

GENETICS



BIO 1103

Winter 2015

February 11, 2015

LEARNING OBJECTIVES

- Conceptualize genetic diversity & its linkages with DNA, RNA & proteins
- Examine genetic and species diversity as genotypes & phenotypes
- Recognize gene variability through alleles
- Define heterozygous, homozygous, dominant, recessive & epigenetics in relation to genetics & diversity
- Predict inherited genotypes and phenotypes

GENETICS

- Study of heredity - explains how characteristics are passed onto offspring
- Based on DNA
- Integral to biodiversity, GMOs, evolution & modern agriculture & medicine



DNA

- Deoxyribonucleic acid - self-replicating, nucleic acid
- Molecule of cellular information & inherited genetic material

- Double helix of:

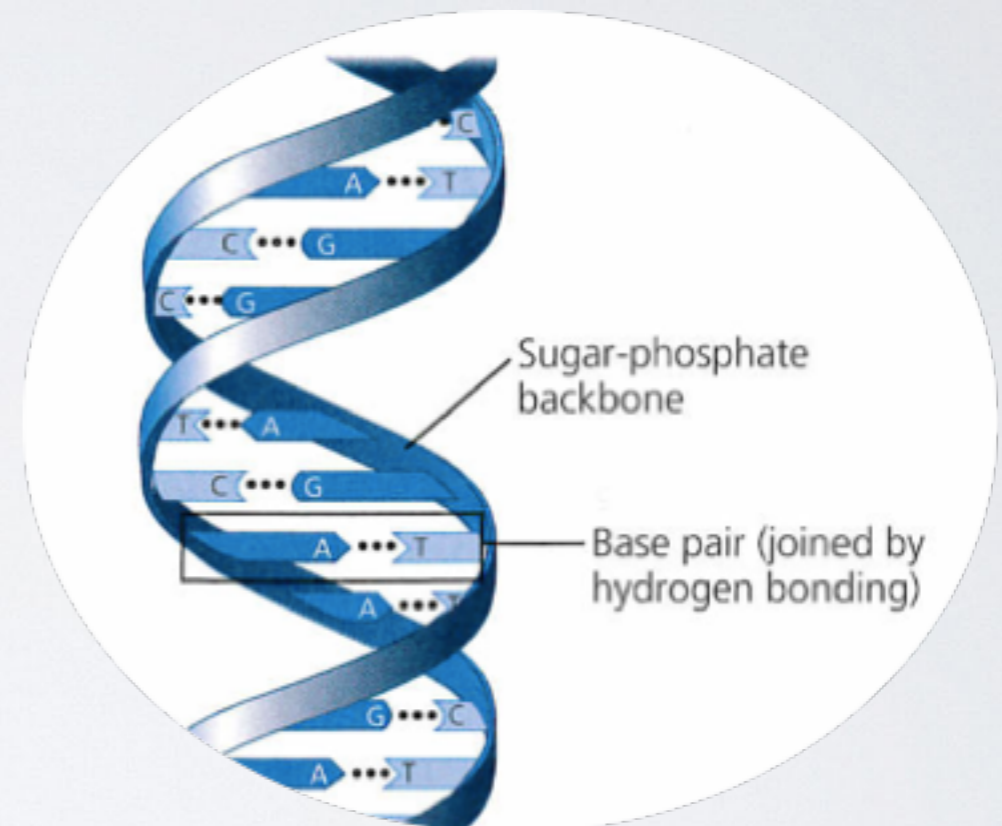
- Sugar-phosphate backbone
- 4 nitrogenous bases

- Adenine (A)

- Thymine (T)

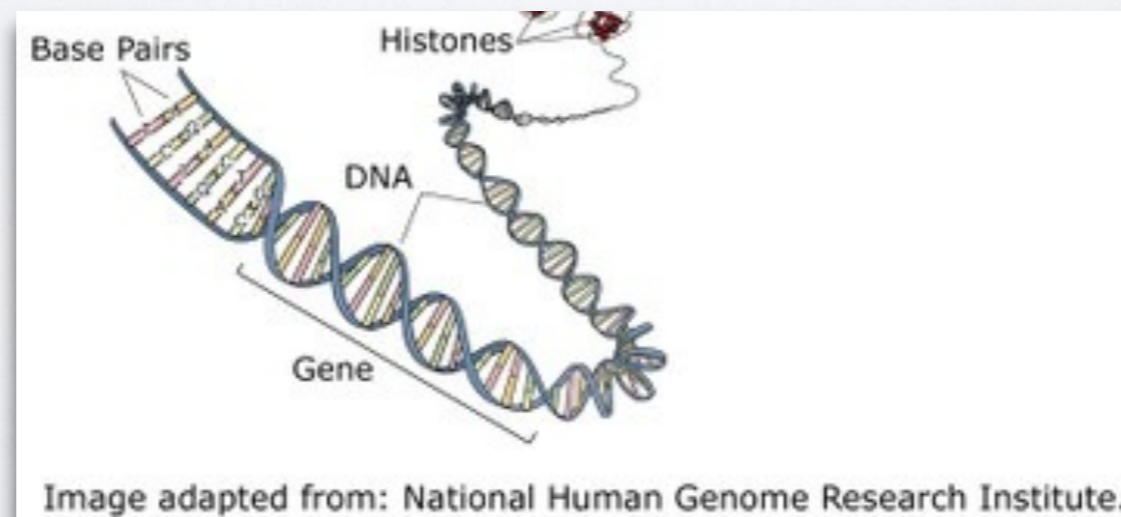
- Guanine (G)

- Cytosine (C)



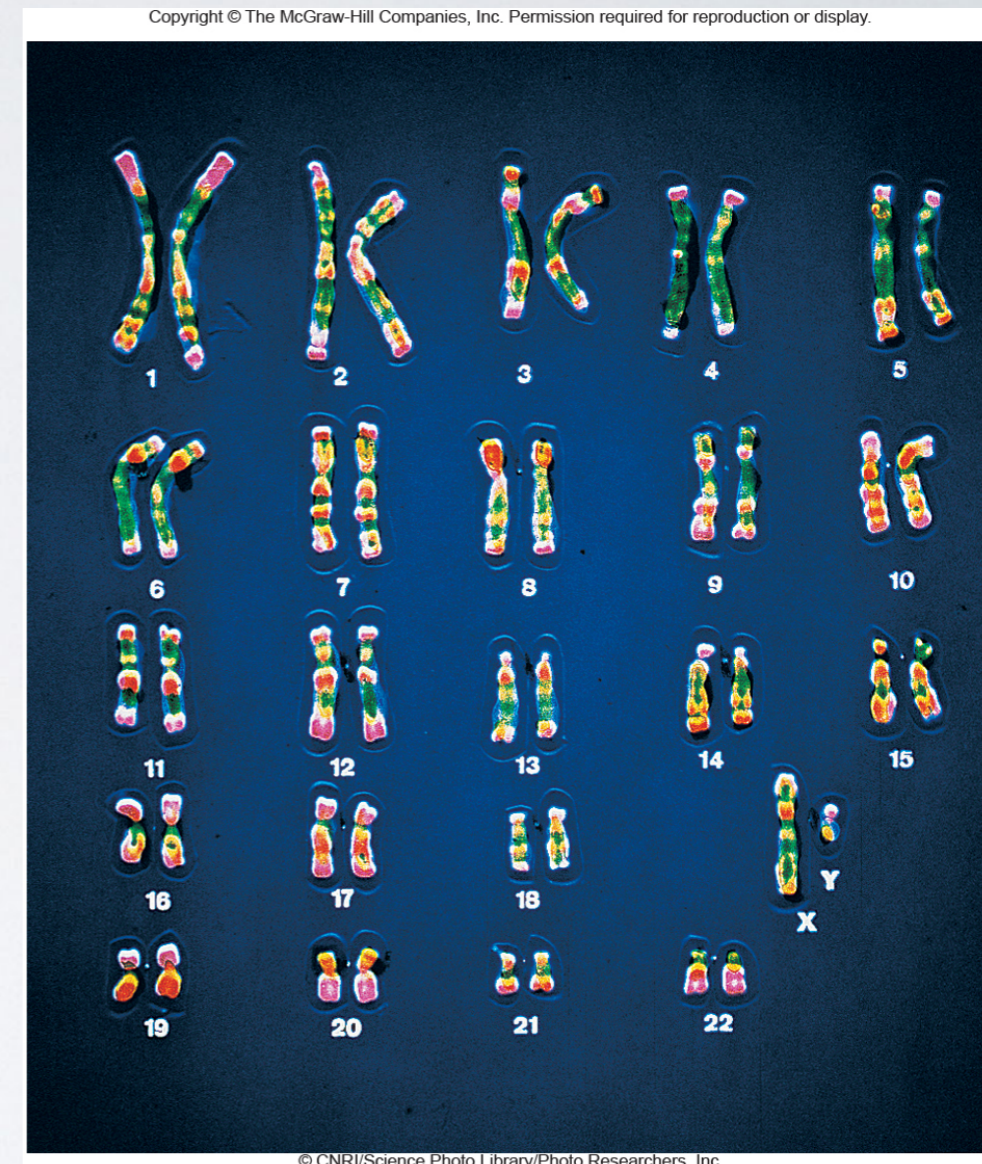
DNA

- Genotype - organism's DNA sequence of As, Ts, Gs, & Cs
- Gene - DNA sequence which encodes a protein
 - Unit of evolution & inheritance
 - All an organism's genes = genome
- Phenotype - combination of an organism's observable traits produced by its genotype

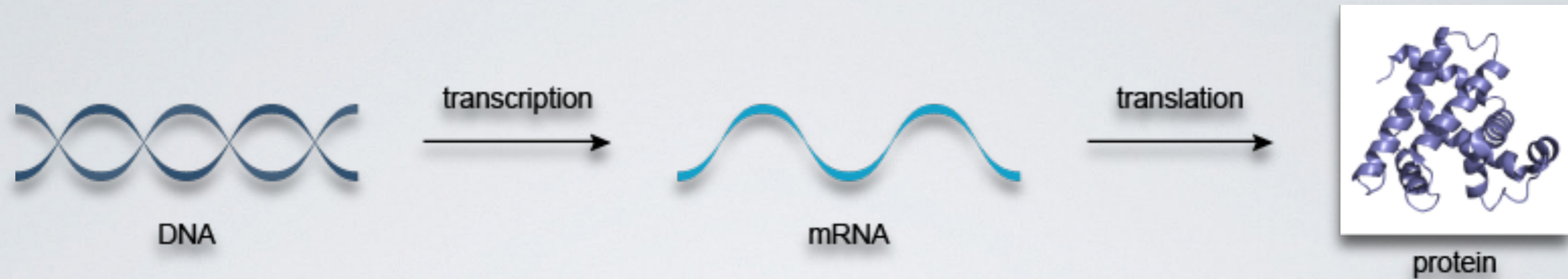


CHROMOSOMES

- Organizational & compaction units for DNA
- Each chromosome contains 1000s of genes (alleles)
- Diploid: 2 copies of each chromosome
- Haploid: 1 copy of each chromosome, gametes & prokaryotes



CENTRAL DOGMA OF BIOLOGY



- Every DNA base transcribed into a messenger RNA (mRNA) base (1:1)
- Every 3 mRNA bases = codon translated into one amino acid (3:1)
- Chain of amino acids = protein
- Protein functions & combinations = organelles

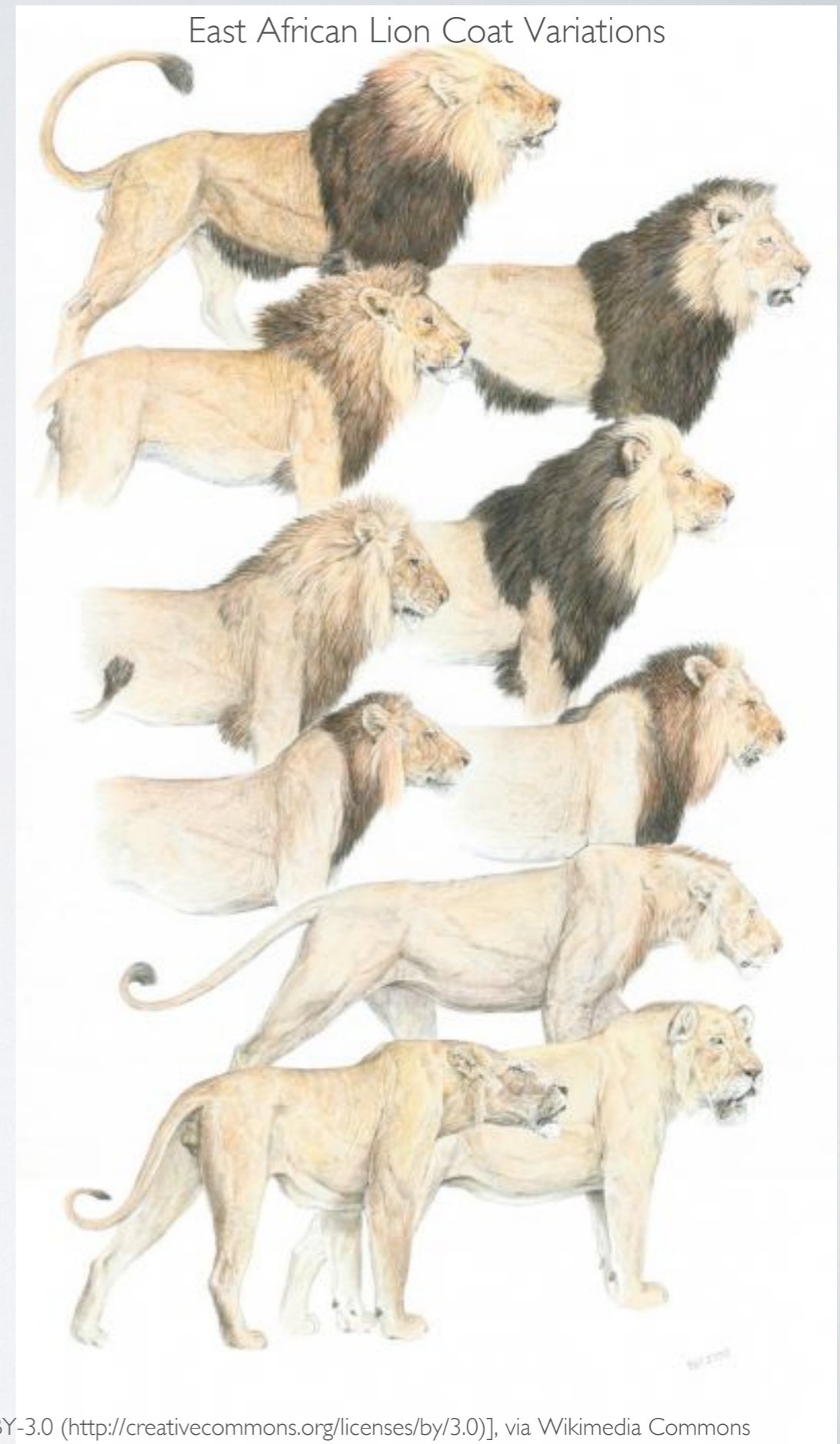
SPECIES

- Organisms which
 - share same DNA & characteristics
 - can interbreed to produce fertile offspring
- 3-5 million eukaryote species worldwide (plants & animals)
- Unknown number of prokaryote species (bacteria & archaea)



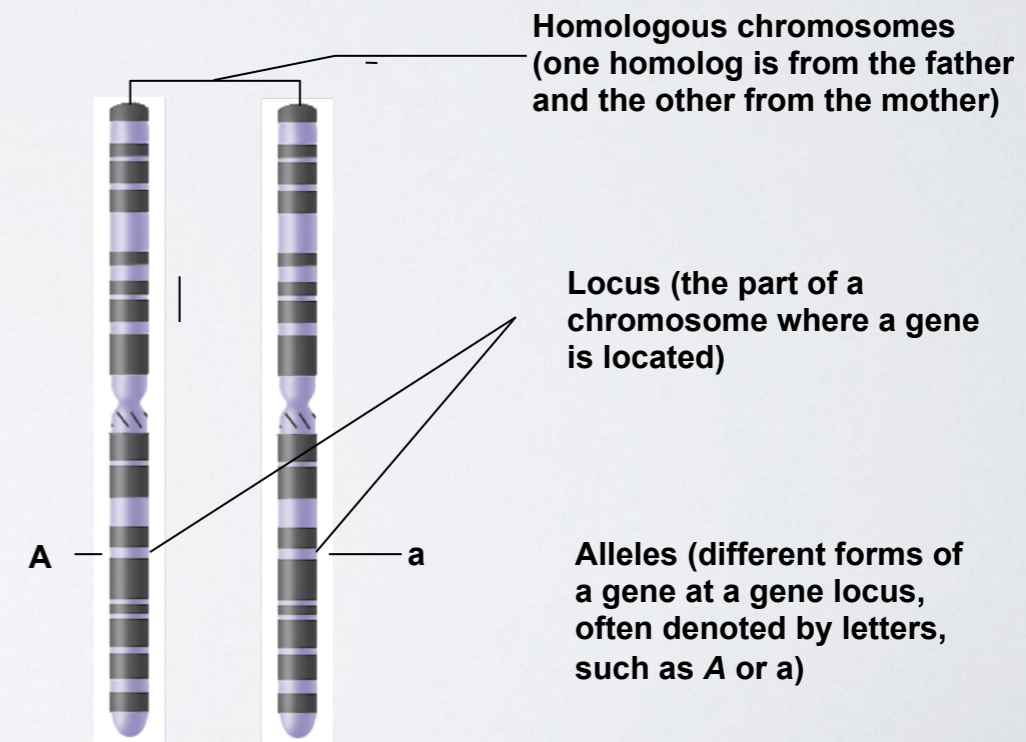
GENETIC DIVERSITY WITHIN A SPECIES

- Variations in DNA sequence within a species
 - Sequence of Base pairs or Genes
 - **Different Forms of a Gene = Alleles**
- Creates variations in traits = Phenotypes
- Every organism has slightly different set of alleles from their unique DNA sequence = basis of all biodiversity & evolution

















ALLELES

- Different forms of the same gene carried on different chromosomes or different locations in genome
- Alleles arise from:
 - Mutation - random DNA errors
 - Sex - recombines & reorganizes DNA



DOMINANT & RECESSIVE ALLELES

- **Dominant:** allele that is always displayed in phenotype (A)
- **Recessive:** allele that is masked in phenotype (a) (sickle cell anemia)
- **Codominance:** some alleles are not entirely dominant & recessive (blood type)
- **Polygenic traits:** traits are controlled by more than one allele (eye & hair color)

Dominant Gene		Recessive Gene	
Cleft Chin		No Cleft	
Widow's Peak		No Widow's Peak	
Dimples		No Dimples	
Brown/Black Hair		Blonde Hair	
Freckles		No Freckles	
Brown Eyes		Gray/Blue Eyes	
Free Earlobe		Attached Earlobe	

CHROMOSOMES + ALLELES

- **Homozygous:** Two of the same alleles for a trait
 - **Homozygous dominant:** AA
 - **Homozygous recessive:** aa
- **Heterozygous:** One dominant & one recessive allele for a trait
 - **Heterozygous:** Aa

MENDELIAN GENETICS

- Eukaryotes receive one chromosome from each parent
 - One allele from mom + one allele from dad = offspring genotype
 - Offspring genotype based on chance, but follows predictable statistics - Punnett Squares

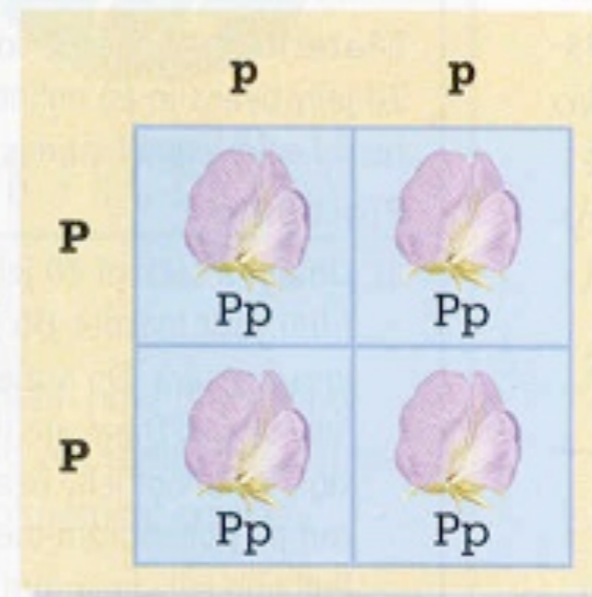
Homozygous dominant
- purple flower



Homozygous recessive -
white flower



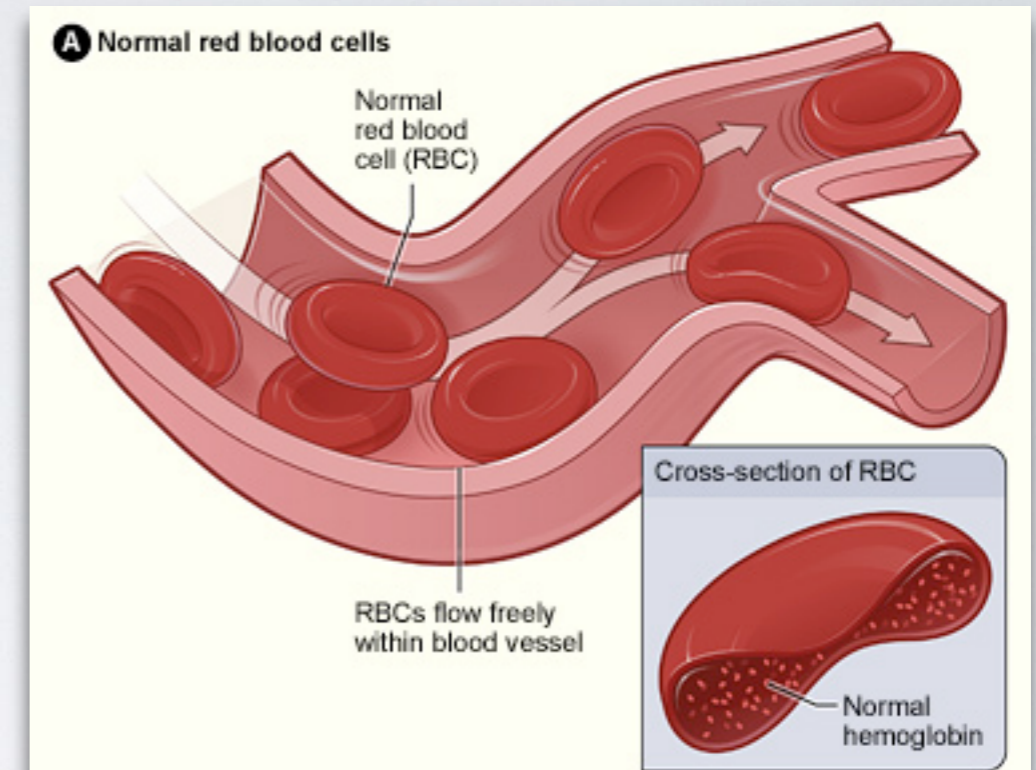
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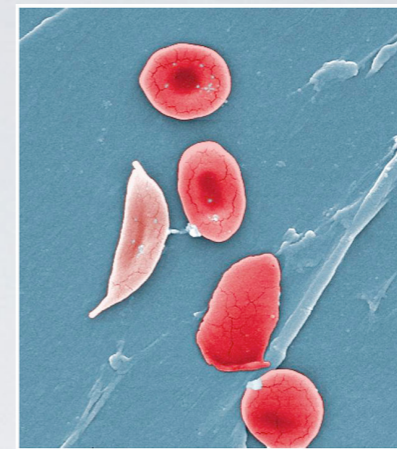
All offspring
heterozygous-
purple flowers

SICKLE-CELL ANEMIA

- Example of homozygous & heterozygous interactions with dominance
- Homozygous dominant (SS) - normal red blood cells
- Homozygous recessive (ss) - sickle cell anemia
- Heterozygous (Ss)- sickle cell trait; partial anemia but reduced malaria; carriers favored by natural selection

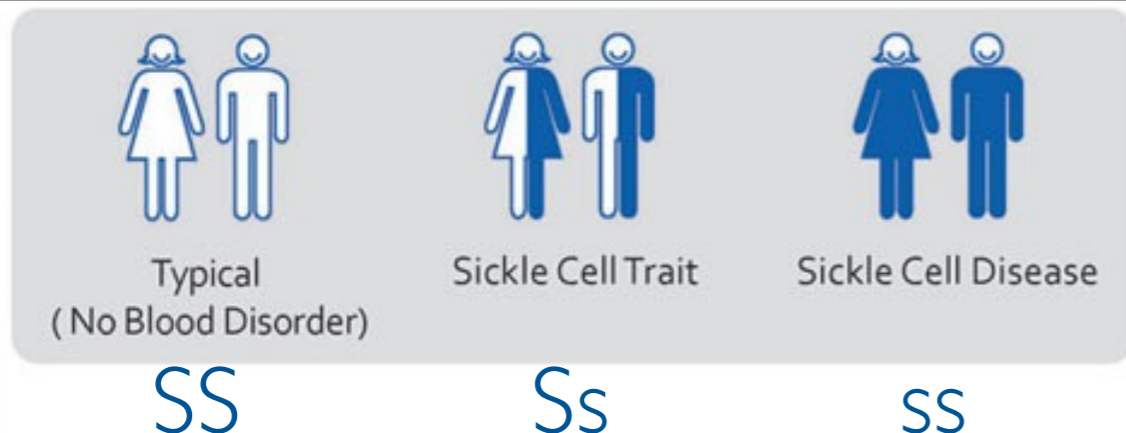


Two heterozygous parents



What are the chances of having a child with full sickle cell anemia (ss)?

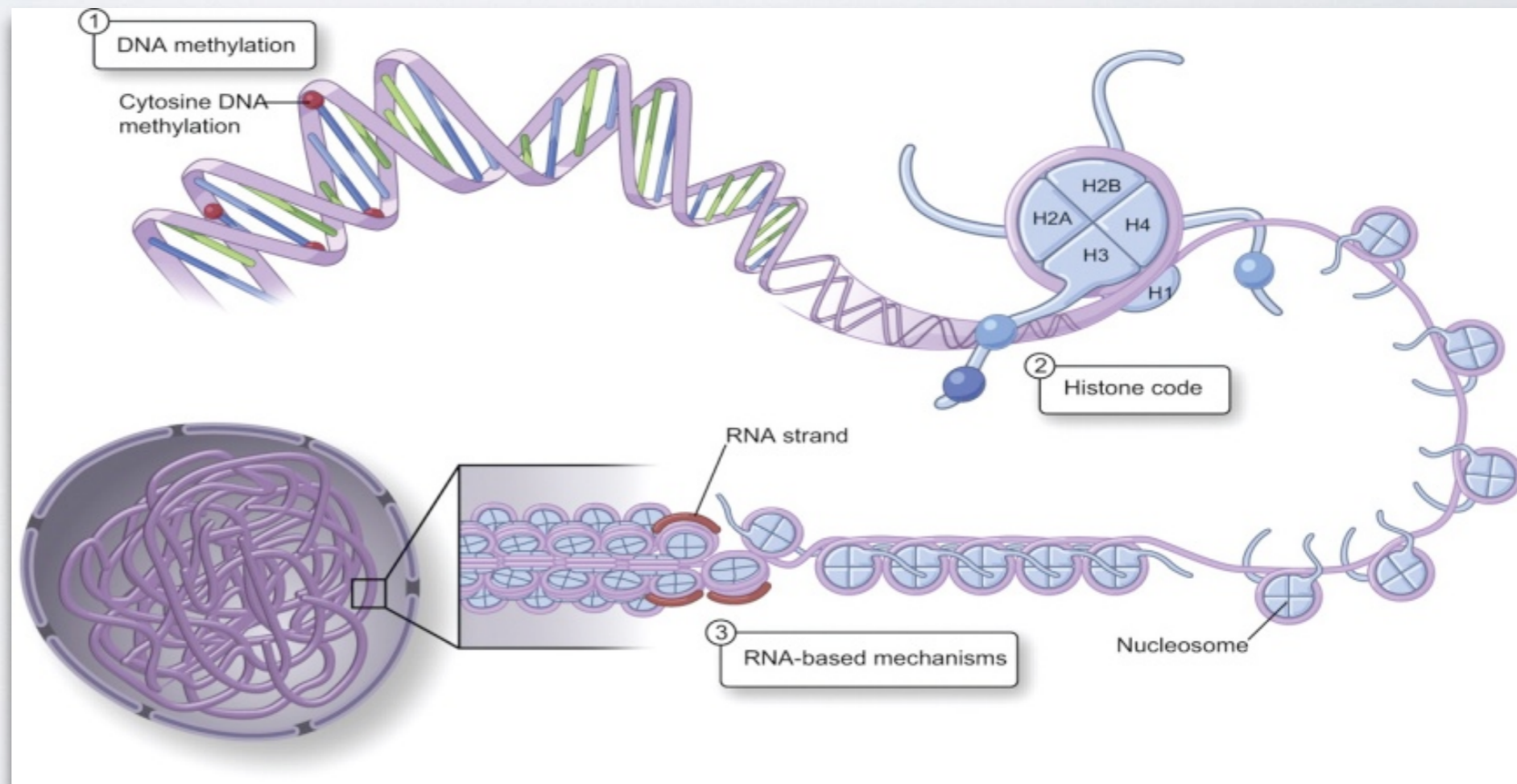
	S	s
S		
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What are the chances the second child will have full sickle cell anemia (ss)?

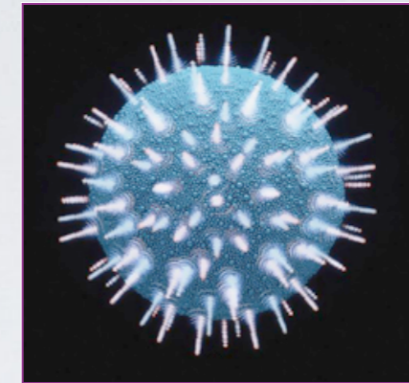
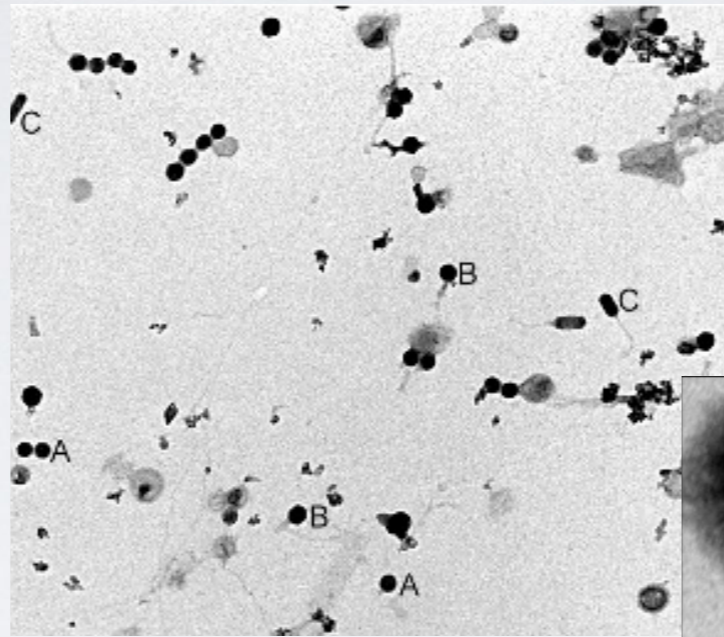
EPIGENETICS

- Study of long-term, stable changes in DNA transcription
- Hereditary change in phenotype
 - No change in DNA sequence, but a change in DNA expression
- Grandpa & You

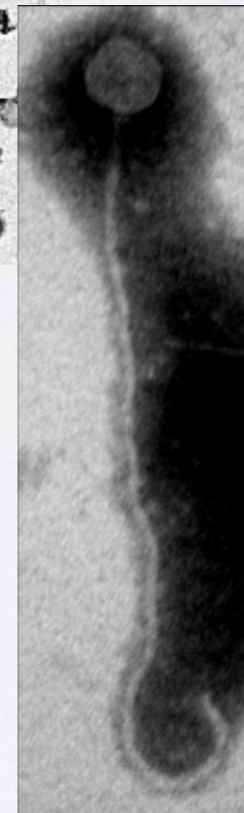
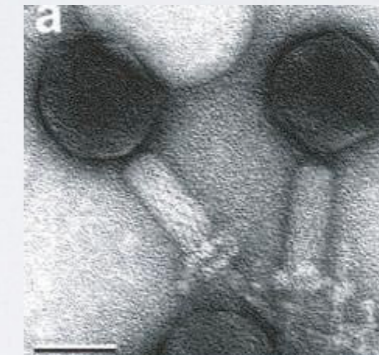


VIRUSES

- Abundant
- Diverse
- Genome + Protein Shell
- Tiny Killing Machines



HIV



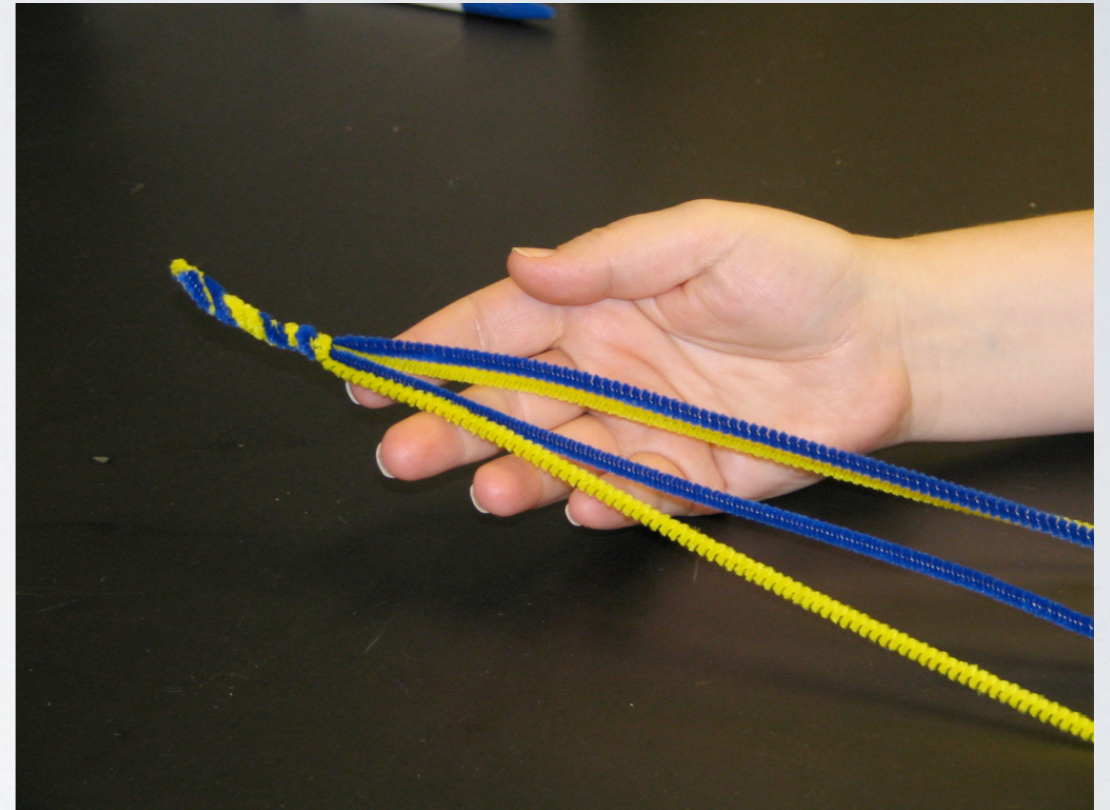
Tobacco Mosaic Virus

BUILD A VIRUS

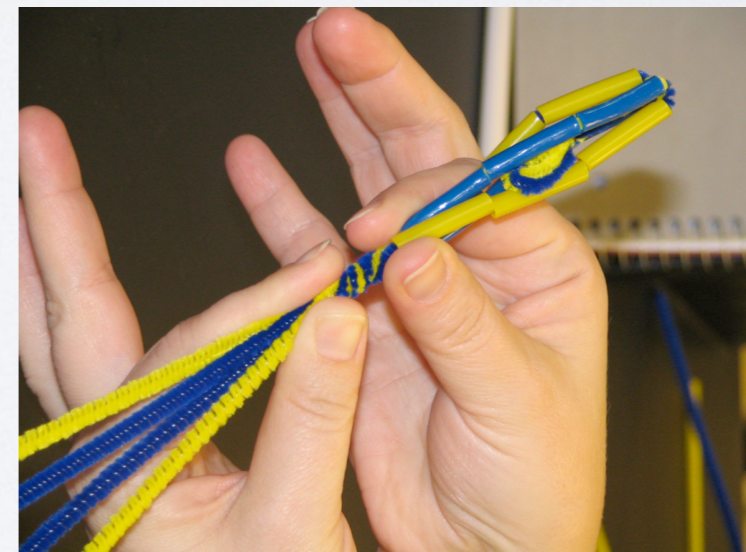
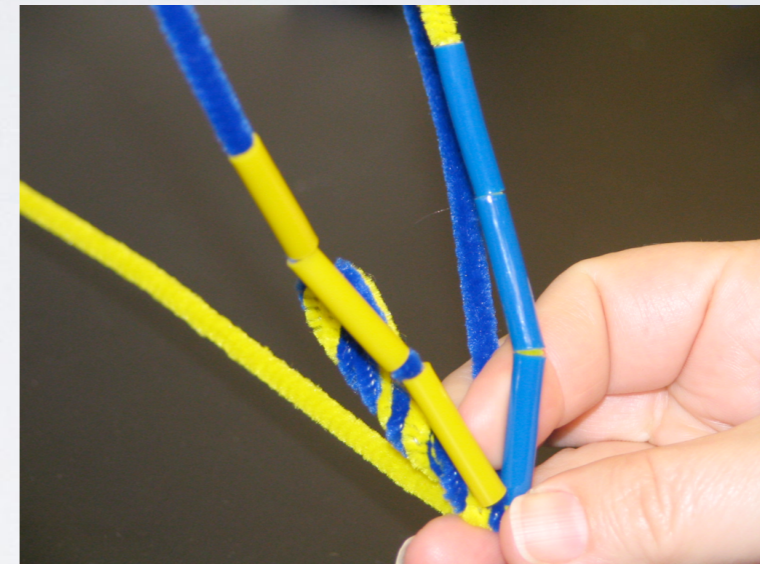
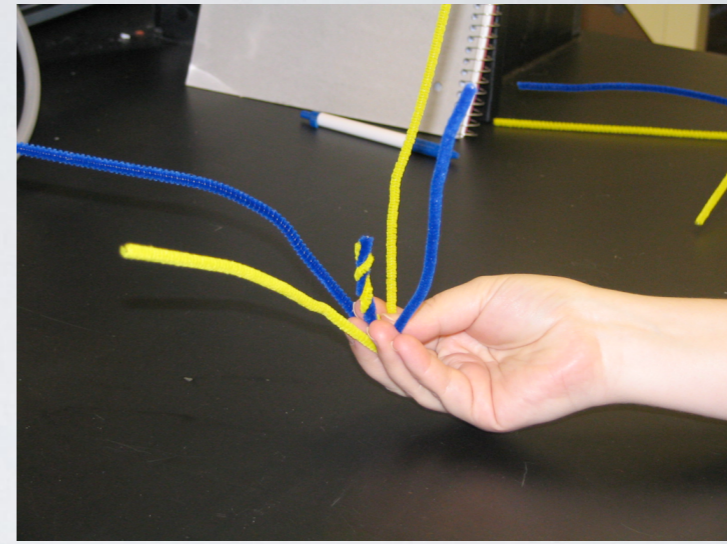
- Pick out 4 pipe-cleaners & 12 straws
 - Select 1 or 2 colors, but not more
 - Combine at your discretion:
 - 4 red pipe-cleaners with 6 red & 6 blue straws
 - 2 red & 2 blue pipe-cleaners with 12 red straws



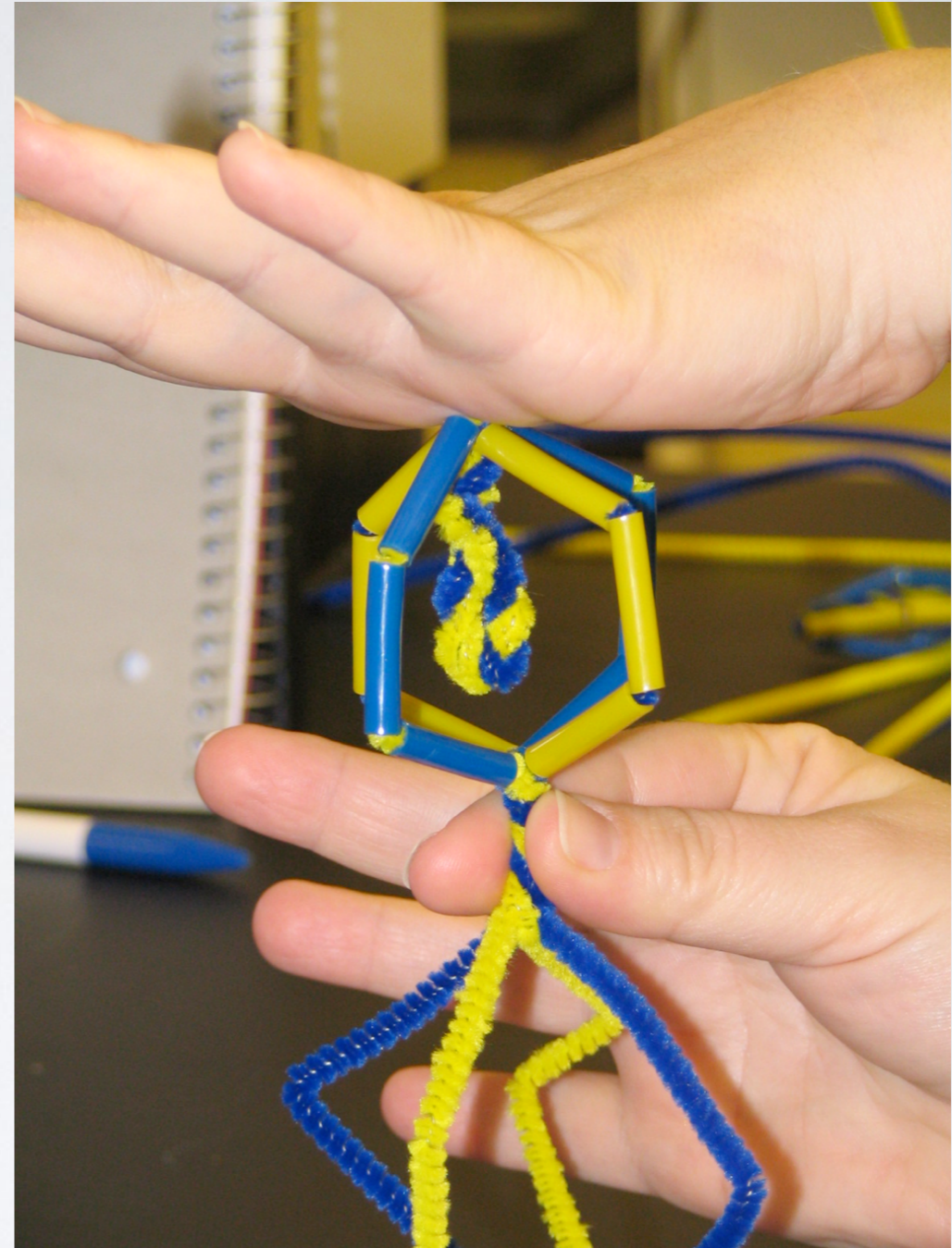
- Hold the 4 pipe-cleaners together in a bundle in your hand.
- Bend 1 end of the bundle of pipe-cleaners down the length of your thumb.
- Twist together the short part of the pipe-cleaners that you just bent over.
- This is your virus's nucleic acid viral genome.



- Hold the pipe-cleaners with the long ends pointing straight up.
- Thread 3 pieces of straw on each pipe-cleaner.
- Twist together the ends of the pipe-cleaners to create your virus's tail.



- Press gently down on the top of the virus to expand the viral head.



VIRUS GENETICS

- Find a partner
- Collect a worksheet
- Look at each of your viruses' genotypes
 - Decide if they are homozygous or heterozygous based on genotype - the pipe-cleaner colors

VIRUS GENETICS

- Look at each of your viruses' phenotypes
 - Decide if your viruses correctly expressed their genotype on their capsid phenotype - straw colors vs. pipe-cleaner colors
- Look at each of your viruses' alleles
 - Which are the dominant colors & which are recessive?

VIRUS GENETICS

- Your viruses have been eyeing each other longingly for a while now...
 - What will your viruses' offspring look like?
 - Predict with Punnett square your offspring genotype & phenotype in the first generation
 - Do your viruses show codominant or polygenic traits?

HOMEWORK

Readings: Genetic Engineering & GMO Rice

Genetics Worksheet due Wed., Feb. 18

Infographic due Today

Distribution instructions on Blackboard

SAVE WATER

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Re-usable: \$15, 5 years

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450 years for a water bottle to decompose

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Sustainability Challenge

 Monday	 Tuesday	 Wednesday
 Thursday	 Friday	 Saturday
 Sunday	Post Your Photo With #SpuSustainabilityWeek For A Chance To Win A \$100 Prize At The End Of The Week!	

March 8-14