Last minute office hours!!!!
Prof. Sive will be available
Tuesday 5/22 10am-12pm
Whitehead 401C

or you can questions to
sive@wi.mit.edu
Subject: “7.013 student”

7.013
5.16.07

Future of Biology
A challenge: how will you tackle the future?!  

1. Understanding: How life works  

Fractals and biology  
Self-similar at different scales  
Infinite complexity!
Scaling “allometry” requires specific IGF1 alleles.

**Human Genome Project**

**Goals:**
- identify all genes in human DNA
- devise tools for data analysis

**Milestones:**
- 1990: Project initiated
- 2003: sequencing completed
- 2007: still working on gene ID, number….

Prof. Lander

---

Next...Describe everything else!

All RNAs
All proteins
All DNA-protein interactions
All RNA-protein interactions
All protein-protein interactions
All signal transduction events
All regulatory circuits
All gene function
All disease genes

Proteomics: 2D gel analysis of proteins

Finding protein differences
Predicting circuitry
Computational (systems) biology

Phenotypes

Individual molecules → Pathways → Complex networks

Data storage
billions of terabytes….

Systems Biology
Yeast regulatory networks
Prof. Young
Prof. Gifford

Transcription factors that regulate other transcription factors

Imaging

Circulating zebrafish red blood cells: GFP labeled (Zon lab HMS)
Neurobiology

How is the brain constructed?
What is the molecular basis for thought?
Why do we sleep?
And much more……..

Brain mutants (zebrafish)

Sive lab, Whitehead Institute/MIT

Molecular basis for natural selection?

Natural selection thought to act on

Single base mutations
Repeat motifs within coding sequence
How is rapid evolution of dog breeds accomplished?

Variations in number of motif repeats within proteins are
- $10^5$ more frequent than point mutations
- occur via slippage during recombination
- change protein function

Much variation in repeat length between breeds and in wild canids

Prof. Fink/ yeast

Dinosaur blood in mosquito in amber
Dinosaur DNA fragments (200bp)
Assemble “Dinosaur” genome
Insert into enucleated crocodile egg
Baby dinosaur

Jurassic Park- the (faulty) premise
2. Application

Disease Taxonomy

- Control tissue: isolate mRNA, cDNA probe (red)
- Test tissue: isolate mRNA, cDNA probe (green)
- Mix probes, hybridize
- Microarray: “DNA chip”
- Each spot contains DNA corresponding to a single gene
- Up to 500,000 spots = all genes
- ~1cm x 1cm

Yellow spots: genes expressed in both tissues
Green spots: test tissue-specific gene expression
Red spots: control tissue-specific gene expression

Number of Disease Genes Identified

Cumulative Pace of Disease Gene Discovery (1981-2003). The number of disease genes identified so far is 1,465. Data provided by Online Mendelian Inheritance in Man.
Microarray: each spot = DNA for 1 gene

Profiling 60 cancer types with 9,700 genes

Acute lymphocytic leukemia
Acute myelogenous leukemia

Expression profiles distinguish clinically similar syndromes
Prof. Lander
Dr. Golub

Acute myelogenous leukemia

Prediction
Your personal DNA profile will include information about ~1,000 “bad” alleles for various traits.

Are you genetically predetermined to get a specific disease?

Do you want this information? Do you want others to have this information?

24

THE AMERICAN KENNEL CLUB
CERTIFICATE OF DNA ANALYSIS

COME SEE CORRINA VOM SALZETAL

Havanese
Female
Birthday: 14-Oct-2001
Reg # TP900512/01
Date of Analysis: 28-Jul-2003
Owned by: Joan Little

The following genotype uniquely represents the MM Genetics certified genetic identity of the dog named Corrina:

[Genetic code]

Design
25 Structure Based Drug Design

Hydrophobic residue
Pocket
Designed site

stem cells cloning

Repair

Prof. Yaffe
Prof. King

Artisan, 1978
xenotransplantation

Pathogen free piglets with human immune system

bionics

Robocop, MGM'1987
Abiocor heart
Artificial heart
DeBakey
Perfluorocarbons (oxygent™)
Hemoglobin-based
Blood substitutes
Prof. Langer and Julie Andrews
Biorubber and the larynx
Aging
Caloric restriction increases lifespan (due to changes in chromatin structure?)

A challenge: how will you tackle the future?!
I wish you all the best of luck!