Biology 30 IB

Genetics

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Unfinished!

Contents

(18.1) Gregor Mendel

- Created the Laws of Inheritance of Traits
- Studied inheritance of traits in pea plants (test question)
- Called DNA and chromosomes particles — he didn't know
- Father of Genetics

Peas

- Can be grown in a small area
- Produce lots of offspring
- Self-pollinate
- Can be artificially cross-pollinated (test question)

Introduction

General

- **Trait** = any characteristic that can be passed from parent to offspring
- **Heredity** = passing of traits from parent to offspring
- **Genetics** = study of heredity

Terms

- **Alleles** = two forms of a gene — dominant & recessive
- **Dominant** = stronger of two genes, represented with capital letter (R)
- **Recessive** = weaker of two genes, represented with lowercase letter (r)
- **Genotype** = gene combination for a trait (RR, Rr, rr)
- **Phenotype** = physical feature resulting from genotype (red, white)
- **Homozygous genotype** = genotype involving 2 dominant OR 2 recessive genes — pure, RR or rr
- **Heterozygous genotype** = genotype involving 1 dominant OR 1 recessive gene — hybrid, Rr

Dominance

- Dominant and recessive alleles can code for different things
- e.x. R = Brown eyes, r = blue eyes
- Any dominant alleles = dominant phenotype — RR, Rr in most cases
- Only recessive alleles = recessive phenotype — rr

Genotypes	RR	Rr	rr
Phenotypes	RED	RED	YELLOW

Crosses

- **Monohybrid cross** = cross involving a single trait
- **Dihybrid cross** = cross involving two traits
- **Test cross** = cross involving always involing a homozygous recessive (rr) parent crossed with an unknown genotype, in order to find the genotype

Generations

- **P1 Generation** = parental generation in a breeding experiment
- **F1 Generation** (1st filial gen) = first-generation offspring in a breeding experiment
- **F2 Generation** (2nd filial gen) = second-generation offspring, and so on...

Mendel's Laws

LAW	PARENT CROSS	OFFSPRING
DOMINANCE	TT x tt tall x short	100% Tt tall
SEGREGATION	Tt x Tt tall x tall	75% tall 25% short
INDEPENDENT ASSORTMENT	RrGg x RrGg round & green x round & green	9/16 round seeds & green pods 3/16 round seeds & yellow pods 3/16 wrinkled seeds & green pods 1/16 wrinkled seeds & yellow pods

(18.2) Punnett Squares

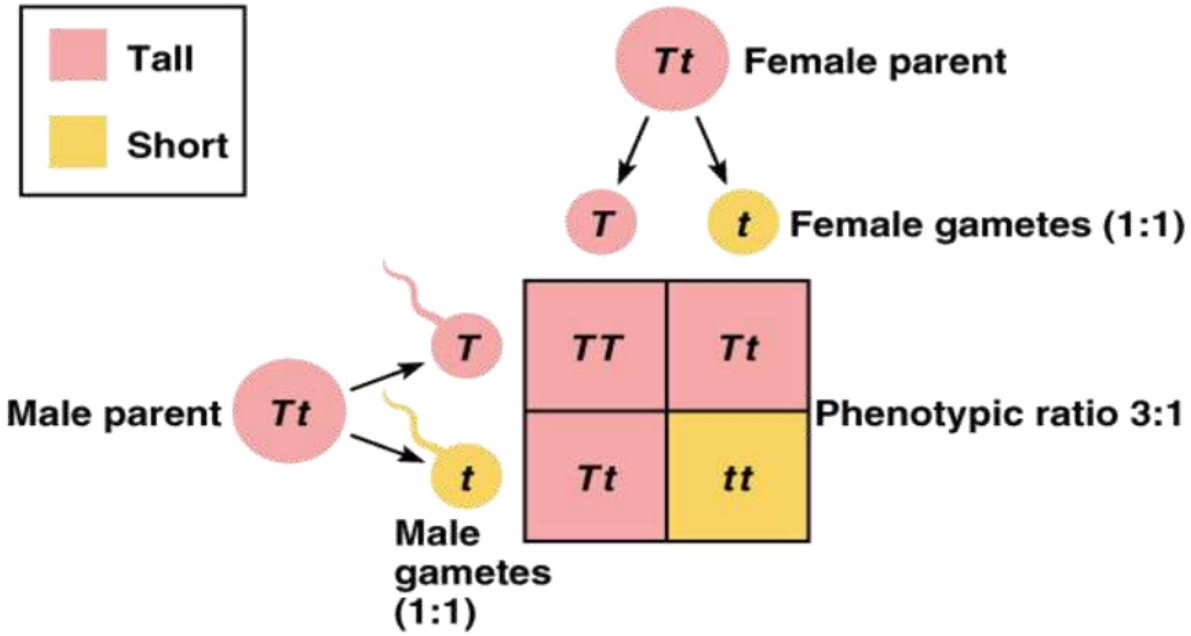


Figure 1: Punnett square demonstrating law of segregation, which occurs in anaphase I

- One gene from father, one gene from mother
- Dominant and recessive alleles compete in punnett squares
- **Phenotypic ratio** = ratio of dominant phenotypes to recessive phenotypes, in this diagram its 3 : 1

(18.3) Pedigree Charts

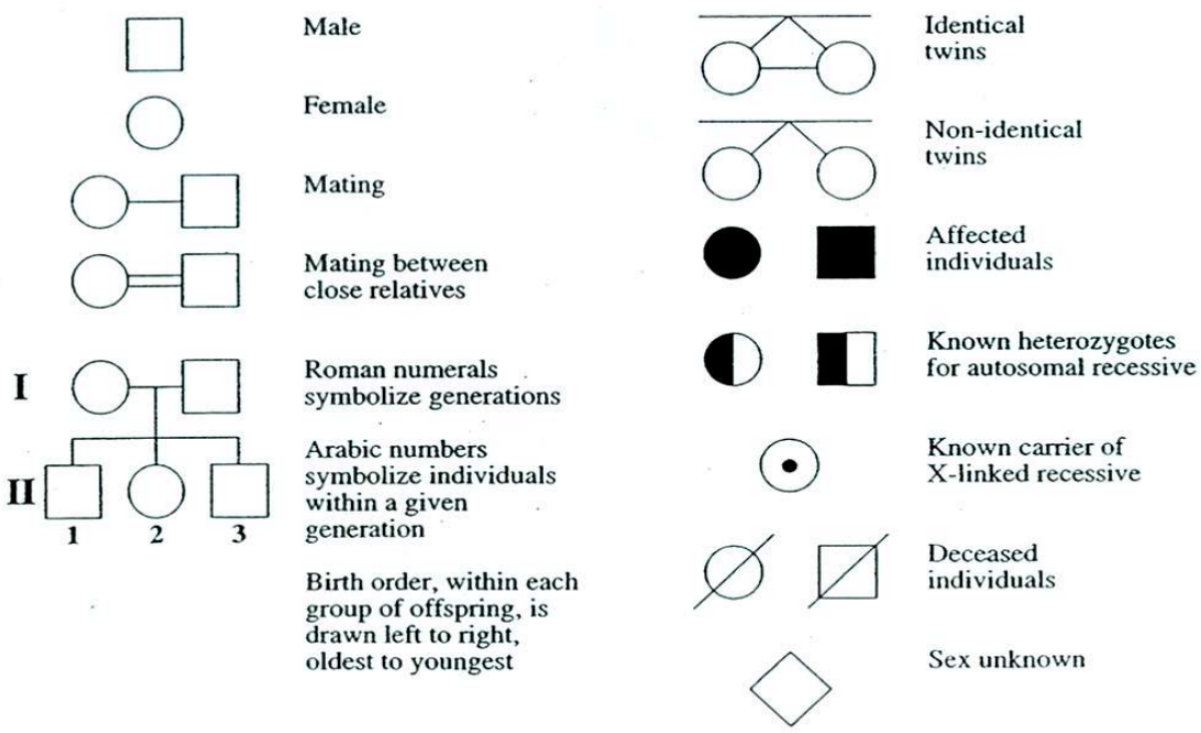


Figure 2: All in your data booklet, except known heterozygotes

- **Pedigree** = a family tree used to trace inherited traits from parents to offspring
- Roman numerals denote different generations (rows)
- Arabic numerals denote different individuals in a generation (columns)

(18.4) Other Patterns of Inheritance

Pleiotropy

- **Pleiotropic gene** = one gene affects more than one phenotypic characteristic
- Examples of wide-ranging effects from a single gene include...
  - dwarfism (achondroplasia)
  - gigantism (acromegaly)
  - Cystic fibrosis = mucus build up in many organs
  - Sickle cell anemia = sickling of blood cells, cannot carry oxygen
    - normal alleles = Hb^AHb^A
    - mutated alleles = Hb^SHb^S
    - carrier alleles = Hb^AHb^S (less extreme effects)

Multiple Alleles

- Possible to have more than two alleles for a trait
- Superscript identifies different alleles
- Different alleles are dominant to one another
  - e.g. $E^1 > E^2 > E^3 > E^4$

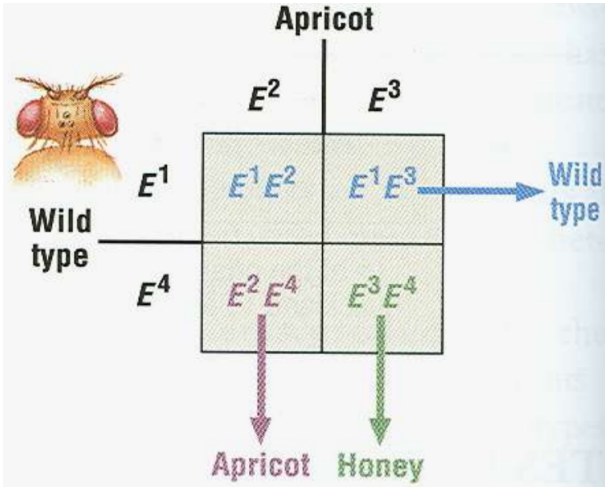
Example

Predict the genotypic and phenotypic outcomes of crossing $E^1E^4 \times E^2E^3$.

- E^1 = wild, E^2 = apricot, E^3 = honey, E^4 = white

Wild type	E^1E^1, E^1E^2, E^1E^3, E^1E^4
Apricot	E^2E^2, E^2E^3, E^2E^4
Honey	E^3E^3, E^3E^4
White	E^4E^4

Figure 3: This is typically given



- Genotype $= 1 \times E^1E^2 : 1 \times E^1E^3 : 1 \times E^2E^4 : 1 \times E^3E^4$
- Phenotype = 2 wild : 1 apricot : 1 honey

Incomplete Dominance

- A hybrid (Rr) appearance can sometimes be in between the phenotypes
- For example...
  - RR = red
  - rr = white
  - Rr = pink (normally red)

Codominance

- Both alleles expressed in heterozygous individuals

Figure 4: Red bull + white cow = red and white hair

Blood Type

Example of codominance and multiple alleles

I^A & $I^B > i$

- Type A = $I^A I^A$ or $I^A i$
- Type B = $I^B I^B$ or $I^B i$
- Type AB = $I^A I^B$
- Type O = ii

(18.5) Dihybrid Crosses

- A breeding experiment that tracks the inheritance of two traits
- **Law of Independent Assortment** = each pair of alleles segregate independently (metaphase)
- The two traits do not influence one another, they are independent
- These traits are on different locations — called **loci**, **locus** — of a chromosome

of Gametes

$$2^n$$

$n = \#$ of heterozygotes

Examples...

- RrBb $= 2$ heterozygotes $= 2^2 = 4$ gametes
- AaBbCCDd $= 3$ heterozygotes $= 2^3 = 8$ gametes
- MmNnOoPPQQRrssTtXx $= 6$ heterozygotes $= 2^6 = 64$ gametes

Drawing a Dihybrid Cross

Determine how many different possible gametes/phenotypes with the formula.

- $2^2 = 4$
- There will be 4 different types of offspring from this cross

Prepare a cross for every possible combination of all heterozygotes.

1. Top header = FOIL between genes of the gene pair of the first parent
2. Left header = FOIL between genes of the gene pair of other parent
3. Fill in the table like usual, including the top and left header, to list every possible combination
4. Make sure to order the alleles dominant to recessive, and same letters together

Using the cross, you can...

- Determine the number/ratio of all possible genotypes by counting
- Determine the number of phenotypes from all possible genotypes

It helps to mark each of the table cells with a symbol to keep track.

Example

- R_ = round, Y_ = yellow
- rr = wrinkled, yy = green

Question: Determine the genotype and phenotype of a RyYy x RyYy cross.

	RY	**Ry**	**rY**	**ry**
RY	RRYY	RRYy	RrYY	RrYy
Ry	RRYy	RRyy	RrYy	Rryy
rY	RrYY	RrYy	rrYY	rrYy
ry	RrYy	Rryy	rrYy	rryy

- Genotype
  $1 \times RRYY : 2 \times RRYy : 2 \times RrYY : 4 \times RrYy : 1 \times RRyy : 2 \times Rryy : 1 \times rrYY : 2 \times rrYy : 1 \times rryy$
- Phenotype
  - 9 round, yellow
  - 3 round, green
  - 3 wrinkled, yellow
  - 1 wrinkled, green