Biology 465 – Integrative Biology of Spider Silk

Summer 2007

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Course Web site: http://my.fullerton.edu (accessed through Blackboard Link)
Required Readings: Readings will be provided in class or through Blackboard
Pre-requisites: Completion of the lower division core (or equivalent) and either Biol 303, Biol 309 **or** Biol 314. Pre-requisite courses must be completed with a passing grade prior to your enrollment in this course.

Course Goals: *Integrative Biology of Spider Silk* is a capstone course for the biology major. As such, the goal of this course is to help you develop and practice skills in analytical reading and scientific writing that will be required of you after graduation. In particular, this course provides you with the opportunity to explore how the various sub-disciplines of biology contribute to our understanding of a common theme – the production and use of silk by spiders.

The general student learning outcomes for this course are as follows:

- Evidence comprehension of the course concepts (Learning Objectives: see below)
- Be able to read and understand primary scientific journal articles
- Be able to identify and locate information required for analysis of a scientific topic
- Be able to use the computer for the collection, analysis, and communication of information.
- Be able to work cooperatively in a group to discuss and analyze information
- Be able to effectively synthesize and communicate scientific information in both oral and written formats.

Instructional Philosophy: A capstone course represents an opportunity to synthesize and apply the knowledge and skills that you have developed over years of study as a biology major. One important skill for any scientist is the ability to critically read and evaluate primary scientific literature. Readings of original research provide you with the opportunity to gain confidence in this skill.

Writing is another important skill in the sciences. The best way to improve your writing skills is through practice. You will be asked to complete several short writing assignments throughout the course leading to the production of a final term paper. The term paper will be in the format of a review article.

Grading Policy: Your grade for this course will reflect your performance on the various assignments and exams administered throughout the semester (see below). Assessment of your performance in this course requires that you attend class on a regular basis. Consistent with University policy, a grade of 'A' represents outstanding performance, a 'B' represents good performance, and a 'C' represents acceptable performance (refer your class schedule). You must earn a C or better to pass the course.

GRADUATE STUDENTS – Graduate students will be graded on a different scale from undergraduate students. This policy is consistent with UPS 411.100 section VI.C. Additional requirements will be described for specific assignments.

Letter Grade	A	A-	B+	B	B-	C+	C	D	F
Undergraduate	≥ 90%	85-89%	82-84%	78-81%	75-77%	72-74%	65-71%	51-64%	≤50%
Graduate	≥95%	90-94%	85-89%	80-84%	76-79%	73-75%	68-72%	59-67%	≤58%

Assignment	Total Possible	Percent of Grade
Participation (In-class & Online)	150 pts	15%
Questions	150 pts	15%
On-demand writing	100 pts	10%
Solve the Controversy	100 pts	10%
Presentations	250 pts	25%
Review Paper	250 pts	25%
TOTAL	1000 pts	100%

Participation – Participation is a requirement of this course. Your participation grade will be determined by your preparation and level of involvement in class discussions. Class discussion leaders will be chosen at random utilizing Sean's magic hat. Participation will also involve activities administered through Blackboard including peer evaluation of writing.

Questions – You will be required to prepare and post five questions on the blackboard discussion board. (graduates must post 8) related to the week's readings. The list of questions will be compiled by the instructor and provided to the class to facilitate discussions. Your questions should be posted by the deadline. Do not post questions like: What are spinnerets? The internet or the library can answer that.

On-demand Writing – You are required to come to class prepared to critically evaluate and discuss the assigned paper. In addition, you will also be asked to complete a short, in-class writing assignment for each paper. These assignments will be used to help you improve your writing skills.

Solve the Controversy – Certain topics we'll discuss this semester have generated controversy among the scientists involved. In class, you will be asked to decide which of the ideas is 'right' in a class debate. This assignment will help you hone your skills at developing logical arguments.

Presentations – Each student will be asked to make an oral presentation and lead a class discussion. The selection of a paper(s) for presentation will be made in collaboration with the instructors and should reflect an area of interest to you or may be based on your review paper (see below). Undergraduates will present a single paper while graduate students will present two related papers. You will be expected to research additional background information as needed to supplement your presentation using primary and secondary literature sources. Students are encouraged to use visual aids (handouts, overheads, PowerPoint) to enhance your presentation. You will be provided with a grading guideline in advance of your presentation.

Review Paper – You will be asked to select a topic related to spider silk that is of interest to you to research for a final paper. This paper will be written in the form of a scientific review article. Several short writing assignments related to the development of this paper will be given throughout the semester. It is expected that you use the feedback you receive on the multiple small

assignments as a guide to improve your writing of the final paper. Information regarding this assignment is provided in a handout and on the course website.

Other Class Policies and Information:

Attendance is required. It is the student's responsibility to notify the instructors of an absence and to obtain any information from classmates. While absence due to health or family emergencies are understandable, extended absence result in a loss of participation grade and can have a serious negative impact on your course grade.

Late Assignments will not be accepted. In-class activities will be considered late if they are not received when requested by the professor. On-line submission of work must be completed by the specified deadline.

Withdrawl from the course after the first week of summer session will only be granted for compelling reasons (physical, medical, emotional or job related). All requests for withdrawl must be supported by documentation. Poor academic performance is not considered a serious or compelling reason. The last day to drop this course with a grade of W is June 26th. However, since this requires the signature of the instructors, Department Chair and Dean, waiting until this date seriously impacts the probability of successfully dropping the course.

Class Etiquette is expected of all students. You should treat your fellow students as you would like to be treated. Respect the opinions and ideas of others and allow all members of a group to contribute. Disruptive behavior in the class will not be tolerated. Excessive talking, use of cell phones and pagers, or chronic late arrival or early departure from class are all examples of disruptive behavior. While in lecture, please turn your cell phones off or to vibrate if you absolutely cannot miss a call (i.e. it is an emergency). Your phone can be a distraction to other students. PLEASE BE CONSIDERATE! Using a laptop to take notes or do course related exercises in class is acceptable. HOWEVER, watching movies, chatting, surfing the internet or doing other non-course related activities on your laptop is not an acceptable practice in class. This is especially problematic if it disrupts class. Students who choose to disrupt the class will be asked to leave or may be administratively dropped from the course.

Classroom Safety

- In the event of an emergency such as earthquake or fire:
    - Take all your personal belongings and leave the classroom (or lab). Use the stairways located at the east, west, or center of the building.
    - Do not use the elevator. They may not be working once the alarm sounds.
    - Go to the lawn area towards Nutwood Avenue. Stay with class members for further instruction.
    - For additional information on exits, fire alarms and telephones, **Building Evacuation Maps** are located near each elevator.
    - Anyone who may have difficulty evacuating the building, please notify the instructor in advance.
- Dial 911 on any campus phone, pay phone, or blue emergency phones to connect directly to University Police. Dialing 911 on your cell phone will connect with the Highway Patrol. Tell CHP dispatcher that CSUF Police are the responding agency. Stay on the line until asked to hang up.
- If you want to bring visitors to the classroom, you must obtain permission from the instructor in advance and must sign a volunteer form.

Academic Integrity: Group work is an important part of this course and I encourage you to work with other students throughout the semester. It is equally important that you know when NOT to share your work with others. Exams (both in-class and online), writing assignments and other designated assignments should only reflect your own work. If the assignment requires that you discuss a problem or issue with your peers, do so, but make sure that your final answer is your own work in your own words.

Academic integrity is a requirement of this course and of the University. Academic integrity applies both to your performance on exams and on written assignments.

- **Plagiarism** is the unacknowledged used of another's words or ideas as your own. Use your own words when writing. Use quotation marks and cite the source of any phrase that you "borrow". Changing one or two words in a sentence is still plagiarism! (see (http://www.fullerton.edu/deanofstudents/judicial/Plagiarism.htm)
- **Cheating** is the use of another's work as your own. Copying another student's homework, looking at another student's exam, or using information from another student to enhance your performance on a task are all examples of cheating.

Students who violate university standards of academic integrity are subject to disciplinary sanctions, including failure in the course and suspension from the university. University policies are strictly enforced in this course. Please familiarize yourself with the academic integrity guidelines found in the current student handbook.

TENTATIVE COURSE SCHEDULE

DATE	TOPIC	READING	ASSIGNMENTS
May 29th	**Introduction to the Class** **Overview of Spider Silk** LEARNING OBJECTIVES: Become familiar with the range of topics associated with the study of spider silk Understand the expectations of an oral scientific presentation		On-demand Writing Assignment #1
May 31st	**Overview of Spider Physiology** LEARNING OBJECTIVES: Become familiar with the basics of spider physiology Identify major spider body parts Describe the basics of spider 'umwelt'	Biology of Spiders Chpt 1 & 5	Discussion Review of core concepts
June 4th	**Behavioral Ecology of Silk** LEARNING OBJECTIVES: Describe the different functions of silk across arthropod phyla Explain why spider's use of silk is unique amongst arthropods Use phylogenies to test hypotheses about adaptation Explain how a cost-benefit approach can be used to predict behavior.	Suppl Reading #1 Spiderwebs & Silk Chpt 1	Discussion On-demand Writing Assignment #2

June 5th	**Behavioral Ecology** (continued)	Suppl Reading #2	Discussion Solve the Controversy
June 7th	**Arthropod Evolution & Silk : Key Innovations in Silk** LEARNING OBJECTIVES: Describe the evolutionary trends related to silk production in arthropods Explain how the production and use of silk differs across the phylum Explain how silk is or is not a key innovation for different arthropod group	Suppl Reading #3	On-demand Writing Assignment #3
June 11th	**Mechanical Properties & Prey Capture** LEARNING OBJECTIVES: Relate the protein structure of diverse silk types with their biomechanical properties. Understand how to interpret stress/strain analysis of silks Describe what variable can influence the mechanical properties of a silk fiber	Suppl Reading #4	Discussion **Prelim. Statement of Topic**
June 12th	**Molecular Genetics of Silk** LEARNING OBJECTIVES: Compare silk motif patterns between insects and spiders Relate the presence of repeated motifs to the evolution of silk genes Describe the current state of knowledge regarding the regulation of silk gene expression	Suppl Reading #5	Discussion On-demand Writing Assignment #4
June 14th	**Silk Synthesis** LEARNING OBJECTIVES: Relate the basics concepts of protein synthesis and export to the production of silk Describe possible mechanisms for post-translational modification or processing within the silk gland Associate histological features of silk glands with their role in the production of a silk fiber	Suppl Reading #6	Discussion
June 18th	**Molecular Evolution of Silk** LEARNING OBJECTIVES: Apply the concept of the motif structure of silk genes to evolutionary trends in distinct silk proteins Compare gene structure of insects and spiders in the context of phylogenetic relationships Describe what is know regarding conserved sequences	Suppl Reading #7	Discussion On-demand Writing Assignment #5
June 18th	**Cool Topics in Silk – Alternate uses of silk** LEARNING OBJECTIVES: Identify potential uses of lipids within silks	Suppl Reading #8	Preliminary Annotated Bibliography Discussion
June 21st	**Cool Topics in Silk – Egg Cases** LEARNING OBJECTIVES: Compare properties of egg case silk with other silk types. Discuss and debate the molecular properties of egg case silk	Suppl Reading #9	Discussion **Solve the Controversy**
June 25th	**Cool Topics in Silk – Natural Selection** LEARNING OBJECTIVES:	Suppl Reading #10	Discussion **Solve the Controversy**

June 26th	**Cool Topics in Silk – Social Spiders** LEARNING OBJECTIVES:	Suppl Reading #11	**Final Paper Due** Discussion
June 28th	**Cool Topics in Silk – Biotechnology of Spider Silk** LEARNING OBJECTIVES: Identify current trends in genetically engineering silks Describe potential uses of synthetic silks	Suppl Reading #12	Discussion
July 2nd	**Student Presentations**		Review of Paper Student Questions
July 3rd	**Student Presentations**		Student Questions
July 5th	**Student Presentations (?)**		Student Questions **Revised Paper Due**

Suppl Reading = Supplemental Readings from primary literature and selected chapters from *Biology of Spiders* by R. Foelix or *Spiderwebs and Silk* by C. L. Craig

Supplemental Reading #1 – Behavioral Ecology (All Required)

Opell, B. D. 1997. The material cost and stickiness of capture threads and the evolution of orb-weaving spiders. Biological Journal of the Linnean Society 62:443-458.

Opell, B. D. 1998. Economics of spider orb-webs: the benefits of producing adhesive capture thread and of recycling silk. Functional Ecology 12:613-624.

Opell, B. D. 1999. Redesigning spider webs: Stickiness, capture area and the evolution of modern orb-webs. Evolutionary Ecology Research 1: 503-516.

Supplemental Reading #2 – Behavioral Ecology (All Required)

Caraco, T. and Gillespie, R. G. 1986. Risk-Sensitivity: Foraging mode in an ambush predator. Ecology 67:1180-1185.

Gillespie, R. G. and Caraco, T. 1987. Risk-sensitive foraging strategies of two spider populations. Ecology 68: 887-899.

Smallwood, P. D. 1993. Web-site tenure in the long-jawed spider: Is it risk sensitive foraging or conspecific interactions. Ecology 74:1826-1835.

Supplemental Reading #3 – Arthropod Evolution & Silk (All Required)

Agnarsson, I. Aviles, L., Coddington, J.A. and Maddison, W. P. 2006. Sociality in Theridiid spiders: Repeated origins of an evolutionary dead end. Evolution: 2342-2351.

Blackledge, T. A. & Gillespie, R. G. 2004. Convergent evolution of behavior in an adaptive radiation of Hawaiian web-building spiders. Proceedings of the National Academy of Science 101:16228-16233

Bond, J. E. & Opell, B. D. 1998. Testing adaptive radiation and key innovation hypotheses in spiders. Evolution 52: 403-414.

Shear, W.A., Palmer, J.M., Coddington, J.A. and Bonamo, P.M. 1989. A deveonian spinneret: Early evidence of spiders and silk use. Science 246:479-481.

Supplemental Reading #4 – Mechanical Properties & Prey Capture
(⌘ Required Reading)

Argintean, S., Chen, J., Kim, M., and Moore, A.M.F. 2006. Resilient silk captures prey in black widow cobwebs. Appl. Phys. 82: 235-241.

⌘ Blackledge, T.A., and Hayashi, C.Y. 2006. Unraveling the mechanical properties of composite silk threads spun by cribellate orb-weaving spiders. J. Expt. Biol. 209: 3131-3140.

⌘ Blackledge, T.A. and Hayashi, C.Y. 2006. Silken toolkits: biomechanics of silk fibers spun by the orb web spider *Argiope argentata* (Fabricius 1775). J. Expt. Biol 209: 2452-2461.

Blackledge, T.A., Swindeman, J.E., and Hayashi, C.Y. 2005. Quasistatic and continuous dynamic characterization of the mechanical properties of silk from the cobweb of the black widow spider *Latrodectus Hesperus*. J. Exp. Biol. 208:1937-1949.

Eisner, T., and Dean, J. 1976. Ploy and counterploy in predatory-prey interactions: Orb-weaving spiders versus bonbardier beetles. PNAS 73: 1365-1367.

⌘ Gosline, J.M., Guerette, P.A., Ortlepp, C.S. and Savage, K.N. 1999. The mechanical design of spider silks: From fibroin sequence to mechanical function. J. Expt. Biol. 202:3295-3303.

Hawthorn, A.C., and Opell, B.D. 2003. Van der Waals and hygroscopic forces of adhesion generated by spider capture threads. J. Exp. Biol. 206: 3905.

Opell, B.D. and Hendricks, M.L. 2007. Adhesive recruitement by the viscous capture threads of araneoid orb-weaving spiders. J. Exp. Biol. 210: 553-560.

Penalver, E., Grimaldi, D.A., and Delclos, X. 2006. Early Cretaceous spider web with its prey. Science 312:1761.

⌘ Tso, I-M., Wu, H-C, and Hwang, I-R. 2005 Giant wood spider *Nephila pilipes* alters silk protein in response to prey variation. J. Exp. Biol. 208: 1053-1061.

Vollrath, F., and Porter, D. 2006. Spider silk as archetypal protein elastomer (Review). Soft Matter 27: 377-385.

Supplemental Reading #5 – Molecular Genetics of Silk (⌘ Required Reading)

⌘ Colgin, M.A., and Lewis, R.V. 1998. Spider minor ampullate silk proteins contain new repetitive sequences and highly conserved non-silk-like "spacer regions". Protein Science 7:667-672.

Fedic, R., Zurovec, M., and Sehnal, F., 2003. Correlation between fibroin amino acid sequence and physical silk properties. J. Biol. Chem. 278: 352555-35264.

⌘ Hayashi, C.Y., Blackledge, T.A., and Lewis, R.V. 2004. Molecular and mechanical characterization of aciniform silk: Uniformity of iterated sequence modules in a novel member of the spider silk fibrion gene family. Molec. Biol. Evol. 21: 1950-1959.

Hinman, M.B. and Lewis, R.V. 1992. Isolation of a clone encoding a second dragline silk fibroin Nephila clavipes dragline silk is a two-protein fiber. J. Biol. Chem. 267: 19320-19324.

Lefevre, T., Rousseau, M. and Pezolet, M. 2007. Protein secondary structure and orientation in silk as revealed by raman spectromicroscopy. Biophys. J. 92: 2885-2895.

Stokstad, E. 2000. Spider genes reveal flexible design. Science 287: 1378.
⌘ Tian, M., Liu, C., and Lewis, R., 2004. Analysis of major ampullate silk cDNAs from two non-orb-weaving spiders. Biomacromol 5: 657-660.
Xu, M., and Lewis, R.V. 1990. Structure of a protein superfiber: Spider dragline silk. PNAS 87:7120-7124.

Supplemental Reading #6 – Silk Synthesis (⌘ Required Reading)

⌘ Bell, A.L. and Peakall, D.B. 1969. Changes in fine structure during silk protein production in the ampullate gland of the spider *Araneus seicatus*. J. Cell Biol. 42:284-295.
Craig, C.L., Riekel, C., Herberstein, M.E., Weber, R.S., Kaplan, D., and Pierce, N.E. 2000. Evidence for diet effects on the composition of silk proteins produced by spiders. Mol Biol. Evol. 17: 1904-1913.
⌘ Guerette, P.A., Ginzinger, D.G., Weber, B.H.F., and Gosline, J.M. 1996. Silk properties determined by gland-specific expression of a spider fibroin gene family. 272: 112.
Li, G., Zhou, P., Shao, Z., Xie, C., Chen, X., Wang, H., Chunyu, L, and Yu, T. 2001. The natural silk spinning process – A nucleation-dependent aggregation mechanism? Eur. J. Biochem. 268:6600-6606.
Marrero, B.M., Cajigas, I., Cajigas, X., Medina, S., Llavona, M., Alameda, A., Ortiz, N., and Candelas, G.C. 2006. Optimization of spider silk glands for the elicited production of a tissue-specific fibroin product. FASEB J 20:A105-A106.
Oroudjev, E., Soares, J., Arcidiacono, S., Thompson, J.B., Fossey, S.A., and Hansma, H.G. 2002. Segmented nanofibers of spider dragline silk: Atomic force microscopy and single-molecule force spectroscopy. PNAS 99:6460.
⌘ Perez-Rigueiro, J., Elices, M., Plaza, G.R., Real, J.I., and Guinea, G.V. 2006. The influence of anaesthesia on the tensile properties of spider silk. J. Expt. Biol 209: 320-326.
⌘ Perez-Rigueiro, J., Elices, M., Plaza, G., Real, J.I., and Guinea, G.V. 2005. The effect of spinning forces on spider silk properties. J. Expt. Biol. 208: 2633-2639.
Philips, K., 2006. How spiders spin. J. Exp. Biol. 209:1-11
Saravanan.D. 2006. Spider silk – structure, properties and spinning. J. Textile and Apparel Tech Manag. 5: 1-20.
Van Beek, J.D., Hess, S., Vollrath, F., and Meier, B.H. 2002. The molecular structure of spider dragline silk: folding and orientation of the protein backbone. PNAS 99:10266.
⌘ Vollrath, F., Knight, D.P., and Hu, X.W. 1998. Silk production in a spider involves acid bath treatment. Proc R. Soc. Lond. B 265:817-820.

Supplemental Reading #7 – Molecular Evolution of Silk (⌘ Required Reading)

⌘ Beckwitt, R., and Arcidiancono, S. 1994. Sequence conservation in the C-terminal region of spider silk proteins (Spidroin) from Nephila clavipes (Tetragnathidae) and Araneus bicentenarius (Araneidae). J. Biol Chem. 269: 6661-6663.
⌘ Garb, J.E., DiMauro, T., Vo, V., and Hayashi, C.Y. 2006. Silk genes support the single origin of orb webs. Science 312:1762.
⌘ Gatesy, J., Hayashi, C., Motriuk, D., Woods, J., and Lewis, R. 2001. Extreme diversity, conservation, and convergence of spider silk fibroin sequences. Science 291: 2603.
⌘ Hayashi, C.Y. and Lewis, R.V. 2000. Molecular architecture and evolution of a modular

spider silk protein gene. Science 287: 1477.

Supplemental Reading #8 – Alternate uses of Silk (⌘ Required Reading)

⌘ Prouvoust, O., Trabalon, M., Papke, M. and Schulz, S. 1999. Contact sex signals on web and cuticle of *Tegenaria artica* (Araneae, Agelenidae). Arch. Insect Biochem & Physiol. 40: 194-202.

Roberts, J. A., and Uetz, G. W. 2004. Chemical signaling in a wolf spider: A test of ethospecies discrimination. Journal of Chemical Ecology 30:1271-1284.

Roberts, J. A., and Uetz, G. W. 2005. Information content of female chemical signals in the wolf spider, *Schizocosa oceata*: male discrimination of reproductive state and receptivity. Animal Behaviour 70:217-223.

Shulz, S., 2001. Composition of the silk lipids of the spider *Nephila clavipes*. Lipids 36: 637-647.

⌘ Stowe, M.K., Tumlinson, J.H. and Heath, R.R. 1987. Chemical mimicry: Bolas spiders emit components of moth prey species sex pheromones. Science 236:964-967.

Supplemental Reading #9 – Egg Cases (⌘ Required Reading)

⌘ Garb, J.E. and Hayashi, C.Y. 2005. Modular evolution of egg case silk genes across orb-weaving spider superfamilies. PNAS 102:11379-11384.

⌘ Hu,X., Kohler, K., Falick, A.M., Moore, A.M.F., Jones, P.R. Sparkman, O.D., Vierra, C. 2005. Egg case protein-1. A new class of silk proteins with fibroin-like properties from the spider *Latrodectus hesperus*. J. Biol. Chem. 280:21220-21230.

Van Nimmen, E., Gellynck, K., Van Langenhove, L., and Mertens, J. 2006 The tensile properties of cocoon silk of the spider *Araneus diadematus*. Textile Res. J. 76:691-628.

⌘ Zhao, A., Zhao, T., SiMa, Y., Zhang, Y., Nakagaki, K., Miao, Y., Shiomi, K., Kajiura, Z., Nagata, Y. Nakagaki, M. 2005. Unique molecular architecture of egg case silk protein in a spider *Nephila clavata*. J. Biochem (Tokyo) 138:593-604.

Supplemental Reading # 10 – Natural Selection (All Required)

Blackledge, T. A. 1998. Signal conflict in spider webs driven by predators and prey. Proceedings of the Royal Society of London Series B 265:1991-1996.

Blackledge, T. A. and Wenzel J. W. 1999. Do stabilimenta in orb webs attract prey or defend spiders? Behavioral Ecology 10: 372-376.

Blackledge, T. A. and Wenzel J. W. 2000. The evolution of cryptic spider silk: a behavioral test. Behavioral Ecology 11:142.145.

Craig, C. L. and Bernard, G. D. 1990. Insect attraction to ultraviolet-reflecting spider webs and web decorations. Ecology 71: 616-623.

Herberstein, M.E., Craig, C. L., Coddington, J. A. and Elgar, M. A. 2000. The functional significance of silk decorations of orb-web spiders: a critical review of the empirical evidence. Biological Reviews 75:649-669.

Supplemental Reading # 11 - Social Spiders (All Required)

Uetz, G. W. 1989. The "ricochet effect" and prey capture in colonial spiders. Oecologia 81:154-159.

Uetz, G. W. 1996. Risk sensitivity and the paradox of colonial web-building in spiders. American Zoologist 36:459-470.

Uetz, G. W., Boyle, J. , Hieber, C. S. and Wilcox, R. S. 2002. Antipredator benefits of

group living in colonial web-building spiders: the 'early warning' effect. Animal Beahvior 63:445-452.
Whitehouse, M. E. A. and Lubin, Y. 2005. The functions of societies and the evolution of group living: spider societies as a test case. Biological Reviews 80:347-361.

Supplemental Reading #12 – Biotechnology of Silk (⌘ Required Reading)

⌘ Du, N., Liu, X.Y.., Narayanan, J., Li, L., Lim, M.L.M. and Li, D. 2006. Design of superior spider silk: From nanostructure to mechanical properties. Biophys. J. 91: 4528-4535.
Foo, C.W.P., Patwardhan, S.V., Belton, D.J., Kitchel, B., Anastasiades, D., Huang, J., Naik, R.R. Perry, C.C., Kaplan, D.L. 2006. Novel nanocomposites from spider silk-silica fusion (chimeric) proteins. PNAS 103:9428-9433.
⌘ Guinea, G.V., Elices, M., Perez-Rigueiro, J, and Plaza, G.R. 2005. Stretching of supercontracted fibers: a link between spinning and the variability of spider silk. J. Exp. Biol. 208:25-30.
Kenney, J.M., Knight, D. Wise, M.J., and Vollrath, F. 2002. Amyloidogenic nature of spider silk. Eur. J. Biochem. 269:4159.
Kojic, N., Clasen, C., McKinley, G.H. 2006. *Ex vivo* reheology of spider silk. J. Exp. Biol. 209:4355- 4362.
⌘ Lazaris, A., Arcidiacono, S., Huang, Y., Zhou, J-F., Duguay, F., Chretien, N., Welsh, E.A., Soares, J.W., Karatzas, C.N. 2002. Spider silk fibers spun from soluble recombinant silk produced in mammalian cells. Science. 295: 472.
Mukhopadhyay, S., and Sakthivel, J.C. 2005. Spider silk – providing new insights in the field of high performance materials. J. Indust. Textiles 35:91-113.
Ohshima, Y., and Suzuki, Y. 1977. Cloning of the silk fibroin gene and its flanking sequences. PNAS 74:5363-5367.
Wilson, D., Valluzzi, R., and Kaplan, D. 2000. Coformational transitions in model silk peptides. Biophys J. 78:2690-2701.
⌘ Yang, M. and Asakura, T. 2005. Design, expression and solid-state NMR characterization of silk-like materials constructed from sequences of spider silk, *Sami cynthia ricini* and *Bombyx mori* silk fibroins. J. Biochem (Tokyo) 137:721-729.

Name (PRINT):_____

Date:_____

On Academic Integrity from the BIOL 465 syllabus.
Academic integrity is a requirement of this course and of the University. Academic integrity applies both to your performance on exams and on written assignments.

- **Plagiarism** is the unacknowledged used of another's words or ideas as your own. Use your own words when writing. Use quotation marks and cite the source of any phrase that you "borrow". Changing one or two words in a sentence is still plagiarism! (see (http://www.fullerton.edu/deanofstudents/judicial/Plagiarism.htm)
- **Cheating** is the use of another's work as your own. Copying another student's homework, looking at another student's exam, or using information from another student to enhance your performance on a task are all examples of cheating.

Students who violate university standards of academic integrity are subject to disciplinary sanctions, including failure in the course and suspension from the university. University policies are strictly enforced in this course. Please familiarize yourself with the academic integrity guidelines found in the current student handbook.

From the Student Guide to Avoiding Plagiarism. by S. Rhoten. 1999. Judicial Affairs, CSUF Dean of Students Office

> Plagiarism is the unacknowledged and inappropriate use of the ideas or wording of another writer. Because plagiarism corrupts values in which the university community is fundamentally committed – the pursuit of knowledge, intellectual honesty – plagiarism is considered a grave violation of academic integrity and the sanctions against it are correspondingly severe. Plagiarism can be characterized as "academic theft."
> **Plagiarism** is:
> • The submission of material authored by another person but represented as the student's own work, whether that material is paraphrased or copied in verbatim or near-verbatim form.
> • The submission of material subjected to editorial revision by another person that results in substantive changes in content or major alteration of writing style and
> • Improper acknowledgment of sources in essays, papers, or presentations.

Please note: Taking a sentence from a particular source and just **changing a few words** is still **PLAGIARISM**.

If plagiarism is suspected you may be asked to submit an electronic version of the assignment in question for checking with one of the available anti-plagiarism software packages. ***All*** incidences of academic dishonesty will be reported to the Associate Dean of Student Affairs.

I ,_____, on _____ date hereby indicate that I have **read** and **understand** the syllabus of BIOL 465 ,understand the definition of *PLAGIARISM,* **and** am **aware of** and **understand** the consequences of academic dishonesty put forth in the BIOL 465 syllabus.