Slide 1

Genetics:
Mendelian Principles

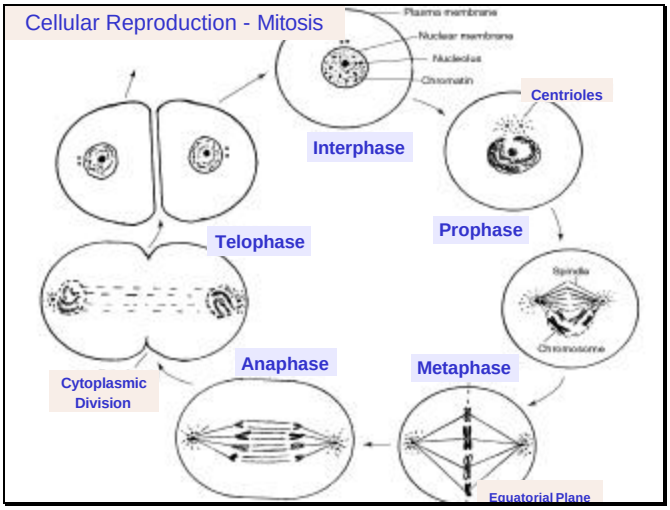
Thine eyes have seen
my unformed substance;
And in Thy book
they were all written,
The days that were ordained
for me,
When as yet there was not
one of them.

Psalm 139: 16

BIO 100 John E. Silvius, Cedarville College

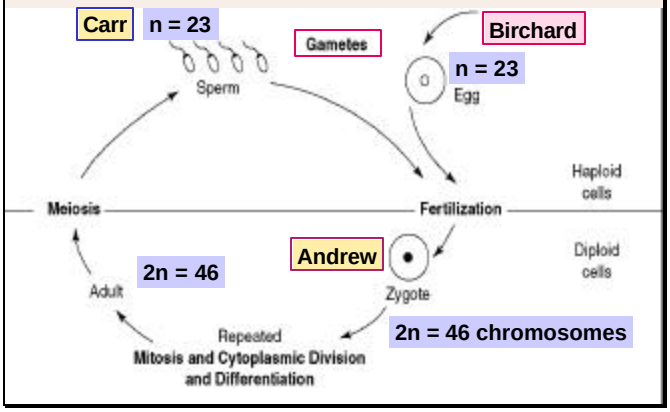
Slide 2

Cellular Reproduction - Mitosis



Slide 3

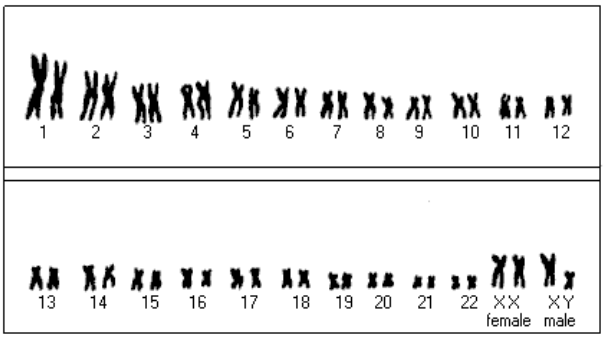
Life Cycles and Sexual Reproduction



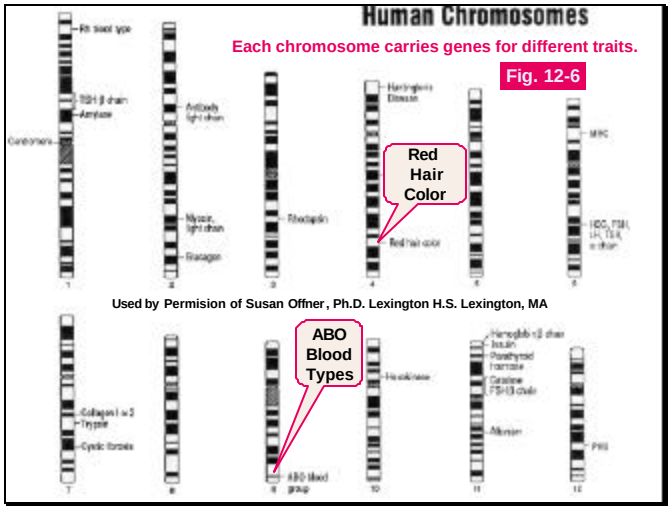
Slide 4

Human Chromosomes

Homologous Pairs in Somatic Cells (2n)



Slide 5



Slide 6

What Meiosis Accomplishes:

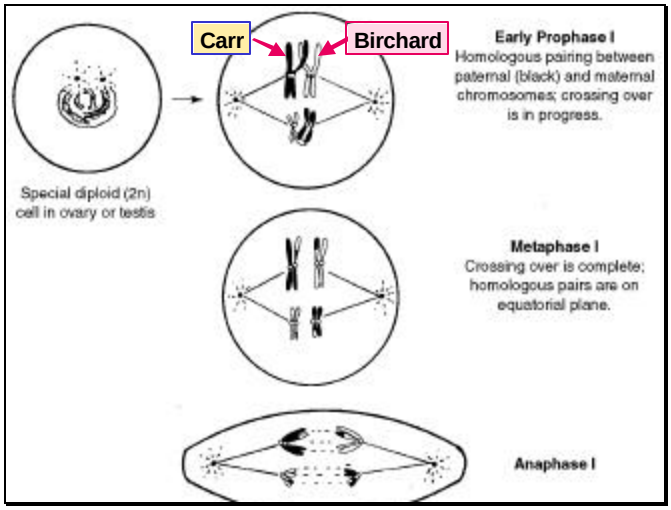
1. **Reduction of chromosome number by half.**
   2n (diploid) → n (haploid)

2. **Independent Assortment -- homologous pairing so that both paternal and maternal chromosomes can be present in each resultant gamete.**

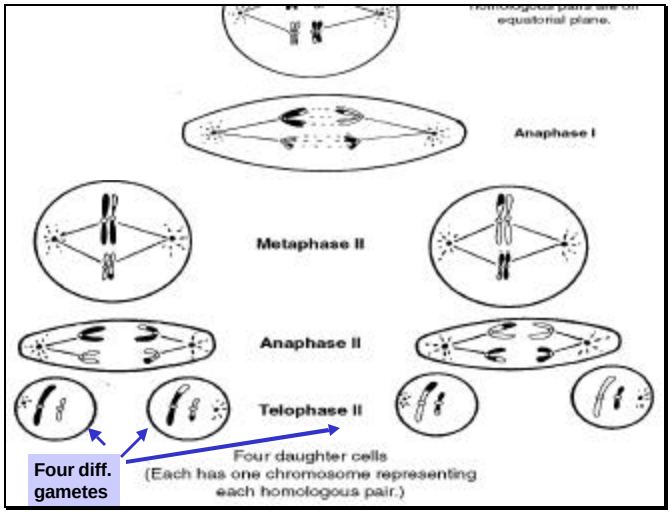
3. **Crossing over -- some chromatids exchange between paternal and maternal.**

RESULT: **Genetic continuity across generations, Genetic diversity among offspring.**

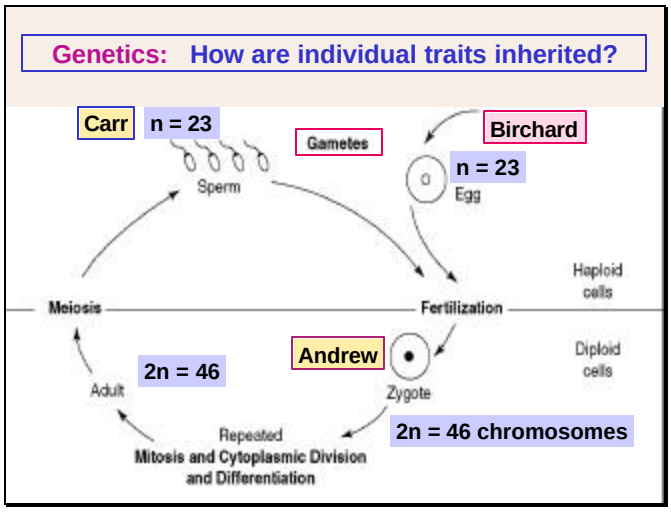
Slide 7



Slide 8



Slide 9



Slide 10

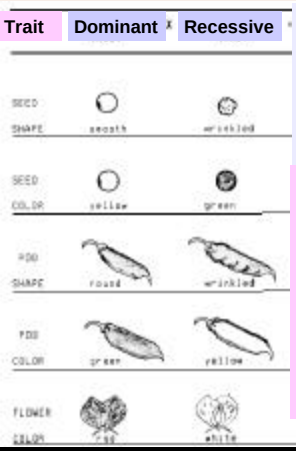
GREGOR MENDEL (Austrian Monk, 1822-1884)

"Father of Genetics"

Slide 11

Table 12-1. Mendel's Experiments with Garden Peas

Trait	Dominant	Recessive
SEED SHAPE	smooth	wrinkled
SEED COLOR	yellow	green
POD SHAPE	round	wrinkled
POD COLOR	green	yellow
FLOWER COLOR	red	white
	705	224



PRINCIPLES OF HEREDITY

Observation #1:
"Many traits have two expressions"

TRAIT

A parameter such as shape, color, or height (Nouns)

Slide 12

Table 12-1. Mendel's Experiments with Garden Peas

Trait	Dominant	Recessive
SEED SHAPE	smooth	wrinkled
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POD SHAPE	round	wrinkled
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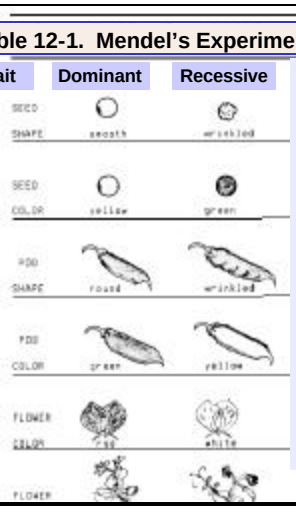
FLOWER		



PRINCIPLES OF HEREDITY

Observation #1:
"Many traits have two expressions"

Principle #1:
Each trait is controlled by two hereditary factors

Slide 13

Table 12-1. Mendel's Experiments with Garden Peas

Trait	Dominant	Recessive
SEED SHAPE	smooth	wrinkled
SEED COLOR	yellow	green
POD SHAPE	round	wrinkled
POD COLOR	green	yellow
FLOWER COLOR	red	white
FLOWER		

PRINCIPLES OF HEREDITY

Observation #1:
"Many traits have two expressions"

Principle #1:
Each trait is controlled by two hereditary factors

PHENOTYPE:
An expression of a trait

(Adjectives)

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Table 12-1. Mendel's Experiments with Garden Peas

Trait	Dominant	Recessive
SEED SHAPE	smooth	wrinkled
SEED COLOR	yellow	green
POD SHAPE	round	wrinkled
POD COLOR	green	yellow
FLOWER COLOR	red	white
FLOWER		

PRINCIPLES OF HEREDITY

Observation #1:
"Many traits have two expressions"

Principle #1:
Each trait is controlled by two hereditary factors

"TWO UNITS"
Mendel Predicts the Diploid Condition

ALLELES:
"Genes for a given trait"

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FLOWER COLOR	red	white
FLOWER		

PRINCIPLES OF HEREDITY

Observation #2:
"Offspring of crosses between two phenotypes often express only one phenotype"

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Table 12-1. Mendel's Experiments with Garden Peas

Trait	Dominant	Recessive
SEED		
SHAPE	round	wrinkled
POD COLOR	green	yellow
FLOWER COLOR	red	white
FLOWER		

SMOOTH Seeds x WRINKLED Seeds

ALL SMOOTH OFFSPRING

PRINCIPLES OF HEREDITY

Observation #2:
"Offspring of crosses between two phenotypes often express only one phenotype"

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Table 12-1. Mendel's Experiments with Garden Peas

Trait	Dominant	Recessive
SEED		
SHAPE	round	wrinkled
POD COLOR	green	yellow
FLOWER COLOR	red	white
FLOWER		

SMOOTH Seeds x WRINKLED Seeds

ALL SMOOTH OFFSPRING

PRINCIPLES OF HEREDITY

Observation #2:
"Offspring of crosses between two phenotypes often express only one phenotype"

Principle #2:
When two factors contrast with each other, one is expressed (dominant) and one is masked (recessive)

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Table 12-1. Mendel's Experiments with Garden Peas

Trait	Dominant	Recessive
SEED		
SHAPE	round	wrinkled
POD COLOR	green	yellow
FLOWER COLOR	red	white
FLOWER		

SMOOTH x WRINKLED

S s

ALL SMOOTH OFFSPRING

Ss

GENOTYPE:
Symbolic notation for alleles

PRINCIPLES OF HEREDITY

Observation #2:
"Offspring of crosses between two phenotypes often express only one phenotype"

Principle #2:
When two factors contrast with each other, one is expressed (dominant) and one is masked (recessive)

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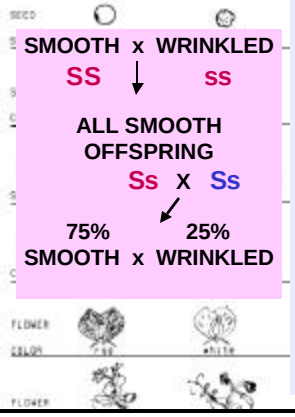
Table 12-1. Mendel's Experiments with Garden Peas

Trait	Dominant	Recessive
SEED		
	SMOOTH	WRINKLED
	SS	ss
	ALL SMOOTH OFFSPRING	
	Ss x Ss	
	75% SMOOTH	25% WRINKLED
FLOWER COLOR		
FLOWER		



PRINCIPLES OF HEREDITY

Observation #3:
Wrinkled offspring reappeared in third generation

Principle #3:
There is a segregation (separation) of hereditary factors during gamete formation

NOTE: Mendel predicts MEIOSIS!!

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Table 12-1. Mendel's Experiments with Garden Peas

Dominant: SMOOTH — Recessive: WRINKLED

SS x ss

ALL SMOOTH OFFSPRING

Ss x Ss

	S	S	s	s
S				
S				
s				
s				

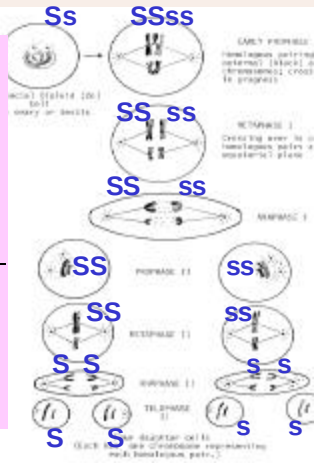

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Table 12-1. Mendel's Experiments with Garden Peas

Dominant: SMOOTH — Recessive: WRINKLED

SS x ss

ALL SMOOTH OFFSPRING

Ss x Ss

	S	S	s	s
S	SS	SS	Ss	Ss
S	SS	SS	Ss	Ss
s	sS	sS	ss	ss
s	sS	sS	ss	ss

PRINCIPLES OF HEREDITY

Principle #4:
When gametes fuse (fertilization) the two factors combine at random.

RESULT:
Ratios of phenotypes can be predicted from partental genotypes

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Table 12-1. Mendel's Experiments with Garden Peas

Dominant	Recessive
SMOOTH	WRINKLED

SS x ss

ALL SMOOTH OFFSPRING

Ss x Ss

	S	S	s	s
S	SS	SS	Ss	Ss
S	SS	SS	Ss	Ss
s	sS	sS	ss	ss
s	sS	sS	ss	ss

PRINCIPLES OF HEREDITY

Principle #4:
When gametes fuse (fertilization) the two factors combine at random.

RESULT:
Ratios of phenotypes can be predicted from partental genotypes

(12 smooth : 4 wrinkled)

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SUMMARY OF MENDEL'S PRINCIPLES

Principle #1:

Each trait is controlled by <u>two hereditary factors</u>

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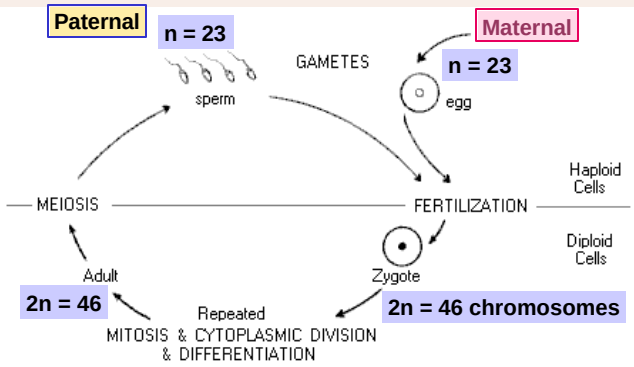
SUMMARY of PRINCIPLES

Principle #1: Each trait is controlled by <u>two hereditary factors</u>



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Principle #2:
When two factors contrast with each other, one is expressed (dominant) and one is masked (recessive)

SMOOTH x WRINKLED
SS ↓ ss

ALL SMOOTH OFFSPRING

Ss x Ss

75% SMOOTH x 25% WRINKLED

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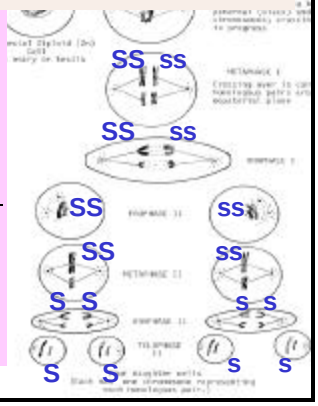
Principle #3:
There is a segregation (separation) of hereditary factors during gamete formation)

SS ↓ ss

ALL SMOOTH OFFSPRING

Ss x Ss

	S	S	s	s
S				
S				
s				
s				



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Principle #4:
When gametes fuse (fertilization) the two factors combine at random.

SS ↓ ss

ALL SMOOTH OFFSPRING

Ss x Ss

	S	S	s	s
S	SS	SS	Ss	Ss
S	SS	SS	Ss	Ss
s	sS	sS	ss	ss
s	sS	sS	ss	ss

RESULT:
Ratios of phenotypes can be predicted from partental genotypes

(12 smooth : 4 wrinkled)
or
(3 smooth : 1 wrinkled)

MENDEL'S DATA:
5,474 smooth
1,850 wrinkled
RATIO = 2.96 : 1