**Biomimicry: Nature’s Designs**

Fall 2019  
DSC_OX 101Q (3 credits)  
Course Number: 3910  
Tues/Thurs 10:00am-11:15am  
Oxford Science Building, Room 201

**INSTRUCTOR INFORMATION**

Professor: Dr. LaTonia Taliaferro-Smith  
Office: Oxford Science Building 324  
Email: ltsmit3@emory.edu

Office hours: Tuesdays and Thursdays, 2-3:30pm  
Office phone: (770) 784-8607

**COURSE SUMMARY**

**What is biomimicry?** Biomimicry is a relatively new science that studies nature’s models and then imitates or takes inspiration from these designs and processes to solve human problems, for example, a solar cell inspired by a leaf. After 3.8 billion years, nature has learned: What works. What is appropriate. What lasts. Biomimicry is a new way of viewing and valuing nature. It introduces an era based not on what we can extract from the natural world, but on what we can learn from it. -- *Biomimicry: Innovation Inspired by Nature*, (Janine M. Benyus, 1997).

**Why biomimicry?** The emerging fields of biomimetics and bioinspiration use biology to inspire solutions to challenging problems, or speed biological progress by reaching outside of biology to other disciplines for inspiration. Common examples include the invention of Velcro, a product mimicking burrs when they stick to fur; or the development of game theory for ecological applications, originating from economic theory. In this course, we will explore how these ideas of biomimetics and bioinspiration permeate our daily lives, examining past and present examples, and creating some of our own.

**Nature runs on sunlight**  
**Nature uses only the energy it needs**  
**Nature fits form to function**  
**Nature recycles everything**  
**Nature rewards cooperation**  
**Nature banks on diversity**  
**Nature demands local expertise**  
**Nature curbs excesses from within**  
**Nature taps the power of limits**

About this curriculum: The primary goal is to introduce the ideas of biomimetics and bioinspiration, while simultaneously developing and honing your abilities to think across disciplines for active problem-solving. Over the course of the semester, you will be encouraged to identify problems and to think cross-disciplinarily for creative, effective solutions. By the end of the course, you should clearly understand what are biomimetics and bioinspiration, and provide examples of each. You should also be able to reach into other disciplines for addressing challenges. Finally, you will be able to evaluate your progress and what you have learned in the course through the completion of a final video presentation that you can continue building upon after the course is finished.
COURSE GOAL/OBJECTIVES

Through this course, the professor and learners alike will:

- Interpret observations in nature with a functional lens for design application by strengthening relationships with the local environment.
- Apply familiar biological concepts in designing products or processes for humans that are inspired by nature’s adaptations.
- Collaborate with nature to devise and apply practical solutions to current challenges.
- Communicate effectively through a variety of verbal and visual means how the process of biomimicry works.

COURSE LEARNING OUTCOMES

Upon successful completion of this course, students will be able to:

- Demonstrate an understanding of biomimicry and bioinspiration through biology, and how these fields can aid human progress and sustainable living.
- Demonstrate increased awareness of how biology can speed progress in other industries and how disciplines outside of biology can enrich the field by hone skills for thinking and communicating cross-disciplinarily for creative problem-solving.
- Demonstrate the ability to work as small research teams to design and implement a biomimicry design project using the design thinking process as a guideline.
- Effectively communicate scientific findings through a variety of formal and informal written, visual, and oral methods.
- Differentiate between primary, secondary and tertiary sources of information and critically analyze and evaluate literature relevant to the topic to be studied.

COURSE MATERIALS/ASSIGNMENTS

What you need to provide:

- **Recommended Readings:**
  - *Nature Design: From Inspiration to Innovation* by Angeli Sachs, 2007. (Almost completely filled with photographs, this book explores the discovery of nature in the Art Nouveau period from the 1930s to the 1970s.)
  - *Nature Got There First: Inventions Inspired by Nature* by Phil Gates, 2010. (Nature is full of amazing designs and ‘mechanisms’ that appear to have inspired the engineering and technology we use today.)
  - *The Hidden Powers of Animals* by Carl P.N. Shuker, 2001. (A fascinating look at the astonishing behavior and super-human abilities of animals, from kings of the jungle to household pets. This book reveals incredible truths about animals and their remarkable sensitivities, skills and strengths.)
- **Reading Assignments:** Additional reading assignments will come from the primary literature, recommended books, news articles, and the instructor. Readings will be distributed to you as needed. All other course documents, readings, and videos will be posted or linked to CANVAS. We will also use CANVAS for posting class announcements and changes to the schedule.
- **Written Assignments:** Unless otherwise indicated, all homework assignments are due the following class period after it was assigned.
  - Recommended 3-ring binder for class handouts, taking notes, and drafting ideas.
  - Flash drive, Google Drive, or some other cloud service for storing files.
  - Internet access and Emory University email address you check every day.
COURSE UNITS

This course will introduce students to a “design thinking process” that can help them apply principles of biomimicry to address critical real-world problems related to important social or environmental issues. It sets the stage for a biomimicry design final project. These lessons provide students with opportunities to practice creative problem-solving by applying strategies and lessons observed in nature within the context of a team design project. Biomimicry itself provides a new way for students to engage with biology, engineering, and design topics.

1. Identify a challenge to address, including its stakeholders, criteria, and constraints
   - Introduction to Biomimicry
   - Lesson 1: Design Thinking and Biomimicry
   - Lesson 2: Identifying the Design Challenge

2. Explore how nature has solved similar challenges
   - Lesson 3: Identifying the Design Challenge
   - Lesson 4: Exploring Nature’s Patterns

3. Brainstorm design ideas that emulate nature’s strategies
   - Lesson 5: Creating Nature-inspired Ideas

4. Evaluate and improve the strongest design ideas
   - Lesson 6: Redefining the Design

5. Summarize design concepts, create a presentation, and share your design
   - Lesson 7: Sharing Design Solutions

COURSE SCHEDULE (subject to change)

<table>
<thead>
<tr>
<th>WEEK</th>
<th>DAY</th>
<th>DATE</th>
<th>TOPIC</th>
<th>CLASS ACTIVITIES/HOMEWORK</th>
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<tbody>
<tr>
<td>AUGUST</td>
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<tr>
<td>1</td>
<td>WED</td>
<td>8/28/19</td>
<td>First Day of Classes</td>
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|      | THU | 8/29/19 | Introductions                              | In-Class:  
- Intros: (classmates & professor)  
- What is Discovery Seminar?  
- Course Syllabus |
| SEPTEMBER | |         |                                            |                                                              |
| 2    | TUE | 9/3/19  | Introduction to Biomimicry (part I)        | HW: Read Chapter 1, “Echoing Nature” (Benyus)  
In-Class:  
- Observe sample of plants, animals, insects in lab  
HW: Read Chapter 2, “How will we feed ourselves?” (Benyus)  
In-Class:  
- “Triple Bottom Line” article  
HW: Complete Lesson 1 Reflection Questions  
In-Class:  
- Mind-mappings Design  
HW: Detective Wall Worksheet  
In-Class:  
- Form a Design Worksheet  
- Build-A-Box Activity  
HW: Glass-half-full Worksheet  
HW: Complete Lesson 2 Reflection Questions |
<p>| THU  | 9/5/19 | Introduction to Biomimicry (part II)       |                                                              |
| 3    | TUE | 9/10/19 | Lesson 1: “Design Thinking and Biomimicry”  |                                                              |
| THU  | 9/12/19 | Lesson 2: Identify-Forming a Design Question (part I) |                                                              |
| 4    | TUE | 9/17/19 | Lesson 2: “Identify-Forming a Design Question” (part II) |                                                              |</p>
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<th>Day</th>
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<th>HW</th>
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<td>Digication (Language Hall, Room 201)</td>
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<td>9/24/19</td>
<td>5 TUE</td>
<td>Guest Lecturer(s)/Lab</td>
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<td>9/26/19</td>
<td>THU</td>
<td>Guest Lecturer(s)/Lab</td>
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<td>9/26/19</td>
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<td>In-Class: Looking for Natural Models</td>
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<td>HW: Read Chapter 3, “How will we harness energy?” (Benyus)</td>
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<td>9/26/19</td>
<td>THU</td>
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<td>In-Class: TBD</td>
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<td>9/26/19</td>
<td>THU</td>
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<td>HW: Read Chapter 4, “How will we make things?” (Benyus)</td>
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**OCTOBER**

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<th>Date</th>
<th>Day</th>
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<th>HW</th>
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<tr>
<td>10/1/19</td>
<td>6 TUE</td>
<td>Lesson 3: Exploring Nature’s Solutions (part I)-Nature Walk (II)</td>
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<td>10/3/19</td>
<td>THU</td>
<td>Lesson 3: Exploring Nature’s Solutions (part II)</td>
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<tr>
<td>10/8/19</td>
<td>7 TUE</td>
<td>Lesson 3: “Exploring Nature’s Solutions” (part III)</td>
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<td>10/10/19</td>
<td>THU</td>
<td>EXAM I</td>
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<td>10/15/19</td>
<td>8 TUE</td>
<td>FALL BREAK-NO CLASS</td>
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<tr>
<td>10/17/19</td>
<td>THU</td>
<td>Lesson 4: “Exploring Nature’s Patterns”</td>
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<td>10/22/19</td>
<td>9 TUE</td>
<td>Group Work Day/Librarians visit</td>
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<td>10/24/19</td>
<td>THU</td>
<td>Group Work Day/Librarians visit</td>
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<td>10/29/19</td>
<td>10 TUE</td>
<td>Lesson 5: Create Nature-Inspired Ideas (part I) “From Inspiration to Application”</td>
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<td>10/31/19</td>
<td>THU</td>
<td>Lesson 5: Create Nature-Inspired Ideas (part II)</td>
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<tr>
<td>11/5/19</td>
<td>11 TUE</td>
<td>Lesson 5: Create Nature-Inspired Ideas (part III)</td>
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<td>In-Class: Work on design ideas</td>
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THU 11/7/19  Academic Technology Team

THU 11/14/19  Lesson 6: Refining the Design (part II)

THU 11/21/19  Lesson 7: Sharing Design Solutions (part I)

THU 11/28/19  THANKSGIVING BREAK-NO CLASSES

DECEMBER

TUE 12/3/19  Student Evaluations

THU 12/5/19  FINAL PRESENTATIONS (PART 1)

TUE 12/10/19  FINAL PRESENTATIONS (PART 2)

THUR 12/12  FINAL EXAMS BEGIN

18 12/18  FINAL EXAMS END

RULES FOR SUCCESS (STUDENT RESPONSIBILITIES)

The value and success of this class depends upon the willingness of its members to read, to listen, to share ideas, to challenge themselves as well as each other, and to ask questions. What you gain from this course will reflect the time and effort you put into it. This course has four important rules. By following these rules, your odds of
learning the materials and earning a good grade in this class will improve greatly (these rules will also help you succeed in your other courses).

1. **Show up!** To be successful in this course, you must choose to attend every scheduled class period in its entirety. If you must miss class due to an authorized University activity such as an athletic competition, you must provide written notification at least one week prior to the class that will be missed. For absences such as illnesses or personal issues, you must contact me prior to class if at all possible. If a true emergency prevents you from contacting me prior to class, contact me as soon as possible following the emergency with appropriate documentation from student health services or your healthcare provider.

   Every student has 1 “free” unexcused absence (though it is not really free, as you always miss something when you miss class). A second unexcused absence will result in a 5% cut in your final class grade and a third absence a 10% cut; these cuts are in addition to any quiz, participation, or in-class assignment points you lose during your absence. **More than 3 unexcused absences may result in a failing grade for the class.**

   If you have other classes that have more lenient attendance policies, I strongly recommend that you not take advantage of the “freedom” to skip class. **Going to classes is the SINGLE MOST important rule in succeeding in college!** Tardiness of over 5 minutes will result in an absence for the day.

2. **Do the work!** To succeed in this course, you must choose to do your very best work in preparing for each class session and on all your assignments. Come prepared with all necessary materials. Take responsibility for your assignments. When directions are given, do your best to follow them the first time. If you are confused or have questions, ask. I would rather have you stop class to clarify than be off task while everyone else is working.

3. **Participate actively!** To succeed in this course, you must stay focused and involved in every class, offering your best comments, questions, and answers. This is a seminar class, not a lecture class, so active discussion is expected of all students. Engage in what is going on in class. If you have a question, ask it! There are not stupid questions, and chances are, if you are wondering about it, someone else in the class it too. Be proactive about your learning and don’t be afraid to ask for help. If you feel most comfortable waiting until after class or during officer hours, that is okay too, but do keep communication open between us.

   **Respect:** Be a kind person and show respect for the professor, yourself, and others at all times. You will be exposed to a variety of viewpoints, values, and opinions in college that will differ from your own. All students in this class should feel comfortable expressing their viewpoints and concerns in class. You are an important part of creating an atmosphere that makes this possible. This applies to the professor as well. Student actions that interfere with teaching and learning in the classroom will **NOT** be tolerated. Offensive, profane, and derogatory language and behavior will **NOT** be tolerated! In order to have a safer classroom environment, ......... Remember, if you don’t have something nice to say, don’t say it at all.

   **Electronic devices:** Turn off your cell phone and all electronic devices and put them away before class starts so you can focus on the class discussion and not cause a distraction for others. Do not “text” or use laptops during class unless instructed to do so by the professor.

4. **Be Honest!** Your professor and fellow students expect you to choose to act with integrity in all your classes, including this one. See [http://oxford.emory.edu/catalog/regulations/honor-code.html](http://oxford.emory.edu/catalog/regulations/honor-code.html) for the Oxford College Honor Code for more clarification.

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**ASSESSMENTS AND GRADING POLICY**

**Grading:** In order to **EARN** a satisfactory grade, a student is expected to attend the weekly discussion groups, conduct research, and present the results as a poster, oral presentation, and/or written manuscript. Students are responsible for knowing and maintaining their grades. Students are expected to demonstrate genuine interest and become intellectually involved in their design project. This may be demonstrated (among other ways) by:

- **Completing all assigned readings for their research** (e.g. published journal articles, previous lab theses, etc.)
• Level of preparation for presentations where the student receives feedback from peers and instructor.
• Frequency or kind of questions asked and interest in discussing the research with their instructor and peers.
• Level of responsibility and dedication toward their independent projects.

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<thead>
<tr>
<th>Homework/Assignments</th>
<th>15%</th>
<th>150 points</th>
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<tbody>
<tr>
<td>Quizzes</td>
<td>10%</td>
<td>100 points</td>
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<tr>
<td>Exams:</td>
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<tr>
<td>Exam 1 (75 points)</td>
<td>15%</td>
<td>150 points</td>
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<tr>
<td>Exam 2 (75 points)</td>
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<tr>
<td>Classwork/Participation</td>
<td>15%</td>
<td>150 points</td>
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<tr>
<td>Attendance</td>
<td>10%</td>
<td>100 points</td>
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<tr>
<td>Notebook/Journal</td>
<td>5%</td>
<td>50 points</td>
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<td>Final Project Presentation</td>
<td>25%</td>
<td>250 points</td>
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<tr>
<td>Written Paper (75 points)</td>
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<td><strong>TOTAL:</strong></td>
<td>100%</td>
<td>1000 POINTS</td>
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**Grading Scale:**
95 - 100% = A
90 - 94% = A-
87 - 89% = B+
84 - 86% = B
83 - 80% = B-
79 - 77% = C+
76 - 74% = C
70 - 73% = C-
69% or below = F

***EXTRA CREDIT: Individual Biomimicry Presentations (50 extra points)***

**OTHER IMPORTANT ASPECT OF THE COURSE**

**Honor Code:** All work for credit in this course come under the regulations of the Honor Code. Your signature on your work attests to your upholding the Honor Code. Please read the information on plagiarism on the Library web page and always ask if you have any questions about assignments. Note that writing assignments will be submitted to an appropriate plagiarism software. Please follow the Honor Code in ALL aspects of this course and include your signature on your work as your pledge.

**Class Participation (see details in “Rules for Success” section above):** Points are assigned for participation. These points are assigned based on your overall engagement in the classroom and laboratory throughout the semester (asking and answering questions, problem solving abilities, level of preparation, displaying your interest by contributing to overall discussion).

**Attendance/Absentee Policy (see details in “Rules for Success” section above):** Unexcused absences, tardiness, or a failure to follow the procedures can result in a reduction in your grade. It is your responsibility to clearly communicate with the instructor as much in advance as possible about medical or family emergencies.

**Late Assignments (Flex Days):** Due dates for every assignment are provided on the course syllabus and course schedule (and posted in CANVAS). Unless otherwise stated, assignments are due on those days. However, I recognize that sometimes “life happens.” In these instances, you may use your allotted 2 flex days. These days allow you to submit an assignment up to two days late without penalty. You can use these days for any assignments for any reason (EXAMS excluded). You do not need to provide me with the reason: simply email me and tell me when you will be using your flex days.

Once you have exhausted your flex days, then point deductions will occur for any assignment submitted after the deadline. An assignment submitted 24 hours after the due date will only be eligible for 80% of the maximum number of points allotted. Assignments submitted more than 24 hours after the due date will not be accepted. If you experience extenuating circumstances (e.g., hospitalization) that prohibit you from submitting your assignment on time, please let me know as soon as you can. I will evaluate these instances on a case-by-case basis.
**Cell Phones:** The use of cell phones is **strictly** prohibited in the classroom and the laboratory. Please turn off your phone before you come to class. Photography with camera phones is only permitted to gather evidence for your research project.

**Personal Computer or Tablet:** If you would like to take notes on your personal laptop or tablet, you must first seek special permission from the instructor. Surfing the web, Facebook, Skype or other multitasking/networking/chat during lecture and lab is **completely unacceptable** and will not be tolerated.

**Accommodations:** Access, Disability Services and Resources (ADSR) provides academic services and accommodations for students with diagnosed disabilities. Students are responsible for initiating the accommodation request process by self-disclosing their disability directly to the ADSR office. All requests and materials are handled in the strictest of confidence. The documentation provided regarding the disability diagnosis must demonstrate a disability covered under Section 504 of the Rehabilitation Act of 1973 and Title II of the Americans with Disabilities Act (ADA) of 1990, amended as of 2008. The ADA defines a disability as a physical or mental impairment that substantially limits one or more major life activities. For more information about applying for accommodations, disability services, and other services associated with the ADSR office please follow the link below for the specific area and forms you are searching for.

**Emory Access, Disability Services, and Resources Office:** [http://equityandinclusion.emory.edu/](http://equityandinclusion.emory.edu/)

**College-Wide Assessment:** Student work submitted as part of this course may be reviewed by Oxford College and Emory College faculty and staff for the purposes of improving instruction and enhancing Emory education.

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**Take care of yourself:**

- Do your best to maintain a healthy lifestyle this semester by eating well, exercising, avoiding drugs and alcohol, getting enough sleep, and taking time to relax. Despite what you might hear, using your time to care for yourself will actually help you achieve your academic goals more than spending too much time studying.
- All of us benefit from support and guidance during times of struggle. There are many helpful resources available on campus. An important part of the college experience is learning how to ask for help. Take the time to learn about all of the resources that are available and take advantage of it. Ask for support sooner rather than later-this always helps.
- If you or anyone you know experiences any academic stress, difficult life events, or difficult feelings like anxiety or depression, we strongly encourage you to seek support. Consider reaching out to a friend, faculty, or family member you trust for assistance connecting to the support that can help. The Counseling and Career Services (CCS) office is here for you: call (770) 784-8394 and visit their website at [http://oxford.emory.edu/life/thriving-at-oxford/counseling-and-career.html](http://oxford.emory.edu/life/thriving-at-oxford/counseling-and-career.html)