Genetics
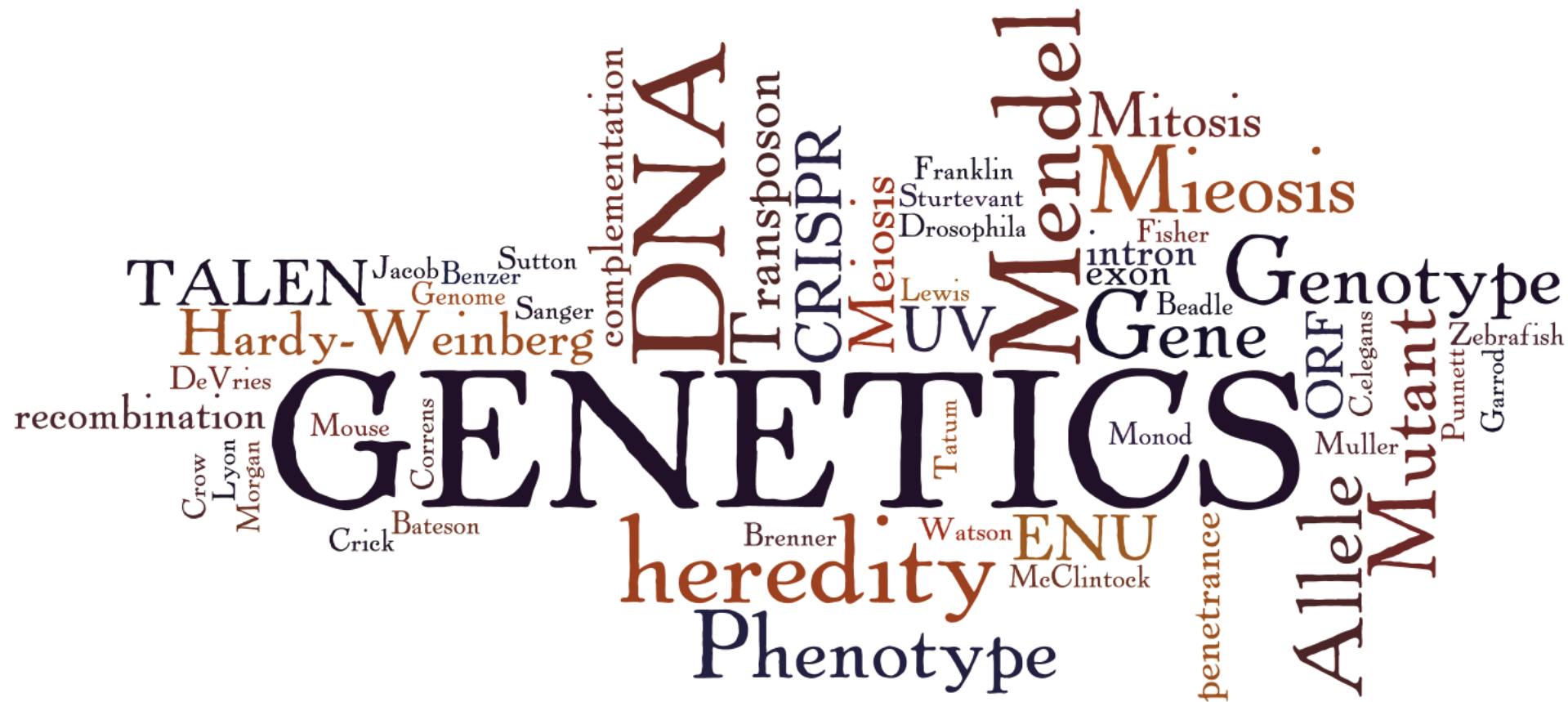# Biology 3332

Welcome!

Instructor Information:

Dr. Katrin Kellner, Associate Professor
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Today

- Roll call
- Syllabus
- Introduction

How this class works:

All communications, grades, points, quizzes, lecture slides and other material will be on Canvas!
Make sure you can log in and have access to the class, and if not, let me know ASAP!

How this class works:

- Lecture
- Co-requisite: Lab – planned to give you hands-on training and practice
- **But**: I am not going to ask you on the exams about topics only covered in the lab!
- **In general:** I am not going to ask you about topics which have not been covered during lecture!
- Everything mentioned on a lecture slide is fair game for the exams!

How this class works: Exams

- **Three exams and Final cumulative exam**
- Exams are multiple choice questions, true – false, short answer, etc.
- ➤ **Exam Make-up Policy:** will be arranged **<u>ONLY</u>** if the reason is legitimate, with written documentation, **within one week**

How this class works:
Online – "Quizzes""Home works"

➢ **Quizzes** (each worth ten points) for each chapter will be opened following the completion of the lecture on that chapter and will remain open for one week.

➢ Quizzes can be found online on **Canvas**.

How this class works:

Grading:

Points Possible		%	Percentage	Grade
Exam 1	100	17	90-100%	A
Exam 2	100	17	80-89%	B
Exam 3	100	17	70-79%	C
Final	150	26	60-69%	D
Quizzes	130	22	50-59%	F
Total	**580**	**100%**		

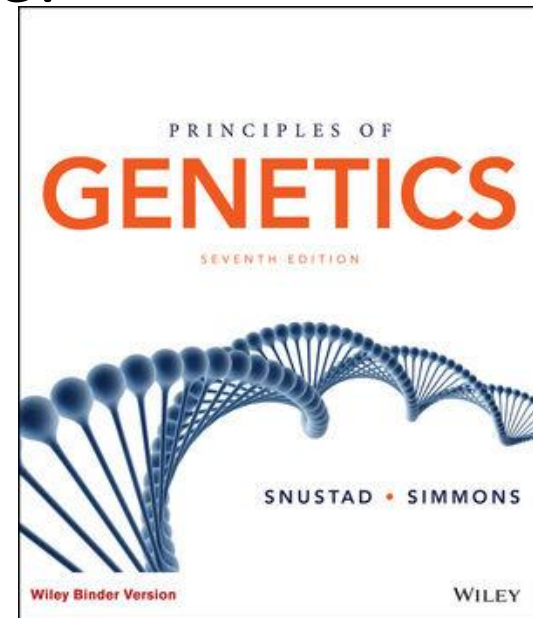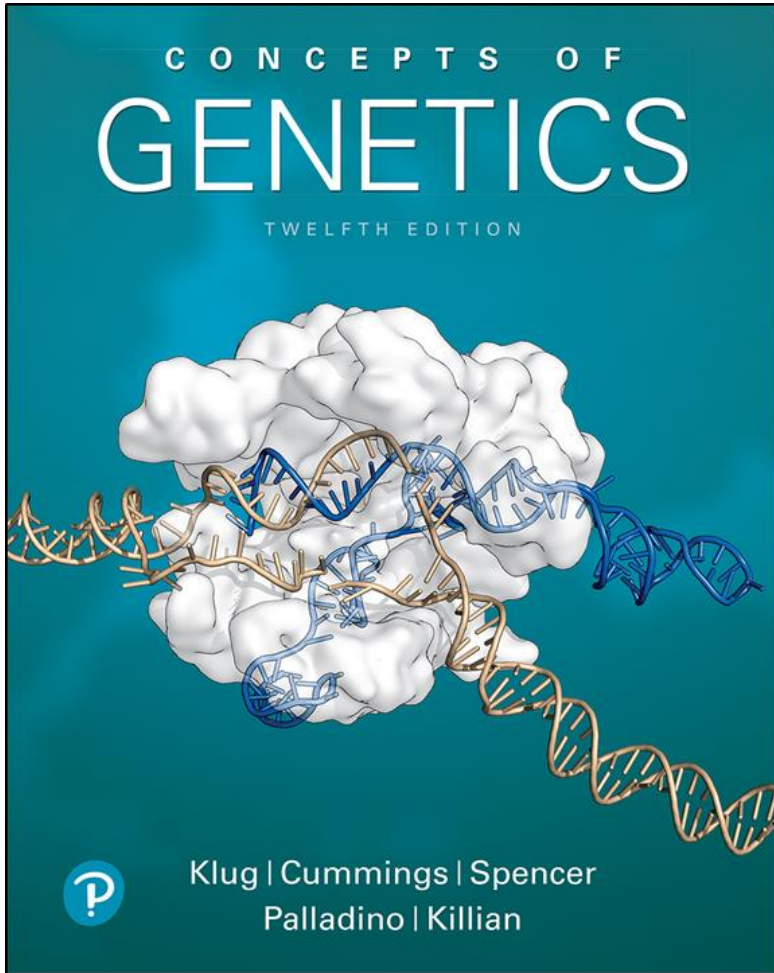Bonus points are added

How this class works:
Bouns points..

- This is an 8 am lecture….
- I do take attendance…
- There are bonus points for in class exercises

Textbook

Lecture slides are based on both books!

Lecture slides, videos and other material will be on Canvas!

You are not required to buy a book, but it certainly helps to have access to one!

Videos on Youtube

- Be careful about the content!
- You will find links to Videos on Canvas

Questions so far?

Introduction:

What is Genetics and why should we care?

What is Genetics?

Term coined in 1905 to describe a new emerging field by William Bateson.

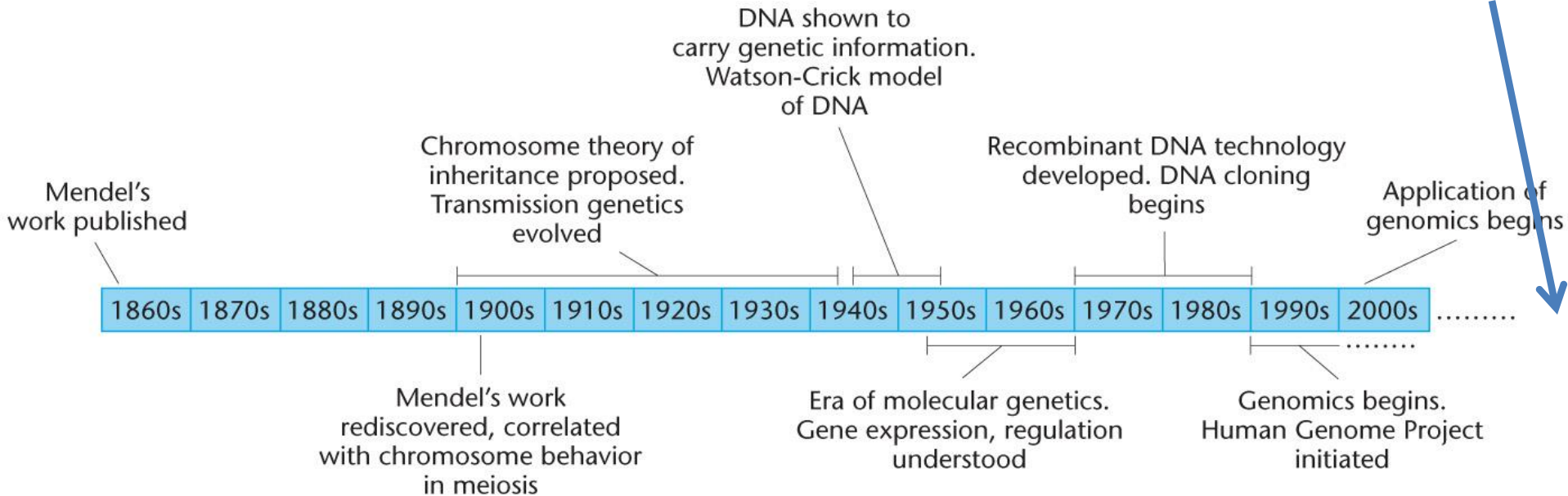➤ From the Greek genētikos meaning origin, fertile, or productive.

What is Genetics?

- The science that deals with DNA

- The science of heredity

➢ Attempts to explain the similarities and differences that occur among related and unrelated individuals

➢ But: there is more to it..

The Age of Genetics

Gene editing/Crispr

mRNA vaccines

DNA shown to carry genetic information. Watson-Crick model of DNA

Chromosome theory of inheritance proposed. Transmission genetics evolved

Recombinant DNA technology developed. DNA cloning begins

Application of genomics begins

Mendel's work published

| 1860s | 1870s | 1880s | 1890s | 1900s | 1910s | 1920s | 1930s | 1940s | 1950s | 1960s | 1970s | 1980s | 1990s | 2000s | .... |

Mendel's work rediscovered, correlated with chromosome behavior in meiosis

Era of molecular genetics. Gene expression, regulation understood

Genomics begins. Human Genome Project initiated

Polymerase Chain Reaction

Improvements in Microscopy

X-ray crystallography
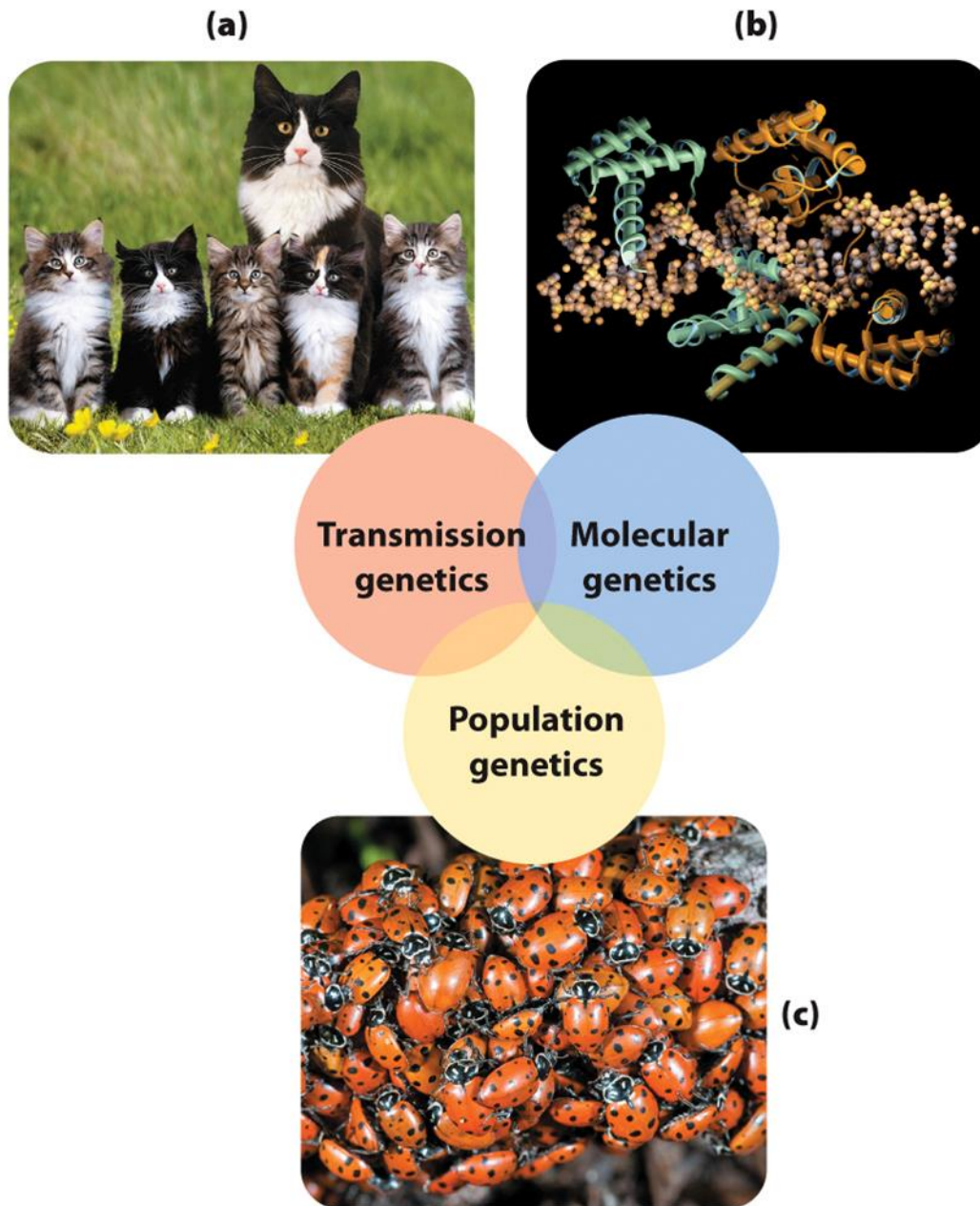
Sanger Sequencing

Technological Progress

Next-generation sequencing

Levels of Genetic Analysis

➢ Geneticists approach their science from different points of view—from that of a gene, a DNA molecule, or a population of organisms.
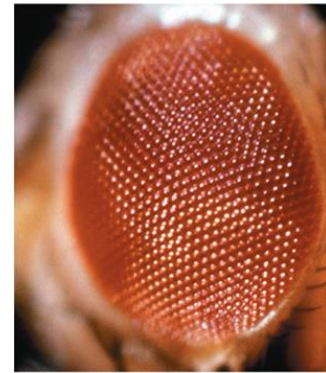
(a)

(b)

Transmission genetics

Molecular genetics

Population genetics

(c)

Part a: Juniors Bildarchiv/Alamy Stock Photo. Part b: Martin McCarthy/Getty Images. Part c: Stuart Wilson/Science Source

Figure 1.6
Genetics: A Conceptual Approach, Seventh Edition
© 2020 W. H. Freeman and Company

Classical Genetics
Mendelian Genetics
Transmission Genetics

scute bristles, *sc*
white eyes, *w*

ruby eyes, *rb*

crossveinless wings, *cv*

singed bristles, *sn*

lozenge eyes, *lz*

vermilion eyes, *v*

sable body, *s*

scalloped wings, *sd*

*Bar* eyes, *B*

carnation eyes, *car*

little fly, *lf*

- Based on analysis of the outcomes of crosses between different strains of organisms.

- Can be coordinated with studies of the structure and behaviour of chromosomes.

Population Genetics

- Individuals within a population may carry different versions (alleles) of genes.

- Population genetics is based on analysing allele frequencies in a population and determining whether these frequencies change over time.

- Population genetics includes evolution and the inheritance of complex traits.
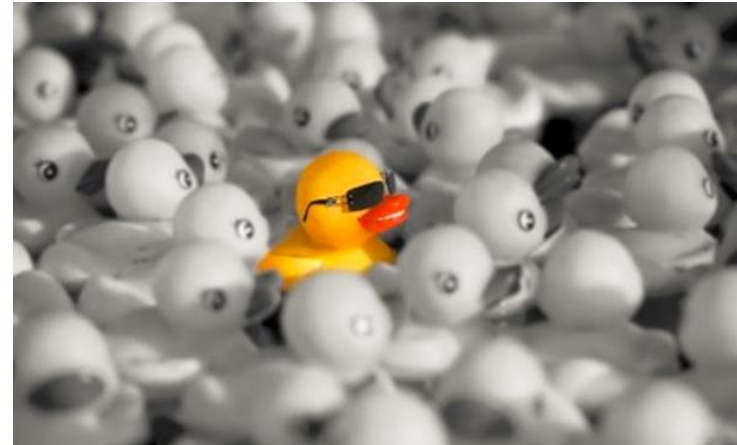
Molecular Genetics

- Studies the replication, expression, and mutation of genes at the molecular level.

- Rooted in the study of DNA sequences and the manipulation of DNA molecules.

Sugar (deoxyribose)

Nucleotide

Phosphate

Complementary base pair (thymine-adenine)
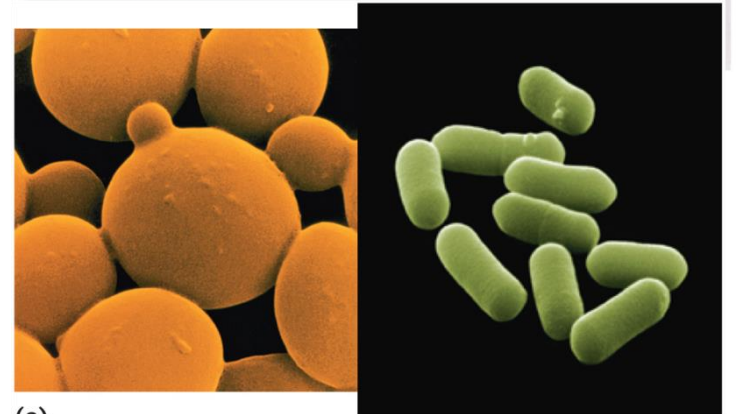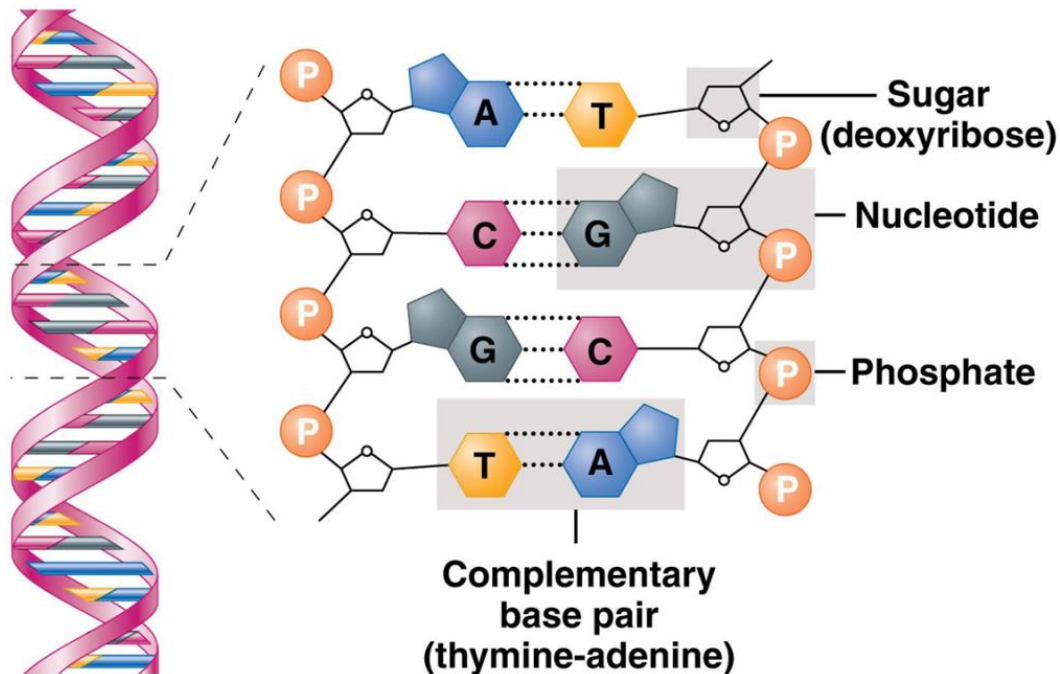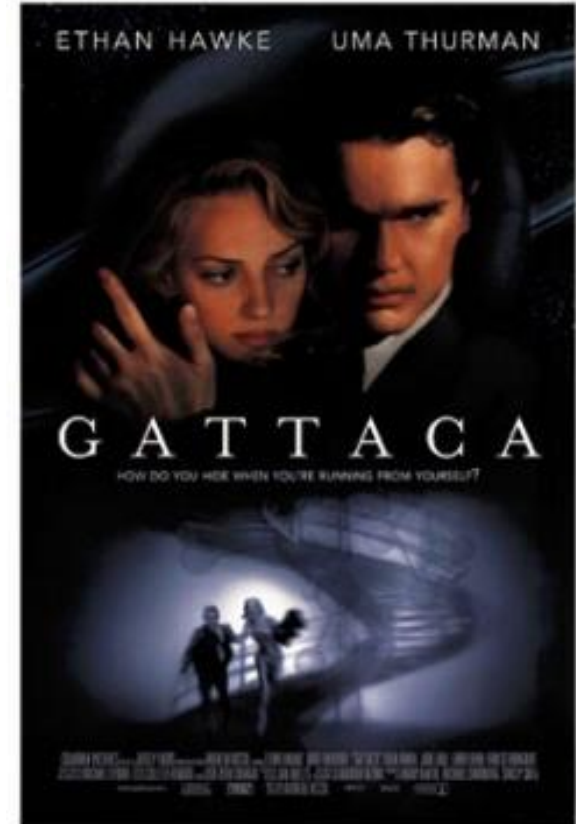
(a)

(b)

Why do we care about Genetics?

Genetically-modified super-humans ?

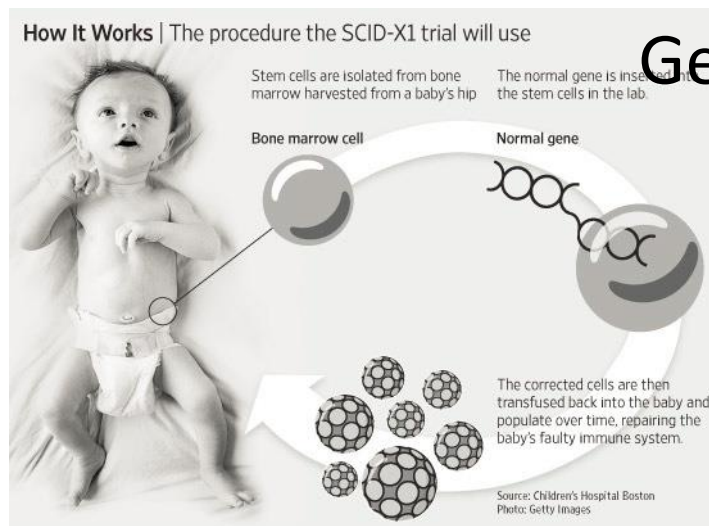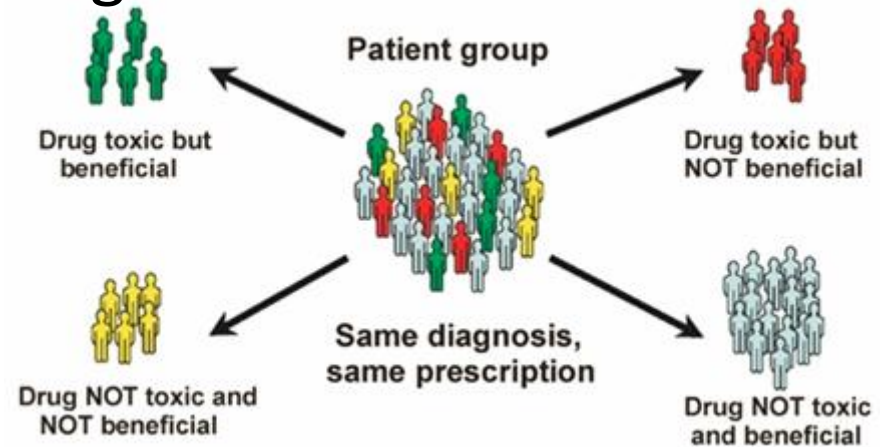Dinosaur Cloning?

Genetic Predetermination?

Why do we care about Genetics?

Genetics is important to us individually, to society, and to the study of biology

Genetics: Medical Applications

- Prenatal Diagnosis & Genetic Counseling
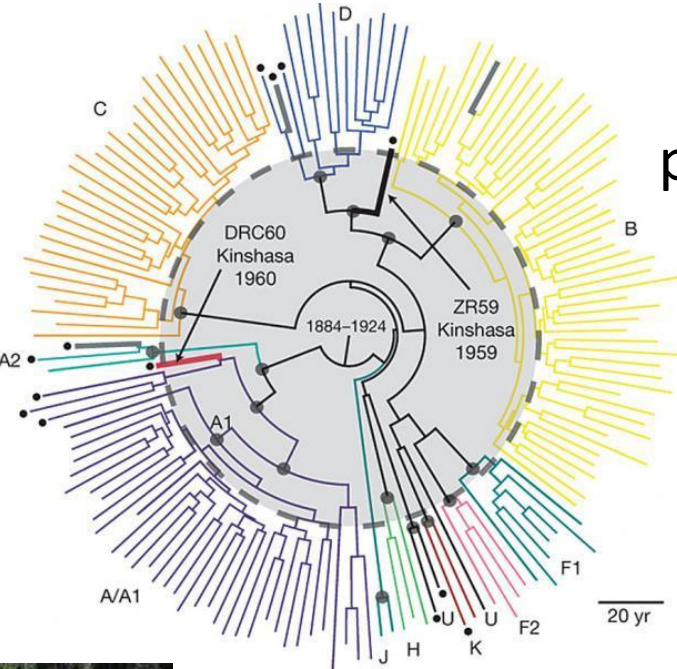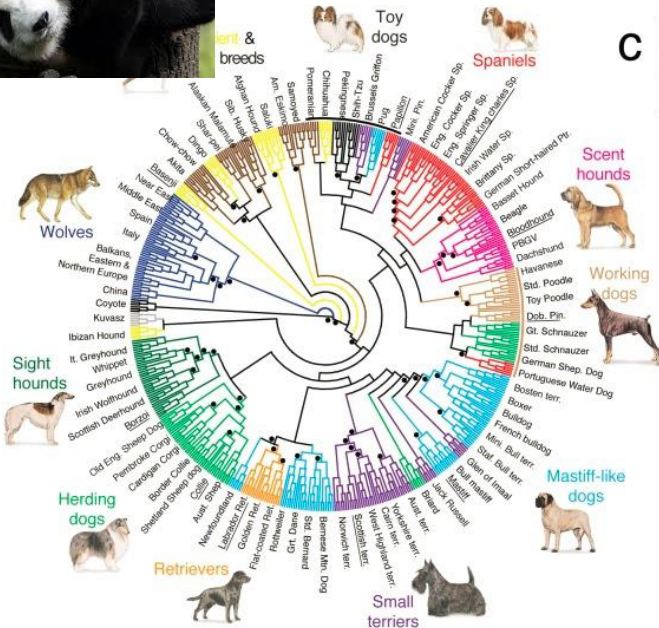- Tests for inheritable disorders
- Genetic testing

Pharmacogenomics: Drug designs

Patient group

Drug toxic but beneficial

Drug toxic but NOT beneficial

Same diagnosis, same prescription

Drug NOT toxic and NOT beneficial

Drug NOT toxic and beneficial

Gene Therapy

Gene editing

How It Works | The procedure the SCID-X1 trial will use

Stem cells are isolated from bone marrow harvested from a baby's hip

The normal gene is inserted into the stem cells in the lab.

Bone marrow cell

Normal gene

The corrected cells are then transfused back into the baby and populate over time, repairing the baby's faulty immune system.

Source: Children's Hospital Boston
Photo: Getty Images

Applications in Ecological and Evolutionary Research and Conservation

HI Virus phylogenetic tree

SARS-COV19 variants

eDNA sampling (environmental DNA)

Genetics in Agriculture: Selective Breeding

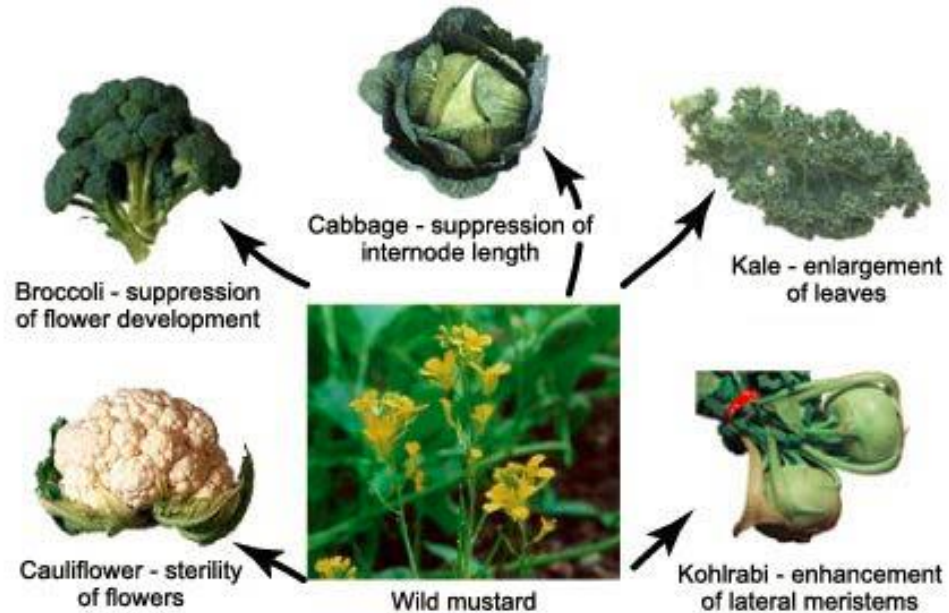**Angus**   **Beef master**   **Simmental**   **Charolais**

(left) A. Humek/Alamy; (center left) Lynn Stone/AG Stock Images/©Corbis; (center right) J.L. Klein & M.L Hubert/Photolibrary; (right) Armin Floreth/ imagebroker/Alamy

6.5 cm

Courtesy John Doebley, Genetics, University Wisconsin

Broccoli - suppression of flower development

Cabbage - suppression of internode length

Kale - enlargement of leaves

Cauliflower - sterility of flowers

Wild mustard

Kohlrabi - enhancement of lateral meristems

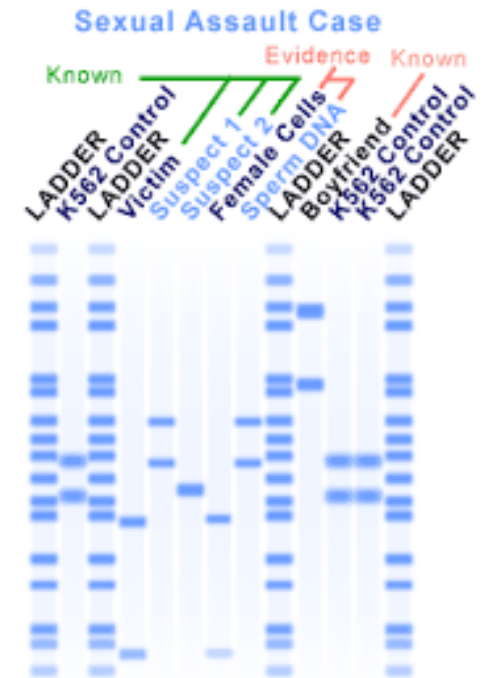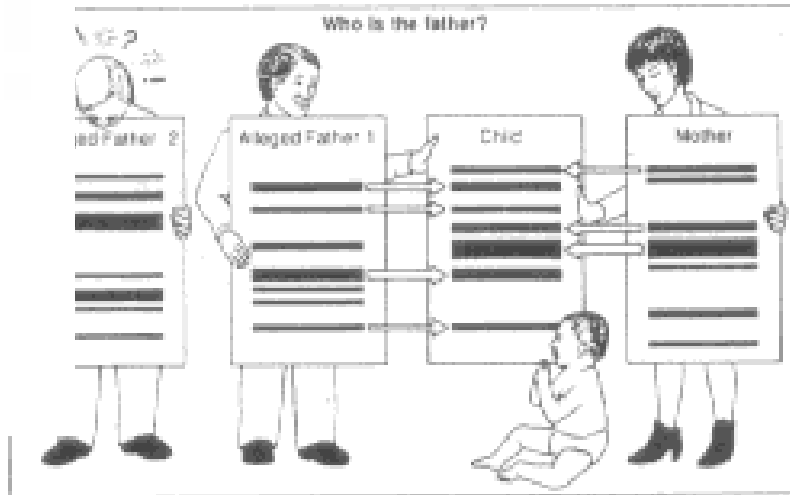# Genetics in Agriculture: Genetically Modified Organisms

(a)

(a)

Courtesy Mycogen

Genetically Modified Organisms (GMOs) have been altered by the introduction of foreign genes.

➢ Increased herbicide, insect, and viral resistance
➢ Nutritional enhancement
➢ Water use reduction

Genetics in Forensic Identification

Genetics and Microbiomes

➢ Next generation sequencing and identification of bacteria, fungi, etc.

➢ **Microbiomes**: sum of all bacteria or fungi in a sample

Environmental Sciences

Agriculture, Soil Science

The NIH Human Microbiome Project

Genetics, Ethics and Society

- Economic impact—biotechnology industry, pharmaceutical industry.

- Legal impact—paternity testing, forensics, identification

➢ The science of genetics and its applications develops faster than social conventions, public policies and laws

- Philosophical impact: privacy, sensitive data, genetic discrimination, prenatal testing, Ownership of genes, safety of GMOs?