8/8/23

MKM

Eukaryotes → genetic material
- 50% from father
- 50% from mother

every organism - single or multicellular

- Propag^n / Reprod^n (transmission of traits)
- Survivability & continuity of species specificity
- Var^n & adapt^n
- Evolution / emergence of new species.

an individual produces new individual of the same species.

- crossing over / recombination
- during meiosis
- mutations

Accelerated evolution

→ in single-cell organisms
→ in laboratory
→ induced mutations accumulating into evol^n.

Modification of genetic material
- Natural processes
  - mutation
  - recomb^n
- Laboratory
  - Genetic Engg.
  - rDNA technology

Genetics :

Classical definitions

scientific study of heredity & varⁿ

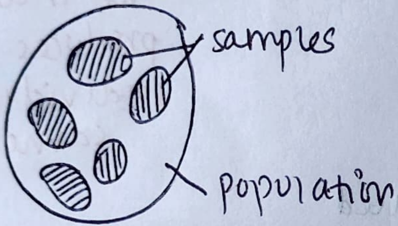
- heredity → transmission of traits from parents to offspring
- varⁿ → differences among individ. members of a species

Modern definition

scientific study of genes or biological info.

genes → molecular unit of heredity → fundamental unit of information for life

a segment of DNA that encodes a functional product (RNA or protein) and essentially consists of a promoter, coding sequence and transcriptional terminator.



C-value paradox :

DNA content of the haploid set

the DNA content is not correlated with the complexity of the organism.

Sub-disciplines of Genetics

- Classical or transmission genetics
- Modern or molecular genetics (Genetic Engineering)
- Evolutionary genetics
- Molecular Breeding

Classical or Transmission Genetics

- Mendelian genetics
- Cytogenetics
- Popul^n genetics
- Quantitati[ve] Genetics

$\boxed{\text{Differential Gene Expr}^n \text{ (DGE) (or) Tissue - specific expr}^n}$

→ only certain genes are expressed in any particular tissue to give it its characterist[ics]

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DNA — DNA Replication

reverse transcription ↑ ↓ transcription

RNA — RNA replication

↓ translation

Proteins

↓ functioning

Biochemical reactions

Traits	Genotype	Phenotype
Height	TT (allele 1)	Tall
	Tt	Tall
	tt (allele 2)	Dwarf
a particular characteristic of an organism	combination of gene alleles	observable outcome of gene $expr^n$

Gene-environment $inter^n$

two individuals may have the identical genotype, but not the same phenotype.

Pollination

- **Autogamy** — within same flower
- **Geitenogamy** — ~~with~~ diff. flower of the same plant
- **Allogamy/ xenogamy** — diff flower on a diff. plant

Alleles → DNA Polymorphism → alteration in nucleotide of the DNA sequence.

- Single-Nucleotide Polymorphism
- Micro-satellite
  - simple sequence repeats (SSR) (or) short tandem repeat (STR)
  - ↓ 2-10 nucleotide units repeated 5-50 times
- Mini-satellite
  - simple sequence length polymorphism (SSLP)
  - ↓ variable no. of tandem repeats (VNTR)
  - 11-100 nucle. units rep. 5-50 times
- indel
  - short stretches of insertion & deletion in the DNA sequence

+/w
R/r
RA//ra

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Mendel's 1st Law: Principle of Segregation

ploidy

- ✓ Pea plant → Gen. time = 60 days → n=7
- ✓ Arabdopsis → " " = 28 days

Parental genern (P)

female from round-seeded line (RR) X male from wrinkle-seeded line (rr)

homozygous

(or) reciprocal cross

Male from round-seeded line (RR) X female from wrinkle-seeded line (rr)

$\boxed{\text{all peas round}}$ first filial (f1) generation

heterozygous (Rr).

(Rr) X (Rr) Selfing/Crossing

Second filial genern (F_2) (RR) (Rr) (Rr) (rr)

3/4th are round seeds, 1/4th are wrinkled seeds ≈ 3:1

selfing	selfing	selfing
RR	RR Rr Rr rr	rr
only round	3:1 round: wrinkled	only wrinkled

Test Cross / Back Cross :

recessive parent (wrinkled in this case)

F_1 round × P wrinkled

(R/r) (r/r)

	R	r
r	R/r	r/r
r	R/r	r/r

1/2 round : 1/2 wrinkled

$\boxed{1:1}$

Particulate factors → Mendel's version of alleles of the gene.

Y/Y × y/y

↓

Y/y × y/y

	Y	y
Y	Y/Y yellow	Y/y yellow
y	Y/y yellow	y/y green

	y	
Y	Y/y	yellow
y	y/y	green

Phenotypic = 3:1

Genotypic = 1:2:1

P = 1:1

G = 1:1

Dihybrid Cross : Law of Indepent Assortment

~~RY//RY~~ ~~ry//ry~~

R//R ; Y//Y RRYY x rryy r//r ; y//y

round, yellow wrinkled, green

RY ry

RrYy round, yellow

RrYy x RrYy

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

P = 9:3:3:1

round ~~green~~ yellow — round green — wrinkled yellow — wrinkled green

~~RRYY~~

dominant pure line in round & recessive pure line in green.

P: RRYY x rryy

↓

$\boxed{RrYy}$

RRyy x rrYY — all are pure lines

↓

$\boxed{RrYy}$

$(3:1)^3 (3:1)(3:1)$

$(9:3:3:1)(3:1)$

Trihybrid: 27 : 9 : 9 : 9 : 3 : 3 : 3 : 1

RRYYPP x rryypp

③ $2^3 = 8$

RrYyPp

	RYP	RYp	RyP	rYP	Ryp	rYp	ryP	ryp
RYP	RRYYPP	RRYYPp						
RYp								
RyP								
rYP								
Ryp								
rYp								
ryP								
ryp								

	RYP	RYp	RyP	rYP	Ryp	rYp	ryP	ryp
RYP	RRYYPP	RRYYPp	RRYyPP	RrYYPP	RRYyPp	RrYYPp	RrYyPP	RrYyPp
RYp	RRYYPp	RRYYpp	RRYyPp	RrYYPp	RRYypp	RrYYpp	RrYyPp	RrYypp
RyP	RRYyPP	RRYyPp	RRyyPP	RrYyPP	RRyyPp	RrYyPp	RryyPP	RryyPp
rYP	RrYYPP	RrYYPp	RrYyPP	rrYYPP	RrYyPp	rrYYPp	rrYyPP	rrYyPp
Ryp	RRYyPp	RRYypp	RRyyPp	RrYyPp	RRyypp	RrYypp	RryyPp	Rryypp
rYp	RrYYPp	RrYYpp	RrYyPp	rrYYPp	RrYypp	rrYYpp	rrYyPp	rrYypp
ryP	RrYyPP	RrYyPp	RryyPP	rrYyPP	RryyPp	rrYyPp	rryyPP	rryyPp
ryp	RrYyPp	RrYypp	RryyPp	rrYyPp	Rryypp	rrYypp	rryyPp	rryypp

Rodund Yellow Purple	Rodund Yellow white	Rodund Green Purple	Rodund Green White	wrinkled Yellow Purple	wrinkled Yellow white	wrinkled Green Purple	Wrinkled Green white
27	9	9	3	9	3	3	1

5/9/23

Genotype from Phenotype Class Ratio:

Forward Genetics

Predicting phenotypic class ratio in progeny from parents of known genotypes.

Reverse Genetics

⇒ Predicting parent genotypes:

① Test Cross:

Unknown genotype (A_) phenotype: dominant A × Tester homozygous recessive (aa).

ⓐ AA x aa

100% Aa (dom. phenotype)

ⓑ Aa x aa

50% Aa (dom. pheno)
50% aa (recessive)

② Selfing:

ⓐ AA x AA

100% AA (dom. ~~ge~~phenotype)

ⓑ Aa x Aa

75% dom. pheno.
25% recessive "

⇒ Predicting progeny phenotype :

↳ Punnett square.

⇒ Rules of Probability in Inheritance of Traits :

① **Product rule of probability** :

2 independent events both occuring simultaneously → probability is the product of individual probablities

② **Sum rule** :

→ **F_2 generation** :

no. of gene = n

no. of types of gametes = 2^n

no. of genotypic classes = 3^n

no. of phenotypic classes = 2^n

Q. AaBbCcDd x aabbccdd.

Aa x aa
1 heterozygous

Genotypic = {Aa, aa} = 2
Phenotypic = {dom., rec} = 2

AaBbCcDd
4 heterozygous

Genotypes = $2^4 = 16$
Phenotype = $2^4 = 16$

Q. Selfing of AaBbCcDd:

1 heterozygous < G = 3, P = 2

4 heterozygous < G = $3^4 = 81$, P = $2^4 = 16$

Q. aa bb cc dd ee from

Aa bb Cc Dd Ee x Aa Bb Cc dd Ee

gam. = 16

gam. = 16

Aa x Aa ⇒ 1/4th aa

bb x Bb ⇒ 1/2 bb

Cc x Cc ⇒ 1/4th cc

Dd x dd → 1/2 dd

Ee x Ee ⇒ 1/4th ee

$\left(\frac{1}{4}\right)^3 \left(\frac{1}{2}\right)^2$ aa bb cc dd ee

$= \frac{1}{256}$

Q. purple flowers, yellow, round seeds X purple flowers, green, wrink seeds

PRY

P – dom
Y – dom
R – dom

Pp Rr Yy x Pp rr yy

2
PP rr yy $Pp \times Pp = 1/4$, $Rr \times rr = \frac{1}{2}$, $Yy \times yy = \frac{1}{2} = 1/16$
Pp rr yy. $Pp \times Pp = 1/2$, $Rr \times rr = 1/2$, $Yy \times yy = 1/2 = 1/8$
~~PP RR yy~~
pp Rr yy → $Pp \times Pp = 1/4$, $Rr \times rr = 1/2$, $Yy \times yy = 1/2 = 1/16$
~~pp rr YY~~
pp rr Yy → $Pp \times Pp = 1/4$; $Rr \times rr = 1/2$, $Yy \times yy = 1/2 = 1/16$
3 [pp rr yy → $Pp \times Pp = 1/4$, $Rr \times rr = 1/2$, $Yy \times yy = 1/2 = 1/16$

3/8

Chi-square (χ^2) test:

↳ quantify & compare the diff. b/w observed frequencies & expected frequencies.

↓

calculates / determines the deviation

t-test:

observed number

Expected number

$$\boxed{\chi^2 = \sum \frac{(O-E)^2}{E}}$$

$$\boxed{df = \text{no. of classes} - 1}$$

Q. 747 tall, 253 dwarf } F_2 plants

$$\text{ratio} = \frac{747}{253} = 2.95$$

$$\chi^2 = \frac{(2.95-3)^2}{3} = 0.01$$

total = 1000

$$\chi^2 = \frac{(747-750)^2}{750} + \frac{(253-250)^2}{250}$$

$$\boxed{\chi^2 = 0.048} = 0.036 + 0.012$$

✓ chi-square value is insignificant

✓ null hypothesis is accepted.

Q.

384

$9:3:3:1 = 16$

4 classes

$\boxed{df = 3}$

$\frac{9}{16} \times 384 = 216$

$\frac{3}{16} \times 384 = 72$

$= 72$

$\frac{1}{16} \times 384 = 24$

$$= \frac{(206-216)^2}{216} + \frac{(65-72)^2}{72} + \frac{(83-72)^2}{72} + \frac{(24-30}{24}$$

$$= 0.46 + 0.68 + 1.68 + 1.5$$

$$\boxed{\chi^2 = 4.32}$$

df	0.05
1	
2	
3	$4.32 \leftarrow \boxed{7.815}$ ⇒ insignificant null hyp acc.

class	O	E	$(O-E)^2$	$(O-E)^2/E$
1	206	216		0.46
2	65	72		0.68
3	83	72		1.68
4	30	24		1.5

$\chi^2 = 4.32$