

Aging, Decision Making & Mobility PET 5077 (3 credits)
Dept. of Exercise Science and Health Promotion
College of Education, Boca Campus
Florida Atlantic University

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Course Description: An inquiry into age related decline in decision-making and mobility with particular emphasis on the role of exercise in attenuating that decline. Prerequisite: PET 4351 or permission of the instructor.

Textbook: No text. See <http://blackboard.fau.edu> for ALL relevant course information.

Evaluation:

Exams 3 @ 40 points each	120 points
Comprehensive Final Exam	50 points
Seminar papers @ 10 points ea.	30 points
* Journal article submissions	5 point deduction if not handed in (YOU CAN ONLY LOSE POINTS – NOT ACQUIRE THEM)

NOTE: The points assigned to each category (e.g. exams) are approximate. While points may change slightly (e.g. I might drop a question after considering the classes response), your grade will be based on the percentage correct.

Grading Scale:

Grading scale(%): A=100-95, A-=94-91, B+=90-87, B=86-82, B-=81-78, C+=77-74, C=73-70, C-=69-67, D+=66-64, D=63-61, D-=60-58, F=<58

Honor Code

Students at Florida Atlantic University are expected to maintain the highest ethical standards. Academic dishonesty, including cheating and plagiarism, is considered a serious breach of these ethical standards, because it interferes with the University mission to provide a high quality education in which no student enjoys an unfair advantage over any other. Academic dishonesty is also destructive of the University community, which is grounded in a system of mutual trust and places high value on personal integrity and individual responsibility. Harsh penalties are associated with academic dishonesty. For more information, see http://www.fau.edu/regulations/chapter4/4.001_Honor_Code.pdf.

Disabilities

In compliance with the Americans with Disabilities Act (ADA), students who require special accommodations due to a disability to properly execute coursework must register with the Office for Students with Disabilities (OSD) located in Boca Raton - SU 133 (561-297-3880), in Davie - MOD I (954-236-1222), in Jupiter - SR 117 (561-799-8585), or at the Treasure Coast - CO 128 (772-873-3305), and follow all OSD procedures.

General Guidelines: You are responsible for all information that I ask you to study in your readings, the lecture notes/materials, labs and basically everything that is said in class. The **study questions** are based on the lectures which are **linked to specific readings, PowerPoint slides and laboratory demonstrations** (NOTE: find syllabus, lab demonstrations, PowerPoint lectures AND journal articles on <http://blackboard.fau.edu> . Hence, USE the **study questions when preparing for exams** (multiple choice and/or short essay questions). **Assigned readings should be read before class!** I do not plan to provide make-up examinations and you will not be allowed to take an exam early or late. **Failure to provide a copy of a journal article during seminars will result in a 5 point deduction from your point total (that's not good!).**

During the seminar you will identify the QUESTION in your paper and we will discuss the studies in your paper and attempt to tie that information to the required readings, laboratory demonstrations and the lecture. Typically, **you will be asked to offer commentary** about the studies in your paper as well as the assigned readings. You will write a 1-2 page summary of **the seminar topic** and provide me with a copy of **ONE of the three** scientific journal articles (**2006 or later**) that you reference in your paper. **YOU CAN NOT USE ARTICLES FROM THE READING LIST in your paper.** When writing your paper, use the instructions for authors provided by Medicine & Science in Sports & Exercise.

Aug. 27th**Introductory Stuff**

Review the syllabus, discuss course expectations, laboratory demonstrations, how to prepare for seminars, including writing of papers required for seminar, and exams - see topics and study questions below.

August 27th**Aging as Mitochondrial Dysfunction, Mitochondrial Adaptation to Exercise**

We will be open by discussing the chapter on aging written by the neuroscientist Serge Duckett. Duckett covers a lot of ground including age related changes in the CNS, causes of death, population dynamics and even the financial implications of an aging America. From Duckett we discuss whether mitochondria can explain aging, mitochondrial structure/function, energy metabolism, biogenesis and finally, the differences in muscle adaptive responses to HIT and ET (i.e. the intricacies of muscle plasticity or for our purposes mitochondrial adaptive responses to exercise (aka as mitochondrial biogenesis)).

Study questions:**1-2/1-4**

- What's your take on Duckett's comments about normal aging, atrophy of the brain, retirement, and the accomplishments of elderly individuals?
- What trends in population growth can be seen in older adults?
- Speculate on the health care costs associated with an aging America.
- Assuming aging research and from a methodological standpoint, what are several important treats to internal validity? How can you control them?
- What are the so called primary and secondary factors of aging and how might they interact?
- Is **mitochondrial** dysfunction a possible definition of aging?
- Can you describe the morphology* of the mitochondrion and major pathways^ associated with energy production?
 - *what are the structures making up the mitochondrion (e.g. outer membrane) and describe their function ([GOTO Wikipedia and search Mitochondrion and Oxidative Phosphorylation for background information](#))
 - ^ mitochondrial energy production - citric acid cycle, the electron transport chain (chemiosmosis);
- Using the steps listed below discuss the compensatory adjustments or adaptations made by **mitochondria** in **response to exercise** (note: exercise serves to disrupt cellular homeostasis necessitating mitochondrial adaptation (i.e. biogenesis or muscle plasticity):
 - cascade of cell signaling (elevated intracellular Ca^{2+} followed by activation of Ca^{2+} sensitive signaling molecules (calcium/calmodulin dependent protein kinase (CaMK).
 - ATP turnover resulting in a rise in AMP leading to activation of AMP activated protein kinase (AMPK)
 - The Ca^{2+} and AMP signaling pathways move to myonuclei to influence gene transcription via the "master regulator" PGC-1 alpha in conjunction with the expression of nuclear respiratory factors (NRF1, NRF2 – transcription factors for nuclear genes that encode a number of mitochondrial proteins)
 - **Review of DNA, transcription, mRNA, translation (see slides)**
 - NRF1 influences or promotes the expression of mitochondrial transcription factor A (Tfam) which (other proteins as well) is imported (note: Tfam) regulates the expression of 13 mitochondrial gene products (cytochrome c & oxidase subunit 1 (COX 1)
 - Mitochondrial proteins and mtDNA encoded proteins assembled to form multi-unit enzyme complexes required for O_2 consumption and ATP synthesis (this is coordination between nuclear and mtDNA is required for mito biogenesis via mitofusion-2 (Mfn-2) (individual mito fused to form larger mito reticulum; fission (Fis 1 – protein involved in mito fission)
 - Mitochondrial membrane potential (proton motive force, see chemiosmosis) associated with ROS from ETC (reduced by uncoupling protein (UCP3)
 - ROS trigger opening of mito permeability transition pore (mtPTP) and release of pro-apoptotic factors cytochrome c and apoptosis-inducing factor (AIF)
 - Apoptosis program influenced by p53 and BAX (see drawing)
 - SIRT1, an anti-aging protein, can inhibit p53 pathway
 - How can exercise slow aging? (see reading# 1, Lanza et al. 2008)
 - Based on the above, explain the role of calcium flux (transient changes in intracellular calcium) and metabolic stress (e.g. ATP usage, AMP levels, glycogen levels, etc) in signaling transcriptional changes associated with muscle adaptation
 - Are muscle adaptive responses different in high intensity interval training (HIT) verse an endurance training (ET) approach?

September 3rd**Aging, Cognitive Decline & Exercise**

In mainstream psychology cognition "to know" or have "knowledge" is about processing of information and tends to apply to [memory](#), [attention](#), [perception](#), [action](#), [problem solving](#) and [mental imagery](#). Dementia (from [Latin](#) *de-* "apart, away," + *mens* ([genitive](#) *mentis*) "mind") is a progressive brain dysfunction resulting in a decline in [cognitive function](#) due to damage or disease in the [brain](#) beyond what might be expected from normal aging.

Study questions:**3/5-8**

- What is dementia?
- Explain several common causes of dementia, including: [Alzheimer's disease](#) ((i.e. deficiency in the production of acetylcholine, tau protein abnormalities, beta amyloid deposits), [vascular](#) (also known as *multi-infarct dementia*), [Dementia with Lewy bodies](#)
- What changes (i.e. axon integrity, neural networks, neurotransmitters, synaptic transmission etc.) in the nervous system are expected with age and how are those changes likely to affect cognitive function?
- What is neurogenesis and do we expect neurogenesis (i.e. plasticity) in old age?
- What specific regions and structures in the brain have been implicated in memory loss associated with Alzheimer's (consider declarative and non-declarative memory (see slides describing the classic works of Lashley and Hebb)?
- Discuss several studies that have tried to link exercise to the prevention of dementia.

September 10th**Laboratory Demonstrations 1/2:** *Observing/Evaluating Dementia* using the Mini

Mental State Examination (MMSE); selected tests of executive function (cognitive processes) 1) Stroop test, 2) Discrimination Test. *Observing Physiological Responses to HIT*. See <http://blackboard.fau.edu> (course assignments) for the description of the laboratory demonstrations.

September 17th –**Seminar: Exercise and Mitochondrial Biogenesis, Exercise and Dementia**

Your paper should: 1) identify a problem or question then discuss the results of several research studies in order to address the problem. Note: You will write ***TWO 1-2 page papers***, ONE for exercise and mito biogenesis and ONE for exercise and dementia.

In order to participate in the seminar (discussion), be able to define terms and articulate main points of your paper, including:

- Identify the research question or hypotheses for each article
- Discuss subject characteristics, methods employed to answer the questions
- Discuss results in connection with lecture the week before
- Compare conclusions with information presented the week before and discuss whether the conclusions support the hypotheses
- Explain if and why there were threats to internal validity for ONE of the articles you read
- Design an experiment that would extend the findings from ONE of the articles that you read.

September 24th**Exam 1****October 1st****Lecture on Sarcopenia**

Sarcopenia (from the Greek meaning "poverty of flesh") is the degenerative loss of [skeletal muscle](#) mass and strength in [senescence](#). About a third of muscle mass is lost in old age. This loss of mass reduces the performance of muscles. Due to the increasing number of elderly people, sarcopenia is an increasing health issue in the developed world.

Study Questions:**3/9-14**

- What factors increase the risk of sarcopenia (e.g. reduced protein synthesis, low IGF-1, low GH, low testosterone, inflammatory response, sedentary lifestyle, dietary habits)?
- How is muscle changed structurally (e.g. alignment of contractile proteins) and functionally (i.e. force, torque) as a result of sarcopenia?
- Is sarcopenia more prevalent in a specific muscle fiber type? If so, why and what effect does a decrease in a particular fiber type have on maintaining functional mobility?
- Discuss the morphology of the neuromuscular junction including the transmission of the AP through the junction (i.e. synaptic transmission) and the molecular basis for contraction – how are these structures affected by age?
- Discuss mTORC (i.e. mammalian target of rapamycin complex) as the premier activating mechanism triggering muscle hypertrophy

- What effect does sarcopenia have on our nation's health care costs and why?
- Discuss in detail several "major" exercise intervention studies that have illustrated the efficacy of resistance exercise in combating sarcopenia
- What is the research telling us regarding pharmacological intervention and its effect on sarcopenia?
- What's the role of nutrient timing and EAA in attenuating sarcopenia?

Date	Activity	PowerPoint files/Readings (e.g. 1/1)
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October 8th	Laboratory Demonstration 2: Evaluating age related strength/functional changes - See http://blackboard.fau.edu (course assignments) for the description of the laboratory demonstration	
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October 15th	Seminar: The role of Exercise in combating sarcopenia Your paper should: 1) identify a question or problem, 2) report on current animal/human studies in order to answer your question and, if warranted, regarding the efficacy of exercise as a means of combating sarcopenia,	
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You MUST be able to define terms and articulate main points of the paper:

- Identify the research question or hypotheses for each article
- Discuss subject characteristics, methods employed to answer the questions
- Discuss results in connection with lecture the week before
- Compare conclusions with information presented the week before and discuss whether the conclusions support the hypotheses
- Explain if and why there were threats to internal validity for ONE of the articles you read
- Design an experiment that would extend the findings from ONE of the articles that you read.

October 22th	Exam 2	
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October 29th	Lecture Part A: Aging and selected systems decline (i.e. visual, vestibular, somatosensory) In this lecture we explore how key systems interact to provide for postural control/balance and what happens when those systems decline.	
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Study questions:

4/15

- Discuss age related changes in perception (i.e. sensory receptors, neural transmission/interpretation, neuromuscular)
- Assuming a basic understanding of the central visual system, identify the most common age related changes in vision and visual perception?
- Explain the role of sarcopenia (specially type II fibers) and a declining neuromuscular interface on postural control?
- Assuming a basic understanding of the vestibular system (sensations transduced by hair cells, semicircular canals, otolith organs) discuss the changes expected with age.
- What implications do changes in the VS have for mobility? Answering this question assumes an appreciation of the VS as a "central reference system" for movement
- What impact might a decline in somatosensory sensitivity (at a cortical level) have on ADL?

Lecture Part B: Age related changes in postural control and functional ability.

Postural control might be explained as an automated neural loop revealed as balance and stability while functional ability pertains to the execution of activities of daily living.

Study questions:

5/16

- What are the neural pathways from the brain to the spinal cord that control posture?
- How is postural control handled at the spinal cord level?
- How are young and old individuals different in terms of their compensatory movements made during a near fall or slip?
- What are the typical types of interventions used to improve balance and reduce the risk of falling?
- What innovations might you suggest in reducing fall risk in the elderly?

November 5th	Laboratory Demonstration 3: Reaction Time, Movement Speed and Balance:	
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The effects of stimulus complexity on response and movement time in old and young subjects. See <http://blackboard.fau.edu> (course assignments) for the description of the laboratory demonstration.

November 12th Seminar: Aging & Behavioral slowing – How can exercise improve postural control and functional ability?

Your paper should: 1) identify a specific question (e.g. mechanism) associated with postural control and aging then (as always) report on current animal/human studies regarding the efficacy of exercise in reducing fall risk and functional ability

You MUST be able to define terms and articulate main points of the paper

- Identify the research question or hypotheses for each article
- Discuss subject characteristics, methods employed to answer the questions
- Discuss results in connection with lecture the week before
- Compare conclusions with information presented the week before and discuss whether the conclusions support the hypotheses
- Explain if and why there were threats to internal validity for ONE of the articles you read
- Design an experiment that would extend the findings from ONE of the articles that you read.

November 19th

Exam 3

December 3rd

Comprehensive Final Exam (6:00 pm – 9:30)

Required Reading (see blackboard under course materials)

1. Duckett, Serge, in Duckett, S, De La Torre JC (eds.) Pathology of the Aging Human Nervous System, 2nd edition, Oxford University Press, New York, 2001, pp. 1-18.
2. See Wikipedia.org (Search Mitochondrion; search Oxidative Phosphorylation – Let's agree that these will provide background information)
3. Hood DA, Irrcher I, Ljubcic V, Joseph A-M. Coordination of metabolic plasticity in skeletal muscle. J Exp Biol 2006;209:2265-2275.
4. Lanza IR, Short DK, Short KR, et al. Endurance exercise as a countermeasure for aging. Diabetes 2008;57:2933-2942.
Whitehurst to discuss results of this study in class (August 27th) **THIS IS NOT REQUIRED READING** Gibala MJ, McGee SL, Granham AP et al. Brief intense interval exercise activates AMPK and p38 MAPK signaling and increases the expression of PCG-1 alpha in human skeletal muscle. J Appl Physiol 2009;106:929-934.
5. See Wikipedia.org (Search dementia – will use for background information)
6. Colcombe SJ, Erickson KI, Raz N, Webb AG, Cohen NJ, McAuley E, Kramer AF. Aerobic fitness reduces brain tissue loss in aging humans. J Gerontol 2003;58:176-180.
7. Erickson K, Kramer AF. Exercise effects on cognitive and neural plasticity in older adults. Downloaded from bjsm.bml.com (December 4th, 2008)
8. Kramer AF, Erickson KI. Capitalizing on cortical plasticity: Influence of physical activity on cognition and brain function. Trends in Cog Sci 2007;11:342-348.
Whitehurst to discuss the results of this study in class (Sept. 3rd) **THIS IS NOT REQUIRED READING** Colcombe SJ, Kramer AF, Erickson KI, Scalf P, McAuley E, Cohen NJ, Webb A, Jerome GJ, Marquez DX, Elavsky S. Cardiovascular fitness, cortical plasticity, and aging. Proc Natl Acad Sci U S A. 2004 Mar 2;101(9):3316-21.
9. Roubenoff R. Sarcopenia and its implications for the elderly. Eur J Clin Nutr, 2000;54:40-47.
10. Janssen I, Shepard DS, Katzmarzyk PT, Roubenoff R. The healthcare costs of sarcopenia in the United States. J Am Geriatr Soc. 2004.
11. Dirks AJ, Hofer T, Marzetti E, Pahor M, Leeuwenburgh C. Mitochondrial DNA mutations, energy metabolism and apoptosis in aging muscle. Ageing Res Rev 2006;5:179-195.
12. Barr K. The signaling underlying FITness. Appl. Physiol.. Nutr. Metab. 2009;34:411-419.
13. Volpi E, Kobayashi H, Sheffield-Moore M, Mittendorfer B, Wolfe RR. Essential amino acids are primarily responsible for the amino acid stimulation of muscle protein anabolism in healthy elderly adults. Am J Clin Nutr 2003;78:250-258.
14. Johnston APW, DeLisio M, Parise G. Resistance training, sarcopenia, and the mitochondrial theory of aging. Appl. Physiol. Nutr. Metab. 2008;33:191-199.
15. Gauchard GC, Gangloff P, Jeandel C, Perrin PP. Influence of regular proprioceptive and bioenergetic physical activities on balance control in elderly women. J of Gerontol. 2003.
16. Gauchard GC, Jeandel C, Perrin PP. Physical and sporting activities improve vestibular afferent usage and balance in elderly human subjects. Gerontology 2001;47:263-270.