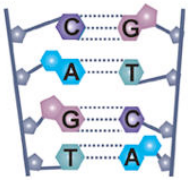
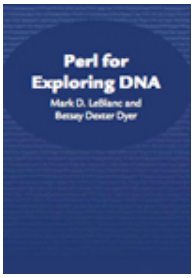



**syllabus for**

# DNA

## comp/bio 242

Instructor: **Mark LeBlanc** SC-103 508.286.3970
mleblanc@wheatoncollege.edu Office Hours:
MW 11:30-12:30, 2-3




Meeting Times: Monday, Wednesday, Friday 10:30 – 11:20
Room 154, SciCenter *or* csLab—A118b

Text: **Perl for Exploring DNA** by LeBlanc and Dyer
(Oxford University Press 2007)

## 10 GOALS for this course

(0) You are at a cocktail party and the topic of genomes comes up. You are able to **recall** significant phrases, terms, and techniques and your **understanding** of the main ideas and concepts enables you to lead the conversation for a while. Your friends raise their eyebrows.
(1) You learn to **identify** and **classify** problems that are candidates for a computer to handle.
(2) You **demonstrate** the ability to **think algorithmically**, breaking what originally seems like an overly complicated problem into a series of smaller, manageable tasks.
(3) You learn to **craft creative solutions** by "**writing software**" ("to program", "to script").
(4) You appreciate when to **include external modules** of previously written software.
(5) You **design experiments** to first solve small computationally-intensive tasks (e.g. on one gene sequence) and then **scale** your solutions to very large sets of data (e.g. all genes in a genome).
(6) You **apply** problem solving strategies previously learned to novel situations.
(7) You learn to professionally **document** your software and produce quality summaries, graphs, and reports of your results.
(8) You begin to appreciate genome-wide **microarray experiments** and the accompanying software that is required to analyze results.
(9) You feel empowered to **evaluate** the ethical implications of your work and learn to **appraise**, **critique**, and **defend** your own as well as the work of others.

## Connections: The Bigger Picture

This course is part of the ***connection "Genes in Context"*** *with Philosophy 111 (Ethics).* Throughout the semester, students will be exposed to the ethical aspects of living in a post-genomic world and the increasing use and challenges of sequenced genomes as applied to "**personalized medicine**". A series of assignments and events with students from other classes will include:

- A showing of the movie GATTACA and follow-up discussion.
- Talks and discussions with a genetic counselor and professor of bioethics.
- Student-produced, one-minute YouTube "commercials" of companies currently promoting and selling medical profiles based on individual genomes. The commercials will be framed from one of two points of view: (i) from the point of view of the company (e.g., 23andME, deCODEme, Navigenics, etc) or (ii) from a consumer advocacy point of view.

**Catalog Description**

An amazing blend of science, computing, and mathematics emerges when considering the molecule "Deoxyribonucleic Acid" (DNA). DNA is the blueprint of life for all organisms on Earth and throughout evolutionary time. Its distinctive and beautiful physical nature, a double helix of four bases, maps onto its functionality as a bearer of information, generation after generation. Fully sequenced genomes including the human genome and hundreds of microbial genomes have become the starting point for attempts to answer a wide range of biological and quantitative questions.


This DNA-242 course satisfies the **Quantitative Analysis (QA**) requirement.

Exact pages to reading and use of web sites will be **assigned in class**. URLs are listed as assigned/needed in the onCourse (Moodle) website.

**Web Resources:**

From the PBS show NOVA: **"Cracking the Code of Life"**
Watch the program in 16 online video segments
**http://www.pbs.org/wgbh/nova/genome/program.html**

From the Dolan DNA Learning Center & Cold Spring Harbor Laboratory: "**DNA From the Beginning**". *DNA from the Beginning* is organized around key concepts. **http://www.dnaftb.org/dnaftb/**

**DNA interactive:** http://www.dnai.org/a/index.html

**NCBI:** National Center for Biotechnology Information
NCBI creates public databases, conducts research in computational biology, develops software tools for analyzing genome data, and disseminates biomedical information. **http://www.ncbi.nlm.nih.gov/**

**A Perl FAQ**
http://theoryx5.uwinnipeg.ca/CPAN/perl/pod/perlfaq1.html

**Notes on grading, due dates, and submission procedures**

Because the lab and class preparation is costly both in money ($) and time, you must attend all classes and labs. When **homework** is "due in class", this means at the beginning of the class on that particular day, e.g., we will collect your homework at the start of class. Homeworks that arrive after the class and up to one day late will lose 10%. No homeworks are accepted after one-day late.

**Programs** are due on various dates (see detailed syllabus); however, since we know from experience that many students like to use the last night for testing, we will allow you to submit your programs until 5am the following day. For example, Program #1 is due THUR, Sept 17th, but you can submit it electronically until 5am FRI, Sept 18th -- Careful! The course website (onCourse) makes it appear as if the program is due on Friday, but remember, Friday at 5am! Programs submitted after this time will lose 20% each day it is late upto two days late. A program submitted more than two days late will not be accepted and will receive a grade of zero. In addition to **electronically submitting** your Perl programs (more instructions will be given in class), you must submit a **hardcopy printout** of your program in class after it is due. Note that Perl programs must *always* be **printed** in **landscape mode** and your source listing must be **stapled** to your sample output and documentation (README) file. (Your professor will say @%^$#&* and will deduct points if you do not staple.)

It is expected that you spend *at least* **2 hours** on **reading and practice problems** for every hour of lecture. This computes to *at least* **6 hours of work outside of class per week.** This should be done throughout the semester. Please assume all deadlines are fixed. Obviously, see your professor if you know of a conflict beforehand.

**Honor Code Revisited:** It goes without saying that all submitted work will be the student's own, in keeping with the Wheaton Honor Code. For labs, you may get help from fellow classmates, but remember that all submitted work must be your own. All homeworks, Perl programs, and other hand-written work must be your own from beginning to end unless otherwise noted in the instructions (e.g., paired work).

**Guest Lectures**

| | |
|---|---|
| Jenny Lanni, Biology | "The Central Dogma", Sept. 4th |
| Teresa Celada, Philosophy | "Designer Babies", Oct. 2nd |
| Mike Kahn, Statistics | "Randomness", Oct. 30th |

**YOUR GRADE**

5% **ATTENDANCE/PARTICIPATION** - based on attendance/participation in all sessions

10% **QUIZZES (5)** - see detailed schedule (usually at start of class)

15% **HOMEWORKS**

| | | |
|---|---|---|
| Sept 4 | Homework #1 – 1 point | - installation of Perl environment |
| Sept 11 | Homework #2 – 2 points | - RegEx (Part I) |
| Sept 30 | Homework #3 – 10 points | - one-minute "personalized medicine" video |
| Oct 02 | Homework #4 – 2 points | - chalking RegEx in sidewalk art |

50% **PROGRAMS** (six)

| | | |
|---|---|---|
| Sept 17 | Program #1 (5%) | - String Play |
| Sept 24 | Program #2 (5%) | - Chargaffin Counts |
| Oct 2 | Program #3 (10%) | - Gene Finder |
| Oct 16 | Program #4 (10%) | - "eLmer" a motif finder |
| Oct 30 | Program #5 (10%) | - Fuzzy Olfactory Gene Counter |
| Nov 18 | Program #6 (10%) | - Building a Concordance |

20% Final **Project**

| | | |
|---|---|---|
| Nov 23 | Written Proposal (Intro & Methods) | (5%) |
| Dec 7, 9, 11 | Oral Presentation | (5%) |
| Dec 11 | Final Paper, Software, and Results | (10%) |

Throughout the semester, you will have the opportunity to show Superior Effort, for example, a homework or programming assignment has additional steps. Remember, when determining your final, overall grade: an 'A' is superior, 'B' is above average, 'C' is average effort, etc.

As you can see, the final projects are a significant part of your final grade (20%). Your professor will determine the team pairs. Each pair of students will be given a certain number of points and it will be up to the pair to determine how those points should be allocated. For example, if the pair was given 150 points, then the pair could decide that Person A, who did more of the work, should get 80 and Person B should get 70. If they pair felt they each did the same amount of effort, then each would get 75 points. Each of the three parts (Proposal, Oral Presentation, Final Paper including your software and results) will receive a separate grade.

Note: Bonus Points will be awarded to students who discover errors (especially technical and factual errors) in the book. The number of points awarded will be determined by the instructor. Before you report an error, please check the Errata to see if someone else has already found this error (see onCourse link to the Errata).

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**Week 1**

**Sept 02, WED**

```
print "hello DNA";
```

**Reading:**

Text: Acknowledgements, Preface, Chapters 1 and 2.
Reading on Central Dogma (read before class on Friday); see onCourse

**Homework #1** (Due at *start* of class, Friday Sept 4): Install Perl summary.

**Sept 04, FRI**

Guest Lecture: Dr. Jenny Lanni, Biology – "The Central Dogma"

**Reading:**

Text: Ch. 4 p47-61 (you need to read this **before** next WED's lab)
Bring your textbook to lab next WED.

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**Week 2**

**Sept 07, MON – Labor Day <no class>**

**Sept 09, WED** (meet in csLab)

**Quiz #1** – Collectively we give a brief Central Dogma lecture. (See Homework #1).

csLab: Playing with **Reg**ular **Ex**pressions ("**Regex**"):
Regex: a tool for searching for patterns in DNA sequences—Be sure to have the book with you; we will be using Chapter 4 "String Play with Regular Expressions".

**Homework #2** (Due at start of class, Friday Sept 11): Finish **Part I** handout on Regex

Opportunity for Superior Effort: If you really get into regex's, complete Part II
… and even make yourself a regex bookmark.

**Fun Readings:**

Agee, J. (1996). So many dynamos! And other palindromes. Farrar, Straus, Giroux Publishers, New York, NY.
Agee, J. (2000). Elvis Lives and other anagrams. Farrar, Straus, Giroux Publishers, New York, NY.

**Sept 11, FRI**

Homework #2 (Playing with Regex – Part I) due at start of class.

Good practices when printing output, using variables, and built-in functions;
Introduction to "genic" and "intergenic" regions and codons.
Intro to Perl: `"hello DNA Land", print`, variables, built-in functions
`length, lc, uc, reverse, index, substr, tr, s`

**Reading:**

Text: Ch. 3 p17-46 and some reading on "algorithms" p203-211

**a1 Specification** is ready: (see onCourse for Starter Kit)
**a1 algorithm** is due MON, Sept 14
a1 program is due Thursday, Sept 17

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**Week 3**

**Sept 14th MON**

**a1 algorithm** is due in class

csLab – playing with Perl … strings, strINGS, STRINGS …
`index, substr, reverse, lc, uc`
and string operators
`tr` and concatenation (`.`)

**Sept 16th WED**

**a1 submission is due tomorrow**, THUR Sept 17 (really, Friday by 5am)

Assign one-minute videos of "personalized medicine" companies
e.g., deCODEme, 23andMe, Knome, Illumina, Pathway Genomics, etc.
(Due: Wed, Sept 30 in class)

more Perl

**Sept 18th FRI**

**a2 Specification** is ready: (see onCourse for Starter Kit)
**a2 algorithm** is due MON, Sept 21
a2 program is due Thursday, Sept 24

Using Perl to do calculations: arithmetic expressions

Specifications "Specs" for Program #2 "Chargaffian Counts" and instructions about completing the program.

**Reading:**
Text: Ch. 5 (all) and Ch. 8 Reading from Files p135-142

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**Week 4**

**Sept 21st MON**

**a2 algorithm** is due in class

csLab: good practices of using arithmetic operators, precedence, math functions, and formatted output with `printf`

Using a subroutine written by someone else (e.g., `readInDNA` )

Quiz #2 next time on Wed, Sept 23rd at start of class

**Sept 23rd WED**

**Quiz #2** at start of class
**a2 due** on **Thursday**, Sept 24

conditional control (`if-elsif-elseif-else`)
**Reading:**
Text: Ch. 6 p93-98, 103-106 and Ch. 7 (all)

**Sept 25th FRI**

**a3 Specification** is ready: (see onCourse for Starter Kit)
**a3 algorithm** is due MON, Sept 28
a3 program is due Friday, Oct 2

**one-minute videos** due next Wed, Sept 30

Transcription – Translation … and a3 specification

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**Week 5**

**Sept 28th MON**

**a3 algorithm** is due in class

Good practices of using `if-else`; using `if` and `index` together;
Using subroutines revisited

Specifications "Specs" for Program #3 "Gene Finder" and instructions about completing the program.

**Sept 30th WED**

**one-minute videos** due today

Regex Chalk: due Friday morning around the dimple (rain date, Sat morning)

**csLab** – practice with `if` and `index`

Reading (in preparation for Friday's guest lecture): TBA

**Oct 2nd FRI**

Regex Chalk: Due in morning before classes

**a3 due today**

Guest Lecture: Dr. Teresa Celada, Philosophy -- "Designer Babies"

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**Week 6**

**Oct 5th MON**

**a4 Specification** is ready: (see onCourse for Starter Kit)
**a4 algorithm** is due FRI, Oct 9th
a4 program is due Friday, Oct 16th

`while` loops, greediness in regular expressions, commenting those tough regex

Introduction to gene regulation

**Reading:**
Text: Ch. 6 p98 – 107 (if-elsif-else) and while loops, p107-115

**Oct 7th WED**

**Quiz #3**

csLab – p114 #1,2,3,6

**Oct 9th FRI** –

**a4 algorithm** is due

More looping, more looping, more looping, more looping ….

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**Week 7**

**Oct 12th MON and TUES 13th "Fall Break"**

**Oct 14th WED**

Introduction to modules and BioPerl

**Oct 16th FRI**

**a4 due today**

More BioPerl

## Week 8

**Oct 19th MON**

**a5 Specification** is ready: (see onCourse for Starter Kit)
**a5 algorithm** is due FRI, Oct 23rd
a5 program is due Friday, Oct 30th

**csLab** -- BLAST Lab (Homework #6; due at the end of lab)

Specifications "Specs" for Program #5 "Fuzzy Olfactory Gene Finder" and instructions about completing the program

Olfaction and seven trans-membrane proteins (Part I)

**Reading:**
Text: 13 (all) – Randomness – "So, like totally random, dude"

**Oct 21st WED**

**Quiz #4**

Using your BLAST output as input …
Olfaction and seven trans-membrane proteins (Part II)

**Oct 23rd FRI**

**a5 algorithm** is due

**csLab**: more subroutines and Perl's rand

## Week 9

**Oct 26th MON**

Tweeking regex

**Reading:**
Text: 12 (all) – Regex Revisited

**Oct 28th WED**

Introduction to arrays and Perl's `split` and `join` functions
**Reading:**
Text: 9 – Arrays, p151-168

Heads/Tails homework – due at start of guest lecture on Friday, 30th

**Oct 30th FRI**

**a5 due today**

Guest Lecture: Dr. Mike Kahn -- "Randomness"

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**Week 10**

**Nov 02nd MON**

csLab: Intro to **microarray analysis** – MagicTool software

**Nov 04th WED**

csLab: Continuation of **microarray analysis** – MagicTool software

**Nov 5th THUR**

Superior Effort: Join us in csLab to help the Genetics class use Magic Tool, 2-5pm.

**Nov 6th FRI**

**a6 Specification** is ready: (see onCourse for Starter Kit)
**a6 algorithm** is due WED, Nov 11th
a6 program is due Wed, Nov 18th

Sorting with arrays and hash tables
**csLab** – Practice with arrays and hash tables

**Reading:**
Text: Ch. 9 – Arrays, p168-177 and Ch. 10 Hash Tables, p179-192

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**Week 11**

**Nov 9th MON**

More hash tables and help on Program #6
**Lots(!) of Reading:**
Text: split – p163-167, join p167-168, sorting p168-173, hashes p179-192
Counting motifs p192-202
Breaking Sequence into Motifs p214-216

**Nov 11th WED**

**a6 algorithm** is due

**csLab** – Entering a valid motif `$MIN <= $size <= $MAX`

**Nov 13th FRI**

**csLab**: Work on a6

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**Week 12**

**Nov 16th MON**

Final Project Specification for Individual Projects

What might *you* do?
How will you present your results?
How do you write the Methods section of a paper?
What is expected of you?

**Proposals due MON, Nov 23rd**

**Nov 18th WED**

**a6 due today**

Class time to search for appropriate datasets for your final project: Go to NCBI, select sequences, store them for future use.

**Nov 20th FRI**

**Quiz #5**

Samples of written and oral presentations—an analysis of examples

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**Week 13**

**Nov 23rd MON**

**Final Project Proposal due**: type-written
Title, Introduction, and Methods due by the beginning of class

csLab: Open lab time for individual and group help on final projects

**Nov 25th WED – Nov 27th FRI**

Thanksgiving Break

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**Week 14**

**Nov 30th MON**

[open TBA]

**Dec 2nd WED**

[open TBA]

**Dec 4th FRI**

Lab time for final presentations

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**Week 15**

**Dec 7th MON**
Oral Presentations on Projects

**Dec 9nd WED**
Oral Presentations on Projects

**Dec 11th FRI**
Oral Presentations on Projects

Experimental program and paper are due at the **BEGINNING of CLASS**

**Course Evaluations and Farewells**