CHAPTER 14: MENDEL AND THE GENE IDEA

how are traits transmitted from parents to offspring?

each parent cell has two alleles for each character

gamete formation

this is an ALLELE

An Allele is one form of an alternated version of a gene and shows itself as a *trait*

example: this is the allele for pink flowers; this is the allele for white flowers; locus for flower color; the gene location of an allele is its LOCUS

what is "true-breeding"? → over many generations of self-pollination parent produces only the same variety of the parent plant.

HYBRIDIZATION is the *mating* or *crossing* of two true-breeding varieties

happens during meiosis: anaphase I

LAW OF SEGREGATION

States that the two alleles for a heritable character separate from eachother during gamete formation and end up in different gametes, thus an egg or sperm only gets one allele

MULTIPLICATION VS. ADDITION RULES!

"probability laws"

the multiplication rule states that to determine the probability of one or more event and the other occuring, we multiply the probability of one event (coin coming up heads), by the probability of the other event (the other coin coming up heads)

the addition rule states that the probability of any one of two or more mutually exclusive events (one event or the other) will occur is calculated by adding their individual properties

example: $1/4 + 1/4 = 2/4 \rightarrow 1/2$

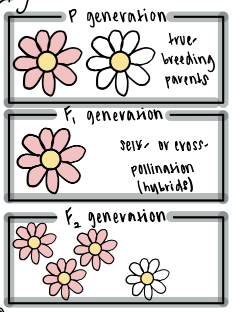
USING PROBABILITY TO SOLVE

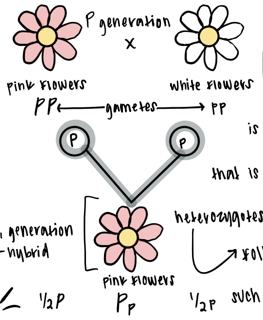
example: $1/2 \times 1/2 = 1/4$

LAW OF INDEPENDENT ASSORTMENT

(note, any allele pairs (ex. Rr) have a 1/4 probability)

generations!!





LAW OF INDEPENDENT ASSORTMENT

one heterozygote → a monohybrid organism (Yy) or (Rr) is heterozygous for one particular character that is followed in a cross, this cross between heterozygotes is called a *monohybrid cross* → following only a single characteristic such as flower color in example below

two heterozygotes → a *dihybrid* is heterozygous (YyRr) for the two characters being followed in the cross, a *dihybrid cross* is a cross between F_1 dihybrids

DID YOU KNOW? genes are allele pairs!

→ two or more genes assort independently - that is, each pair of alleles segregates independently of any other pair of alleles during gamete formation

*if two alleles @ a locus differ, then the DOMINANT ALLELE determines the organisms appearance and the RECESSIVE ALLELE has no noticeable effect

PUNNETT SQUARE

sperm from F_1 (Pp) plant; eggs from F_1 (Pp) plant

	P	p
P	PP	Pp
p	Pp	pp

3 : 1

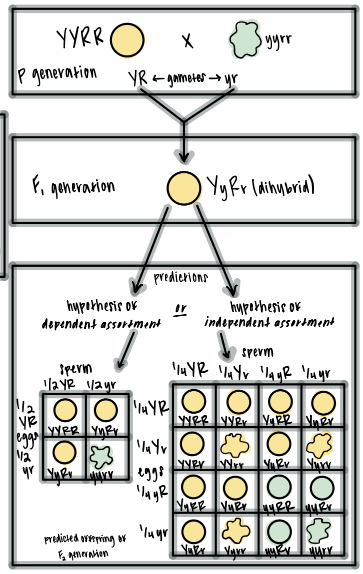
genotype	phenotype
PP (homozygous)	pink
Pp (heterozygous)	pink
Pp (heterozygous)	pink
pp (homozygous)	white

ratio! 1PP : 2Pp : 1pp (genotype)

ratio! 3 pink : 1 white (phenotype)

KEY
Y - yellow (dominant)
y - green (recessive)
R - round (dominant)
r - wrinkled (recessive)

DIHYBRID CROSS



DIHYBRID CROSS results

what is the probability of "YYRR"? 1/4 (prob. of YY) x 1/4 (prob. of RR) = 1/16

what is the probability of YyRR? 1/2 (Yy) x 1/4 (RR) = 1/8 probability of a YyRR offspring.

what fraction of offspring from this cross are predicted to exhibit the recessive phenotypes for @ least 2 of the 3 characters?

ppyyRr	1/4 (pp) x 1/2 (yy) x 1/2 (Rr) = 1/16
ppYyrr	1/4 (pp) x 1/2 (Yy) x 1/2 (rr) = 1/16
Ppyyrr	1/2 (Pp) x 1/2 (yy) x 1/2 (rr) = 2/16
PPyyrr	1/4 (PP) x 1/2 (yy) x 1/2 (rr) = 1/16
ppyyrr	1/4 (pp) x 1/2 (yy) x 1/2 (rr) = 1/16

= 6/16 = 3/8

*there is a 3/8 chance of @ least two recessive traits

WHAT IF????

two traits that Mendel looked @ in his dihybrid cross had been controlled by genes that were located near eachother on the same chromosome, then the F_2 generation would have deviated from the 9:3:3:1 phenotypic ratio that is predicted by the law of independent assortment.

genetics vocab

An organism that has a pair of identical alleles for a gene encoding a character is a HOMOZYGOTE and is homozygous

An organism that has two different alleles for a gene is a HETEROZYGOTE and is heterozygous

genotype vs. phenotype

a phenotype is an organisms appearance or observable traits (pheno : photo)

a genotype is an organisms genetic makeup

★ you can perform a testcross if known phenotype of 1 and known pheno and genotype of the other

HUMAN BLOOD TYPE'S → geno/pheno types

are governed by 3 alleles, I^A, I^B, and i (codominant; recessive to both)

example: man has type B, woman has type A (all info) answer

	I^A	?
I^B	I^AI^B	I^B?
?	I^A?	??

could be A, B, AB, or O because the other alleles are unknown

genotype	antigen (type)	antibody	phenotype
I^AI^A, I^Ai	A	B	A
I^BI^B, I^Bi	B	A	B
I^AI^B	AB	neither	AB
ii	neither	A, B	O
RH!! (+ or -)			
DD, Dd	Rh	no Rh antibody	+
dd	no Rh	Rh antibody	-

on diff. chromosomes

REMEMBER THIS!!!!

for the multiplication rule, in any situation when finding the probability of two alleles, a heterozygous pair has a 1/2 probability and a homozygous pair has a 1/4 probability of occuring (when self-pollinating)

DEGREES OF DOMINANCE

① COMPLETE DOMINANCE

offspring always looks like one of the two parents. Heterozygotes and dominant homozygotes are indistinguishable...example! pheno vs. genotype

purple — PP homozygous
purple — Pp heterozygous
purple — Pp heterozygous
white — pp homozygous

↓ RATIO'S ↓

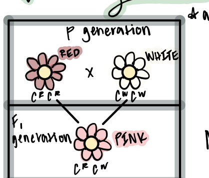
3 purple : 1 white

1PP : 2Pp : 1pp

② INCOMPLETE DOMINANCE

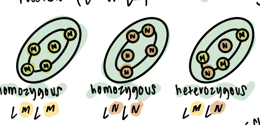
neither allele is completely dominant, F_1 hybrids (two parent repro.) have a phenotype somewhere between those of the two parental varieties...example

★ a little of each ★



③ CODOMINANCE

The two alleles affect the phenotype in separate, distinguishable ways; example the human "MN" blood group is determined by codominant alleles for two specific molecules located on the surface of red blood cells, a single gene (L), for which two allelic variations are possible (L^M or L^N)



NATURE VS. NURTURE

environmental impact on phenotype - generally, phenotypic range is broadest for polygenic characters, the environment contributes to the quantitative nature of these characters; such are called multifactorial, meaning many factors,

PEDIGREE ANALYSIS

a pedigree is the analysis of a families history for a particular trait

~example~

KEY ☐ male ☐ male w/ trait

RELATIONSHIP BETWEEN DOMINANCE AND PHENOTYPE

Tay-Sachs Disease: an inherited disorder in humans, a lethal disease that only affects children that inherit two copies of the recessive allele and are therefore homozygotes BUT in this disease, the degree of dominance varies by which organismal level you look at.

MULTIPLE ALLELES

example: The ABO blood group in humans

antigen = type

antibody = opposite

EPISTASIS

is the phenotypic expression of a gene @ one locus alters that of a gene @ a second locus

example... labrador retrievers!

black coat dominant to brown coat

brown (bb)

black (Bb) (BB)

BUT a second gene determines whether or not pigment will be deposited

(E) is the dominant allele which results in pigment being distributed OR (ee) in which no pigment is distributed and results in yellow fur.

POLYGENIC INHERITANCE

multiple gene(s)

(multiple genes affecting one phenotypic character)

an additive effect of two or more genes on a single phenotypic character, opposite of pleiotropy

examples... #1 HEIGHT #2 SKIN COLOR

characters vary (heritable features) continuously over a range rather than in an either-or fashion

these are called QUANTITATIVE CHARACTERS

*there are usually an indication

DOMINANTLY INHERITED

PLEIOTROPY!!

(one gene affecting multiple phenotypic characters)

in most genes, occurs when genes have multiple phenotypic effects

in humans, pleiotropic alleles are responsible for the multiple symptoms associated w/ certain hereditary diseases

examples

#2 cystic fibrosis - the most common leathal disease in the U.S, normal allele codes for membrane protein that functions in the transport of chloride ions between certain cells + extracellular fluid

a child MUST inherit 2 recessive alleles, pleiotropic effects are;

#1 sickle cell - the most common inherited disorder among people of African descent

in HOMOZYGOUS individuals, all hemoglobin is of/has the sickle-cell (abnormal) variety and has symptoms; weakness, anemia, pain and fever,

in HETEROZYGOUS individuals w/ the sickle-cell trait, hemoglobin is partly sickle-cell and partly normal and experience symptoms; when blood O_2 is very low BUT

AA

male female female w/ trait genetic + environment collectively influence phenotype

mating offspring, in birth order left to right 1 2 3 4 5

Ww ww ww Ww

Ww ww ww ww Ww Ww (carrier) ww

Ww or ww ww

1st generation (grandparents)

2nd generation (parents, aunts, uncles)

3rd generation (two sisters)

huntington's disease caused by a lethal dom. allele that has no obvious phenotypic effect until individual is 35-45 y/o. It degrades nervous system and is irreversible once degradation begins.

CVS diagnostic sampling

insertion of tube through cervix

POLYGENIC INHERITANCE DISORDERS

any gene w/ dominant allele is affected

example: achondroplasia a form of dwarfism that is a trait in which the recessive allele is much more prevalent than its dominant allele

polygenic inheritance means the genes build on each other to achieve a phenotypic character!!!!

almost 200 genetic variations in over 180 genes affect height

@ least 3-8

of polygenic inheritance separately inherited genes; consider this, there are 3 genes

1 2 3

the dark-skin allele (A, B, or C)

the light-skin

allele (a, b, or c)

SO...

for each gene each contribute 1 "unit" of darkness. It is *incompletely dominant* to the light-skin allele

a person with (AABBCC) would be very dark, whereas a person w/ (aabbcc) would be very light

poor absorbance of nutrients from intestines, chronic bronchitis, and recurrent bacterial infections

Did you know?

untreated cystic fibrosis can cause death by age 5 BUT antibiotics and treatments now prolong the life of more than half as those w/ cystic fibrosis into their 40s in the United States

also have a reduction of malaria symptoms and organ damage

sickle-cell allele
normal allele