 12)</p>	<p>Mandatory Bibliography</p> <p>Digital Multimedia Material</p> <ul style="list-style-type: none"> • Presentations on the topics in module 6 <p>Articles/Conference Proceedings:</p> <ol style="list-style-type: none"> 1. Tipton MJ. Environmental extremes: origins, consequences and amelioration in humans. Exp Physiol. 2016 Jan; 101(1):1-14. doi: 10.1113/EP085362. Epub 2015 Oct 16. PMID: 26391095. 2. Foster PP, Butler BD. Decompression to altitude: assumptions, experimental evidence, and future directions. J Appl Physiol (1985). 2009 Feb; 106(2):678-90. doi: 10.1152/japplphysiol.91099.2008. Epub 2008 Dec 12. PMID: 19074573. 3. Niclou A, Sarma M, Levy S, Ocobock C. To the extreme! How biological anthropology can inform exercise physiology in extreme environments. Comp Biochem Physiol A Mol Integr Physiol. 2023 Oct;284:111476. doi: 10.1016/j.cbpa.2023.111476. Epub 2023 Jul 7. PMID: 37423419. 4. Castellani JW, Tipton MJ. Cold Stress Effects on Exposure Tolerance and Exercise Performance. Compr Physiol. 2015 Dec 15; 6(1):443-69. doi: 10.1002/cphy.c140081. PMID: 26756639. 5. Périard JD, Travers GJS, Racinais S, Sawka MN. Cardiovascular adaptations supporting human exercise-heat acclimation. Auton Neurosci. 2016 Apr;196:52-62. doi: 10.1016/j.autneu.2016.02.002. Epub 2016 Feb 12. PMID: 26905458.

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Assessment		<p>The evaluation of the course includes activities of continuous / formative assessment (formative), self-evaluation (self-evaluation and debriefing / final evaluation (summative). Specifically, the evaluation of this course includes the following: final written exam, 2 evaluation assignments, 2 evaluative online interactive discussions, various weekly educational activities such as interactive activities, interactive presentations/ videos and self-assessment activities.</p> <p>From the above, the following are scored:</p> <ul style="list-style-type: none"> • Evaluation work 1 (20%) • Evaluation work 2 (15%) • Online interactive activity 1 (7.5%) • Online interactive activity 2 (7.5%) • Final exam (50%) <p>All assignments (except the final exam) are assigned and delivered to the online platform, as well as a plagiarism check through the turnitin tool. The final exam is developed by the instructor and completed by the students on a special platform used exclusively for the exams.</p>
Language		English / Greek