

Heredity

Division B

Georgia Tech Event Workshop Series
2025-26



Where to start (general)

Rules manual (for all events!) (make sure you're looking at the correct division)

- Look in detail → Regional vs State vs National
- What to bring (make a list with partner)
- Binder or papers?

Heredity: Event Overview

- Class 2 calculator (check on scioly website about what this means)
- Writing utensils (pencils, pen, eraser) (bring extra!)
- “Each team may bring one (1) 8.5” x 11” sheet of paper that may contain information on both sides in any form and from any source. The sheet of paper may be laminated or placed in a sheet protector to increase durability. Affixed labels, as well as multiple sheets of paper (whether in a single sheet protector or not) are prohibited.” (will refer to this as “cheat sheet” in workshop)
- 50 minutes to take the test
 - Do practice tests using this time limit to get an idea

Calculator Info

<https://scioly.org/wiki/Calculators>

Test

3. **THE COMPETITION**: This Event will be administered as a written test which may be arranged in stations. **Questions will emphasize process skills such as quantitative reasoning, making calculations, analyzing and interpreting experimental results, and drawing evidence-based conclusions.** The Event will cover topics a.i. - a.v. without overemphasis on any one particular topic. The list of topics and subtopics should be considered exhaustive.
 - a. For each of the following topics, participants will be expected to use quantitative reasoning and computational skills, analyze and interpret experimental results, and draw evidence-based conclusions.

1. Mendelian Genetics

- (1) Describe Mendel's Laws of Inheritance and their implications in heredity. State and Nationals only: Describe inheritance patterns which violate these laws (i.e. linkage, incomplete and codominance, complementation).
- (2) Use provided information to construct Punnett Squares of mono- and dihybrid crosses.
- (3) Predict genotypes and phenotypes of offspring and compute their likelihood based on Punnett Squares and experimental data using probability rules.
- (4) Evaluate pedigrees to predict modes of inheritance (i.e. dominant vs recessive traits and autosomal vs sex-linked traits) and construct pedigrees based on data from a case study. (5) State and Nationals Only: Understand recessive epistasis and its implications in predicting phenotypic outcomes.

2. Mitosis and Meiosis

- (1) Understand, compare, and contrast the major stages and key structures in mitosis and meiosis
- (2) Understand the steps involved in human karyotype analysis and be able to interpret a karyotype

3. Molecular Biology of DNA

- (1) Be able to identify and explain the components of DNA (i.e. structure of the nucleotides and backbone), directionality of DNA (5' and 3' ends).
- (2) Explain Chargaff's rules in the context of DNA structure and base pairing.
- (3) Understand the basic stages of DNA replication, with focus on DNA elongation and the processes that happen at the replication fork.
- (4) Identify and understand the organization of DNA structure, such as plasmids, chromatin complexes, euchromatin and heterochromatin, and chromosomes.
- (5) State and Nationals only: Identify, explain, and classify DNA mutations on the DNA level (i.e. chromosomal rearrangements, insertions, deletions, and substitutions), and the potential impact of the resulting protein sequence (i.e. frameshift, silent, missense, and nonsense mutations).

4. Gene and Protein Relationship

(1) Be able to explain the Central Dogma of Molecular Biology.

(2) Transcription: Understand and explain initiation, elongation, and termination stages of transcription, the mechanism of RNA polymerase, and how transcription is regulated by activators and repressors.

(3) Translation: Understand and explain the initiation, elongation and termination stages of translation, the mechanism of the ribosome, and the role mRNA and tRNA play in translation.

(4) State and Nationals only: Understand the function and mechanism of the lac operon.

5. Technology and Techniques

(1) Polymerase chain reaction (PCR): Describe what occurs and which molecules are involved in the denaturation, annealing, and extension steps of a PCR reaction; Explain the role of temperature in PCR; Identify the components needed for a PCR reaction; Identify experimental questions which could be addressed by PCR.

(2) State and Nationals only: Sanger sequencing: Describe how the steps and components in Sanger sequencing differ from a standard PCR reaction; Identify experimental questions which could be addressed by Sanger sequencing.

How to Start

1. Look over rules
2. Split the topics between partners (or all partners do all topics- up to you and how much time you have before the competition)
3. Go through the wiki to get a rough idea
4. For each topic, do research and take notes (add important stuff to your “cheat sheet”- 8.5 x 11 paper)
 - a. Notes are important to have so you can review them before the competition
5. Do practice questions about each topic along the way
 - a. Khan Academy or ask ChatGPT (more about AI to come in this workshop)
6. Once you feel you’ve covered the material, do practice tests
 - a. Take note of topics you frequently miss. Add important things to your “cheat sheet”

Scioly Wiki

[https://scioly.org/wiki/
Main_Page](https://scioly.org/wiki/Main_Page)

Welcome to the Scioly.org Wiki!

The collaborative resource that anyone can edit

Currently hosting 4,969 articles for Science Olympiads

[Getting Started](#)

[Wiki Guidelines](#)

[FAQ](#)

[Other Help Pages](#)

[Scioly.org Forums](#)

[Scioly.org Discord](#)

[Pages That Need Work](#)

[WikiProject Dark Mode](#)

About Science Olympiad		
National Science Olympiad History		
Starting a Team		
Online Tournament Formats		
Scoring	Rules Manual	
Divisions		
A	B	C

Preparing for Competition	
Note Sheets	Calculators
Binders	Safety Glasses
Field Guides	Trial Events
Test Taking Skills	Transporting Builds

Scioly.org Resources	
Forums	
Test Exchange	
Test Archive	
Image Gallery	

About Scioly.org	
Needs Work	Scioly.org History
Help Pages	Scioly.org FAQ
Report Wiki Issues	Site Rules
Scioly.org Discord	

2026 Events	
Division B	Division C
Anatomy and Physiology	Anatomy and Physiology
Boomilever	Astronomy
Circuit Lab	Boomilever
Codebusters	Bungee Drop
Crime Busters	Chemistry Lab
Disease Detectives	Circuit Lab
Dynamic Planet	Codebusters
Entomology	Designer Genes
Experimental Design	Disease Detectives
Helicopter	Dynamic Planet
Hereditiy	Electric Vehicle
Hovercraft	Engineering CAD
Machines	Entomology
Meteorology	Experimental Design
Metric Mastery	Forensics
Mission Possible	Helicopter
Potions and Poisons	Hovercraft
Remote Sensing	Machines
Rocks and Minerals	Materials Science
Scrambler	Remote Sensing
Solar System	Robot Tour
Water Quality	Rocks and Minerals

Invitational Tournaments	
Invitational Pages	List of Tournaments

State Pages			
State Tournament Results			
AL	ID	MO	PA
AK	IL	MT	RI
AZ	IN	NE	SC
AR	IA	NV	SD
CA (N)	KS	NH	TN
CA (S)	KY	NJ	TX
CO	LA	NM	UT
CT	ME	NY	VT
DE	MD	NC	VA
DC	MA	ND	WA
FL	MI	OH	WV
GA	MN	OK	WI
HI	MS	OR	WY

National Tournament	
Venues	The Best of Nationals
2026 Southern California	The Best of 2026
2025 Nebraska	The Best of 2025

Practice Tests

<https://scioly.org/tests/>

Ctrl F (and search Heredity) and you'll find practice tests and keys

Sit down with a timer (50 minutes) and get to work. Go somewhere with no distractions or noise and no devices (other than your timer) and take the test. Then grade your test and see what you missed. You can make note of things you missed (see if there are frequently missed topics) and learn about why you missed the question and what to do or learn differently for next time.

More Practice

You can find Quizlets with Heredity info and practice questions

You can also find videos on YouTube about the event that have practice questions

Also looking up “Heredity Division B Science Olympiad Tests” on Google could bring up more practice tests.

Begins with ▾

heredity

1 of 14



Done

233	2020	Fossils	BC	Scioly Summer Study Session	dchen22	key1 test1
234	2020	Fossils	BC	Scioly Summer Study Session	ElizavetaK	key test
235	2020	Fossils	BC	Scioly Summer Study Session	Reninkidney	key
236	2020	Fossils	BC	Scioly Summer Study Session	wec01	key sheet test
237	2020	Fossils	C	Captains Tryouts	Montgomery Blair High School	key test
238	2020	Game On	B	Scioly Summer Study Session	person-v132	notes
239	2020	Geologic Mapping	C	Captains Tryouts	Carmel High School	key test
240	2020	Gravity Vehicle	C	Scioly Summer Study Session	samuel.barlow003	notes notes notes1 notes2
241	2020	Heredity	B	Scioly Summer Study Session	amk578	key test
242	2020	Heredity	B	Scioly Summer Study Session	NeilMehta	key test
243	2020	Heredity	B	Scioly Summer Study Session	Phenakism	key1 sheet test
244	2020	Heredity	B	Scioly Summer Study Session	Rowiew125	test
245	2020	Heredity	B	Scioly Summer Study Session	summerwinter	key test
246	2020	Mousetrap Vehicle	B	Scioly Summer Study Session	kendreaditya	notes notes notes1 notes2
247	2020	Ornithology	C	Captains Tryouts	duPont Manual High School	key sheet test
248	2020	Ornithology	C	Captains Tryouts	Mason High School	key test
249	2020	Ornithology	C	Captains Tryouts	Montgomery Blair High School	key test

Using AI

Use it as a study resource!

If you have tried to learn a topic various times (through websites and videos) and still don't get it, ask AI for help. Tell it what the rules manual says that you need to know about the topic or give it a question you're stumped on. Ask it to explain from the basics!

Use AI ethically as a study tool, and it can help you immensely! Ask it to make practice questions, to go over topics, to give you examples, etc. And always ask it for explanations to make sure you fully understand the content.

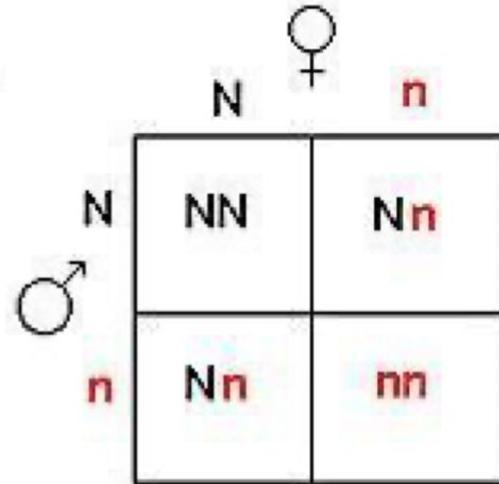


PRINCIPLES OF GENETICS

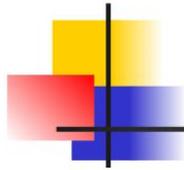
- **GENES** – come in pairs
 - Section of DNA – codes protein or part of protein
 - One from each parent
- **ALLELE** – different forms of a gene
- **MULTIPLE ALLELES** – more than 2 forms of a gene
- **HOMOZYGOUS** – same alleles
- **HETEROZYGOUS** – different alleles

Dominant vs. Recessive

- **Dominant** – always expressed
 - ◆ Capital letters – **N**
 - ◆ Homozygous - **NN**
 - ◆ Heterozygous - **Nn**
- **Recessive** – prevented by dominant
 - ◆ Lower case letters – **n**
 - ◆ Homozygous – **nn**



Punnett Square – Box showing allele combinations



Dominant and Recessive

- **Autosomal Dominant**
Dominant gene on an autosome
- **Autosomal Recessive**
Recessive gene on an autosome
- **Sex-linked Dominant**
Dominant gene on a sex chromosome
- **Sex-linked Recessive**
Recessive gene on a sex chromosome

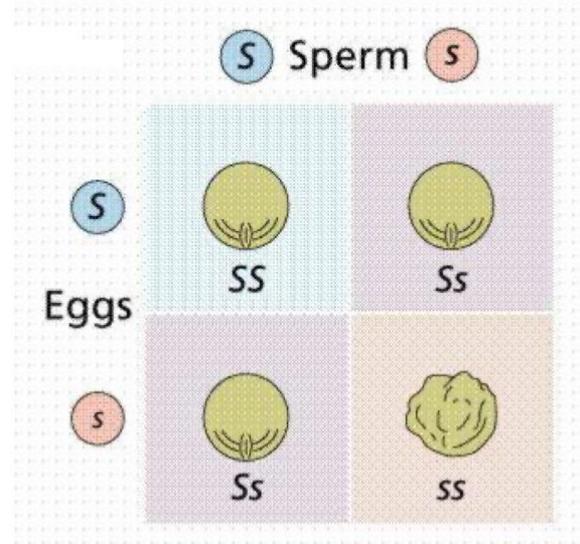
Monohybrid Cross

Hybrid – Ss X Ss

One Trait – Smooth vs wrinkled

Two gametes per parent
S and s

Punnett Square with 4 boxes – 4 offspring



Genotype & Phenotype

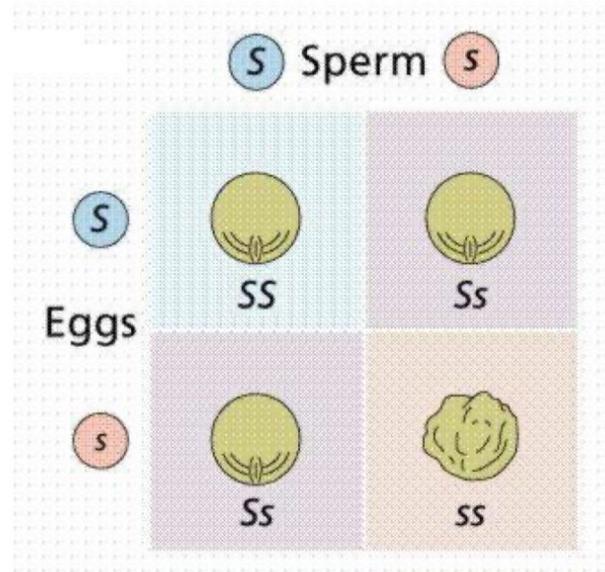
Genotype **Phenotype**
SS or Ss **Round**
ss **Wrinkled**

Genotype frequency

1:2:1

Phenotype frequency

3:1



Dihybrid Cross



Dihybrid – 2 traits

Gametes per parent = 4

Punnett Square – 16 boxes

**Genotype ratio
1:2:1:2:4:2:1:2:1**

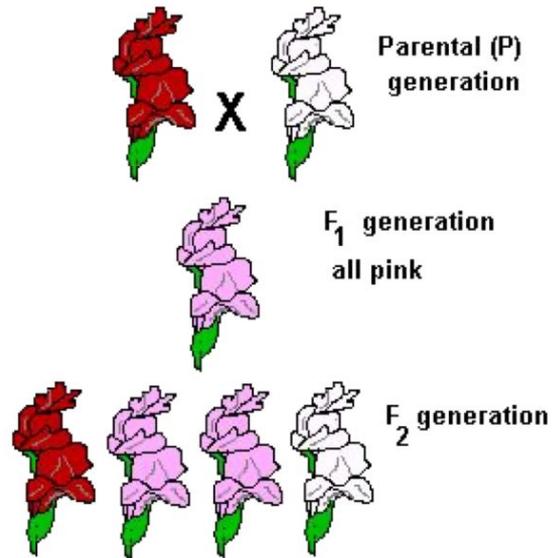
**Phenotype ratio
9:3:3:1**



		SY	Sy	sY	sy			
SY	SSYY		SSYy		SsYY		SsYy	
Sy	SSYy		SSyy		SsYy		Ssyy	
sY	SsYY		SsYy		ssYY		ssYy	
sy	SsYy		Ssyy		ssYy		ssyy	

Incomplete Dominance

- **Hybrid** is a blend of two traits
- **Genotype frequency**
1:2:1
- **Phenotype frequency**
1:2:1
- **Examples:**
Flowers, Animal fur





Co-dominance

- **More than one dominant allele**
- **Blood types – A,B,O alleles**
- **Phenotypes Genotypes**

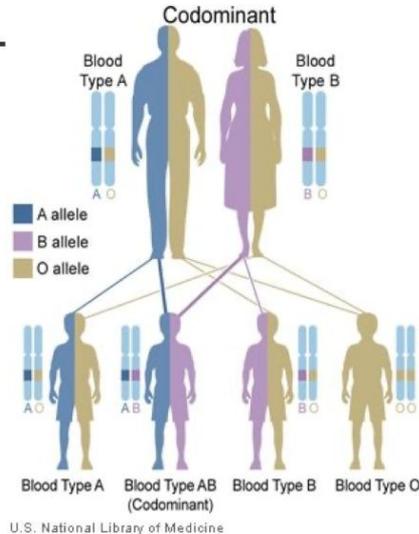
A $I^A I^A$ or $I^A i$

B $I^B I^B$ or $I^B i$

AB $I^A I^B$

O ii

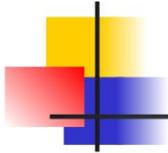
Co-dominance



Blood Type	Genotype		Can Receive Blood From:
A	$i^A i^A$ $i^A i$	AA AO	A or O
B	$i^B i^B$ $i^B i$	BB BO	B or O
AB	$i^A i^B$	AB	A, B, AB, O
O	ii	OO	O

- **co-dominance** – both dominant alleles (genes) in an individual are expressed as blood types
- A and B genes are co-dominant and both dominant over the O gene which is recessive

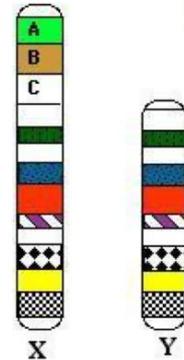
Independent Assortment vs. Linkage



- **Independent Assortment** – genes on different chromosomes separate independently during meiosis
- **Linkage** – genes on the same chromosome are inherited as a group
 - ❖ **Autosomal linkage** – on autosomes
 - ❖ **Sex-linked** – on sex chromosomes

Linkage – Sex Linkage

- **Linkage** – genes on the same chromosome inherited as a group
- **Sex-linkage** – genes on sex chromosomes (esp. X)
- **Y-chromosome shorter** – some genes from X missing
- **X-linked traits** more common in men
- Men get X-chromosome from mom
- Red-green colorblindness, hemophilia

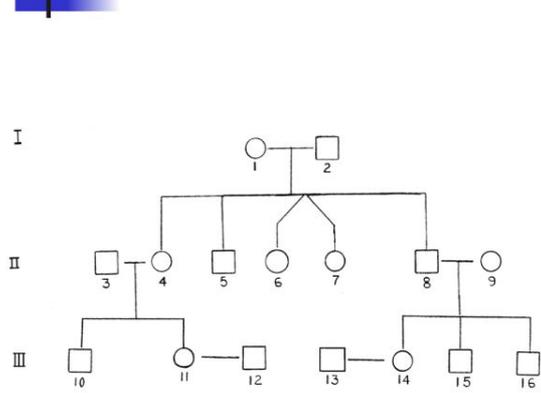




Environmental influence on genes expression

- **Gene function** is influenced by environment as with identical twins
- **Genes** have blueprint for proteins or parts of proteins
- **Proteins** can be structural proteins (parts of body) or functional proteins (hormones/enzymes)

Pedigree Symbols



Symbols Used in Pedigree Analysis

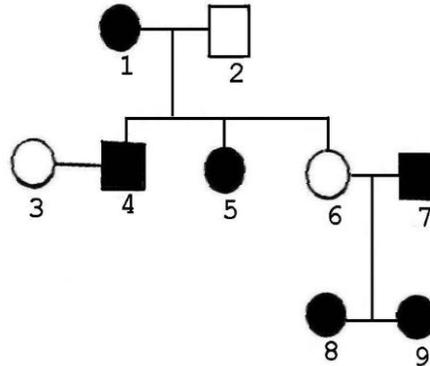
	Male		Offspring of unknown sex
	Female		Aborted or stillborn offspring
	Mating between individuals		Deceased offspring
	Mating between close relatives		Affected individual
	Parents (top row) and their offspring (bottom row) listed in birth order.		Propositus (male) or proposita (female). First case in family that was identified.
	Roman numerals indicate generations; arabic numbers indicate birth order within a generation		Heterozygotes
	Identical (monozygotic) twins		X-linked carrier
	Nonidentical (fraternal) twins		Indicates date of death
			Questionable whether individual had trait

- Generations = I – Original Parents, II- F1 (children), III – F2 (grandchildren)

Pedigree – Curly vs Straight Hair

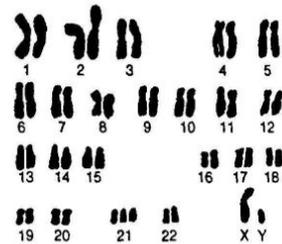
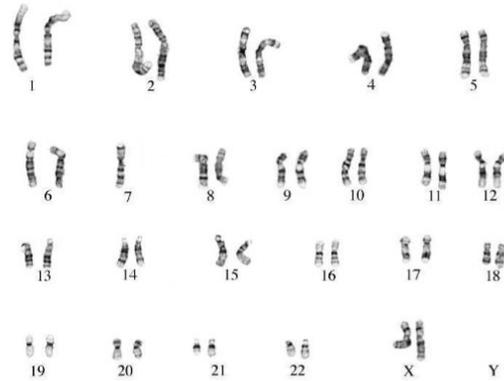
Types of Analysis

- **Relationships**
- **Dominant Gene – H**
Curly
- **Recessive Gene – h**
Straight
- **Genotypes**
- **Phenotypes**



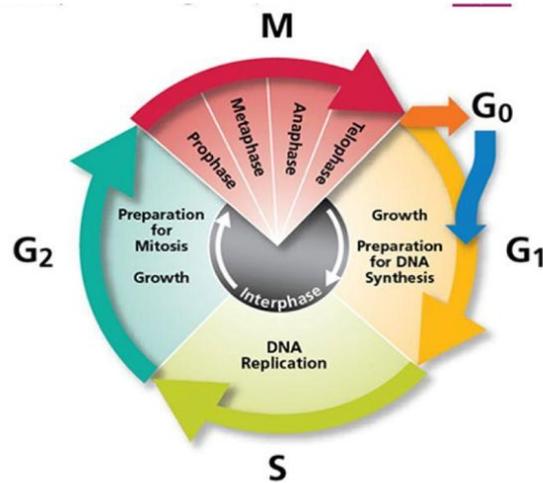
Karyotypes

- **Pairs 1-22 = Autosomes**
- **XY = Sex chromosomes**
- **Male = X & Y**
- **Female = only X**
- **Nondisjunction**
- **Extra chromosomes (Trisomy)**
- **Missing chromosomes (Monosomy)**



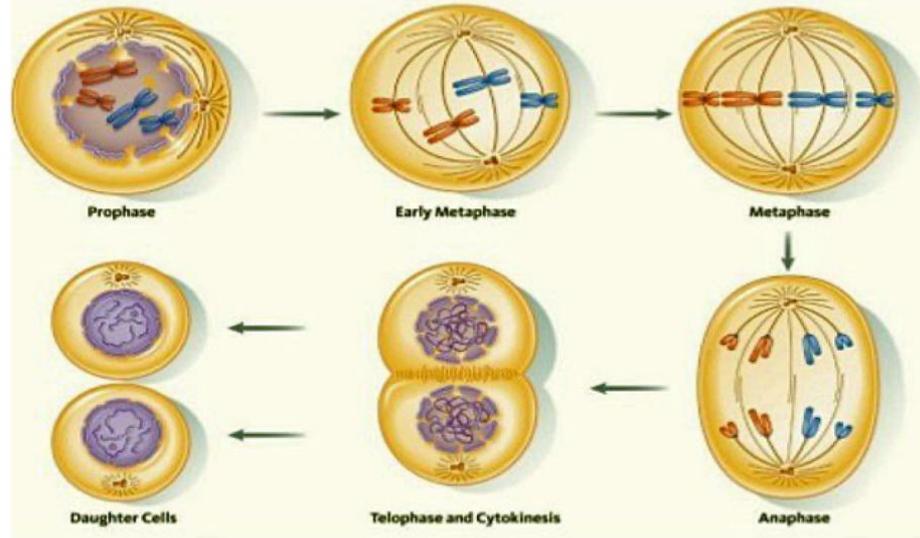
Cell Cycle

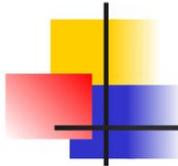
- **Interphase**
 - ◆ G1
 - ◆ S – DNA replicates
 - ◆ G2
- **Mitosis**
 - ◆ Prophase
 - ◆ Metaphase
 - ◆ Anaphase
 - ◆ Telophase





Stages of Mitosis

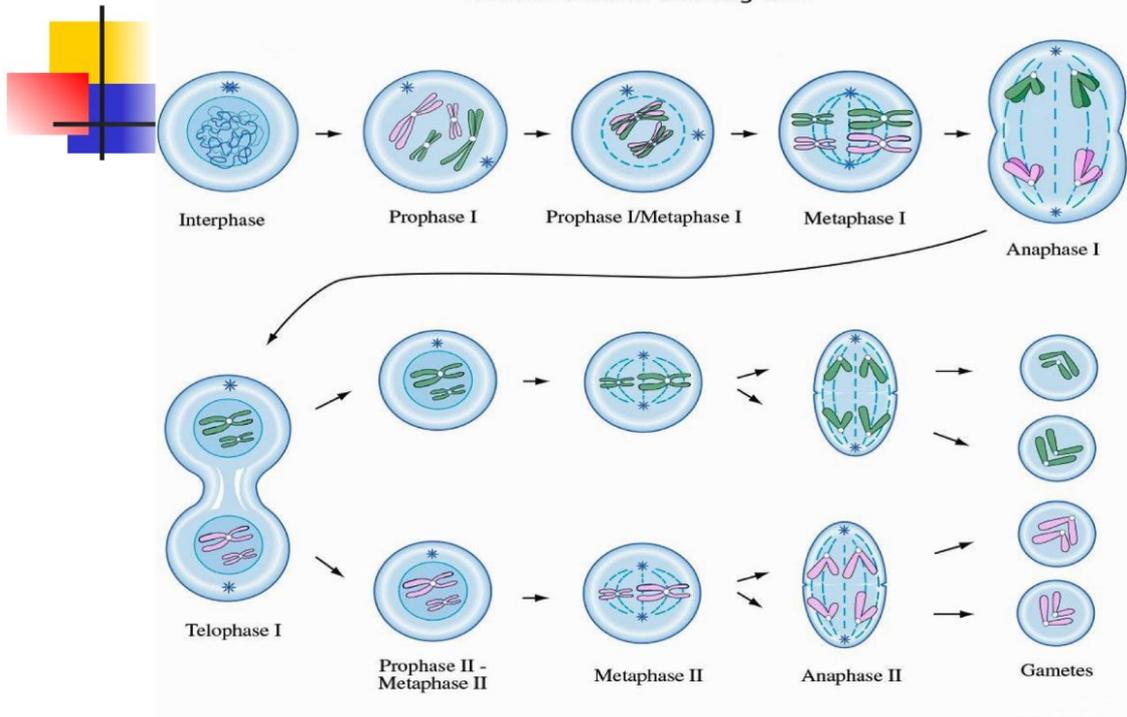




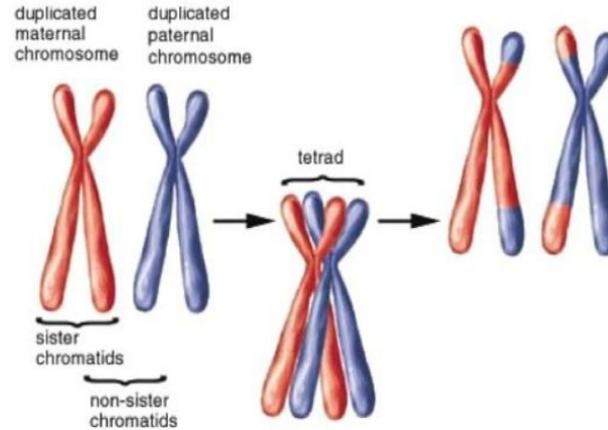
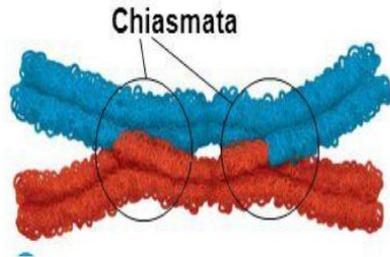
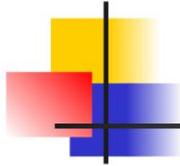
Mitosis vs. Meiosis

- **Mitosis**
 - ◆ Growth and Asexual Reproduction
 - ◆ One division – 2 diploid cells
 - ◆ Genetically same as original
- **Meiosis**
 - ◆ Gametes for Sexual Reproduction
 - ◆ 2 divisions – 4 haploid cells

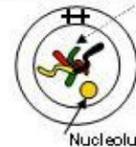
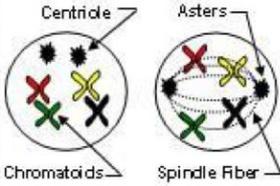
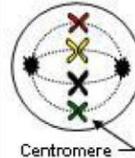
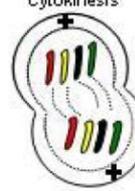
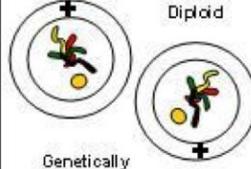
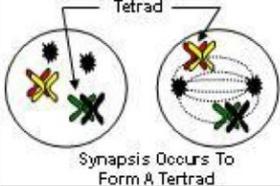
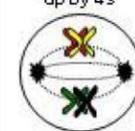
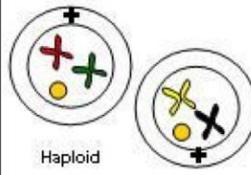
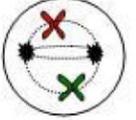
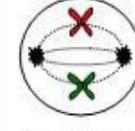
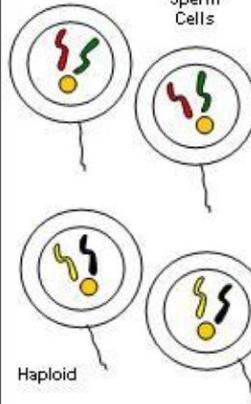
Meiosis With No Crossing-over



CROSSING OVER IN MEIOSIS I

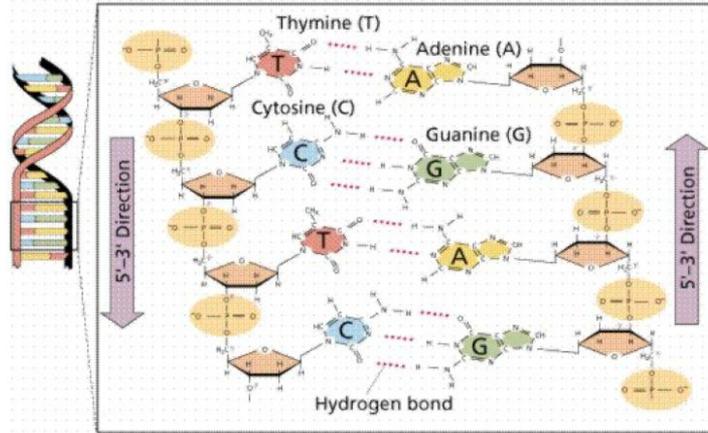


Comparison of Mitosis and Meiosis

	Interphase	Prophase	Metaphase	Anaphase	Telophase	Resulting Cells
Mitosis	<p>Diploid</p> <p>Chromatin Material</p>  <p>Nucleolus</p> <p>DNA Replicates</p>	 <p>Centriole</p> <p>Asters</p> <p>Chromatoids</p> <p>Spindle Fiber</p>	<p>Chromatids line up by 2's</p>  <p>Centromere</p>	<p>Independent Chromosomes</p>  <p>Separate & Move To Poles</p>	<p>Cytokinesis</p> 	 <p>Diploid</p> <p>Genetically Identical</p>
Meiosis I	<p>Diploid</p>  <p>Sperm Reproduction</p> <p>DNA Replicate</p>	 <p>Tetrad</p> <p>Synapsis Occurs To Form A Tetrad</p>	<p>Chromatids line up by 4's</p> 	<p>Chromatid Pairs</p>  <p>Separate & Move To Poles</p>		 <p>Haploid</p>
Meiosis II	<p>DNA does "not" Replicate</p>  <p>Haploid</p>	 	<p>Chromatids line up by 2's</p> 	<p>Independent Chromosomes</p>  <p>Separate & Move To Poles</p>		 <p>Sperm Cells</p> <p>Haploid</p>

DNA Structure

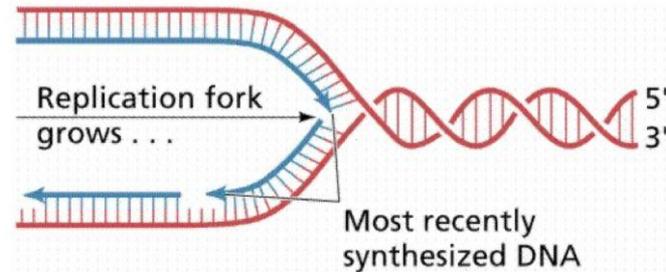
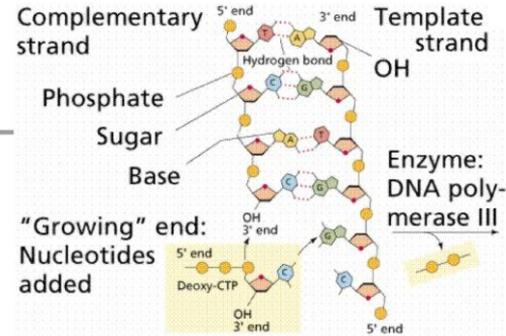
- **Double helix**
- **Antiparallel – 3' to 5'**
- **Nucleotide**
 - ◆ **Deoxyribose sugar**
 - ◆ **Phosphate**
 - ◆ **Nitrogen bases**
 - **Adenine**
 - **Thymine**
 - **Guanine**
 - **Cytosine**



DNA

Replication

- **Replication** (in nucleus)
- **DNA** uncoils & splits
- **Reads 3' to 5'**
- **Assembles 5' to 3'**
- **4 types of nucleotides**
- **Okazaki fragments**





Types of RNA

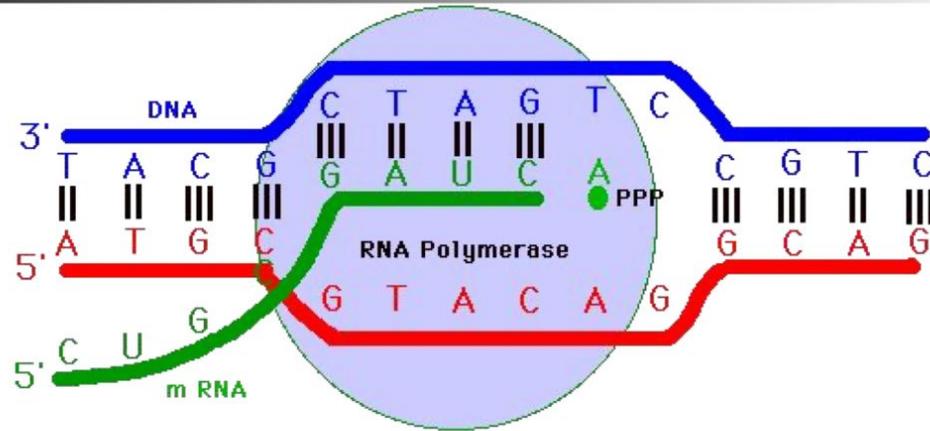
- **Differences between DNA & RNA**
 - ◆ **Single strand**
 - ◆ **Ribose instead of Deoxyribose**
 - ◆ **Uracil instead of Thymine**
- **Messenger RNA (m-RNA) – carries blueprint**
- **Transfer RNA (t-RNA) – brings amino acids**
- **Ribosomal RNA (r-RNA) – reads code**

Gene Expression - Transcription & Translation



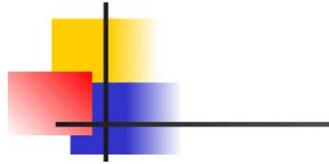
- **Transcription** – makes RNA (in nucleus)
- **Translation (protein synthesis)** -Reads blueprint and makes protein or part of protein (in cytoplasm at the ribosome)

Transcription of RNA from DNA

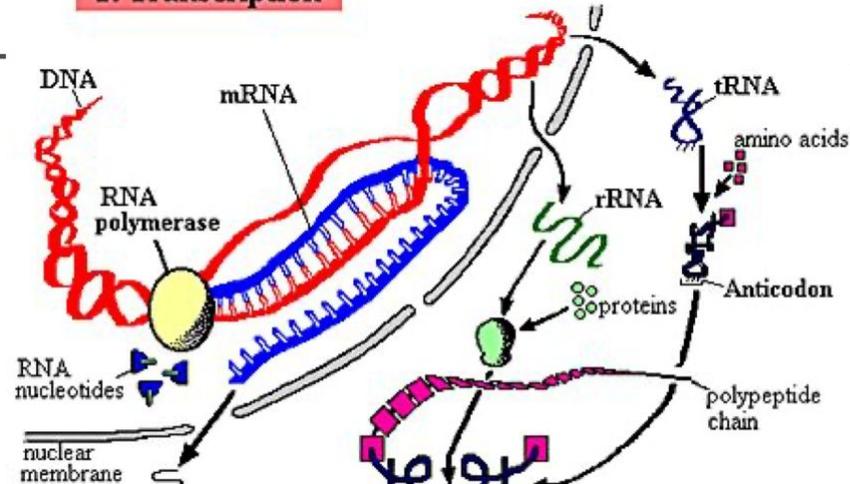


- **Transcription:** Synthesis of RNA from a DNA Template.
- Requires DNA-dependent RNA polymerase plus the four nucleotides (ATP, GTP, CTP and UTP).
- Synthesis begins at a the initiation site on DNA
- The template strand is read 3' to 5' and the mRNA is synthesized 5' to 3'

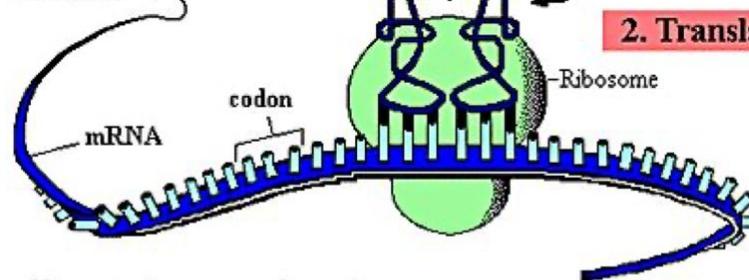
Translation – Protein Synthesis



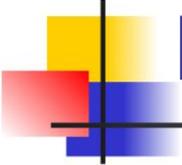
1. Transcription



2. Translation

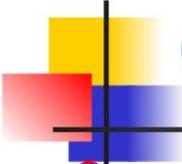


Protein synthesis



Mutations

- **Mutation** – any change in the DNA
- **Gene mutation**
- **Chromosomal mutation**
- **Agents causing mutations** –
radiation, chemicals, excess heat



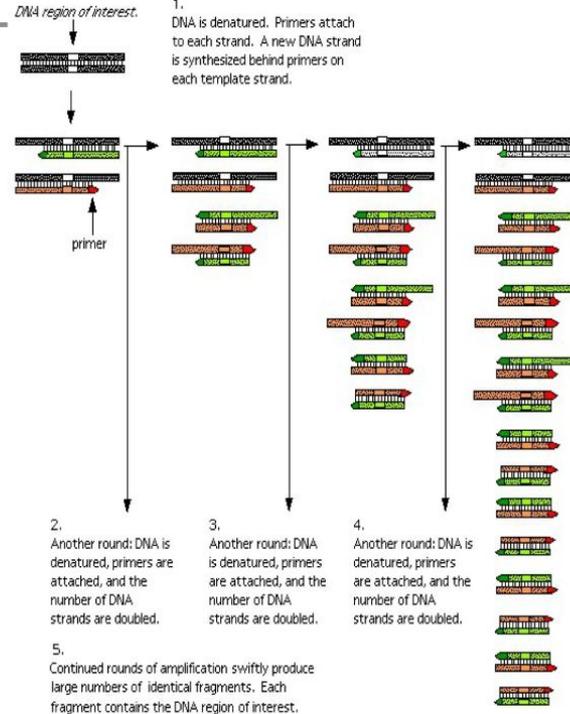
Genetic Disorders

- **Causes of mutations** – chemicals, radiation, temperature, viruses
- **Nondisjunction** – chromatids do not separate properly during meiosis. Individual formed from such gametes have extra or missing chromosomes. as Down's Syndrome
- **Trinucleotide repeats** – sequences of 3 nucleotides is repeated, often several times in a gene when too many repeats are formed – cause genetic disorders triplet nucleotides -repeated too often as Huntington's
- **Defective genes** – does not produce correct protein as sickle cell anemia (A & T traded places)
- **Genetic disorders and their causes** as nondisjunction (Down's syndrome), trinucleotide repeats (fragile X and Huntington's), defective genes (sickle cell anemia, hemophilia)
- **Human genetic disorders** – can be dominant, recessive, sex-linked, epistatic, variable expressed
- **Crossover frequency** – during meiosis, pieces trade places – determining frequency

Polymerase Chain Reaction (PCR)

- **Technique** for quickly making an unlimited number of copies of any piece of DNA
- Sometimes called "**molecular photocopying**"

POLYMERASE CHAIN REACTION



Hope that helps!