

# Physiol. Genetics

Intro. - delimitation of field.

## I The Relation between genes and adult characters

enzymes, histog., morphog. → complicated 3-dimens. forms  
Direct & Indirect

## II The Nature of the gene

1. Frazer hybrid exps

2. Physical + chemical

Correspondence between physic. & physiol. cross-over block

3. Physiol. props

General  
Synchronous & special  
crossing-over

### Cytoplasmic Heredity

Criteria

Plants

Animals

= a 310 subject & does not concern gene action.

## III Gene in Ontogeny - its Action

### A. Time of Gene Action.

when start? duration?

1. Organism - oocytes, gametes, zygote

2. Single cell

### B. Nature of Gene Action

import. to cell life.

1. Intra-cellular char.s

(1) Immunological Ris

(2) Growth

(3) Differentiation  
No. 3 theories

(4) Relation to enzymes pigments

(5) Factor Interaction (g.p. shape & flowers)

(6) Dominance

2. Inter-cellular char.s

(over)

— wr. out complete outline-answers to the various questions  
— then read thru notes & make additions of all facts not covered.

— finally re-outline the course more specifically, so have outline already to lecture from  
— keep

— get examples

Inden. of some species corn - case of Anderson & Purves showed a ratio of 73 mendelian to 3 non-mendelian characters & this was in early <sup>where</sup> ~~substituting~~ <sup>obs. only</sup> chlorophyll, involved where most cases of cyto plasm occur.  
 Introp. Remark plastid & ♀ factor = general effect.

Position Effect ③ genes producing products tend to escape (when double gene, less of product destroyed)

- 1) Heterozygous repeat > homo  $\frac{BB}{+} > \frac{B}{+}$
- 2) lethal - large no. of trans. in Drosophila
- 3) new character - Pale larva, (red - reversion showed no loss)
- 4) Weakening of Dominant of normal allele over its recessive after recessive is moved away (pts. inactiv. OK) ~~+~~ ~~+~~  $\frac{+}{+}$
- 5) Unstable Dominant - Phen in new position produces unstable matching effect.
- 6) " when heterozyg. <sup>in place</sup> - white & mottled u

2 genes <sup>in place</sup> together have diff't effect than when removed, but ~~or~~ the exception. In general the physical cross-over blocks act as physical units & doesn't matter what their position.

Results typical specificity Rii

Parent	<u>donor</u> AA bb	aa BB	F <sub>1</sub> Aa Bb
AA bb	+	-	-
aa BB	-	+	-
F <sub>1</sub> Aa Bb	+	+	+
F <sub>2</sub> 9 A- B-			
3 A- bb			
3 aa B-			
1 aa bb			

Dominant factors in transplant cause rejection unless these factors are in host  
 + = OK  
 - = reject

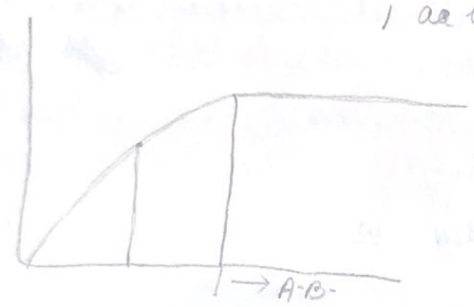
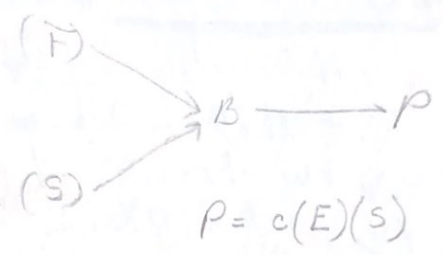
- ① aa bb x aa BB
- ② aa bb x aa BB

Duplication = protein specificity extreme specificity for each kidney

9. At least 4 significantly diff. relations between genotype & phenotype in actual multiple allelic series & interaction of genes. while series of crosses morphs & graphs & interaction theory  $\rightarrow$

10)  $F_2$  ratios

$$F_1 \text{ } AaBb \times AaBb = 9 A-B- \\ 3 A-bb \\ 3 aaB- \\ 1 aabb$$



9:3:4

+++ +    +++ +  
A d    B d

- 9 A-B- plenty of both enzymes & substrate
- 3 A-bb - " " substrate, not enough enzyme
- 4 { aa BB - no substrate, plenty "
  - aa - no " no "
- 9 A-B- as above
- A-bb. bb = no enzyme
- aa-Bb no substrate.

95:1 = aaB-  
A-bb = enough  
aabb not enough



### Primi Gene Action

No action at distance so genes don't act primarily on each other, or = chrom. & must react in. subunit of cytoplasm chemically. Evid its enzyme action coat pigment colors act by duplicating + haploids.



Haldschmidt's theory sex determination (shows Pattern due Timing)

Depends on balance between X-chrom. & cytoplasm.

a ♂-determining tendency in X...

♀- " " " cytoplasmic

Both strong in some races & weak in others.

Let all diff. sex intergrades by varying amts of X & also by crossing S & W races.

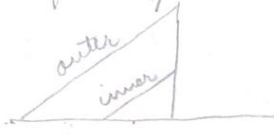
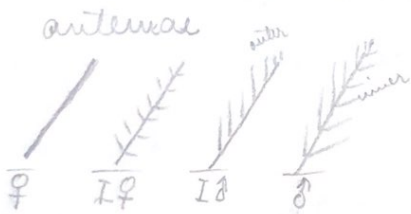
But not a simple matter of balance, or there be only one series of intersexes & he finds 2.



There are 2 opposed processes related in time, the cytoplasmic and the chromosomal.

Both go along together but strength increase may be of diff. rates so that ♂ process may be dominated by ♀ later and the intergrade depends on which gets started first & at the turning point where the oppos. process come to dominate

at turn pt { Organs present in 1st sex - continue (antennae "Hald's organ")  
 " absent " " - start at turning pt.  
 " rudimentary - go in either direction (laminae genit.) wing



Depending on where turning point occurs

♂ → ♀

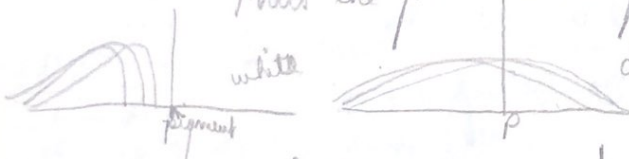
t.p. late = ♂

t.p. med = I♂

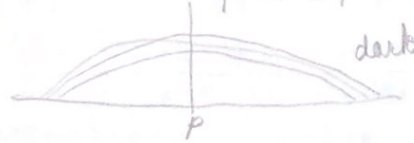
t.p. early = ♀

to grow, but chitin comes in makes dim ♀ → ♂ if t.p. late then organs start

Thus the pattern depends on timing (as for wings)



♀ → ♂ = I♀



♂ → ♀ = I♂



nuclear start & then cyto come in

Usual Rule w. respect Dominance & Cell Series

$w^+w^+$   $w^+w^e$   $w^+w$  = red  
 $w^+w^k$  — 'erin  
 $w^+w$  — lt "  
 $w^p w^p$  — pearl  
 $w w$  — white

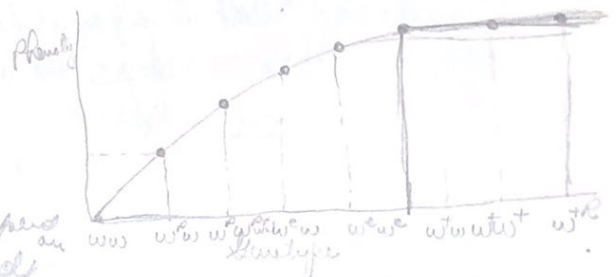
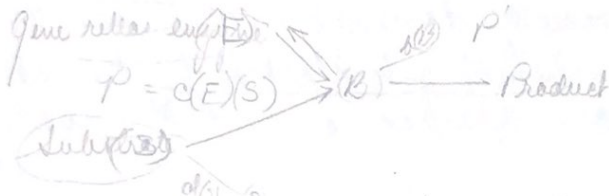
Let a variation effect are dominates any below it & is dominated by those above.

Explain it in terms of inactivation of the

recessives w. increasing inactivation from dominant to complete recess.

hypermorph —  $w^e$   
 type — " —  $w^+$   
 hypo — " —  $w^e$   
 anti — " —  $w^p$  w.  $w^e$  reduces  $w^e$  more in w. does  
 a — " — w. defic.  
 neo — " — brachypoda mice 2-lethal hetero = normal.

Gives all morphs & allelic series



In constant flux equilibrium R depends on  $w^+ w^+ w^+ w^e w^+ w w w$  since product, phenotype, depends on reaction between substrate & the enzymes of gene, then the more activation of enzyme present, the greater the product. Complete absence = amorph ww.

C F red  
 C ff yll  
 c' d' ff "  
 c' d' ff Cream

Role Hered. & Envir.

When  $10 \times 30 = 300$  pres. x temp = vol.

how much = due 10

" " = " 30

Genes control specific

Envir - needs, limits, accessory

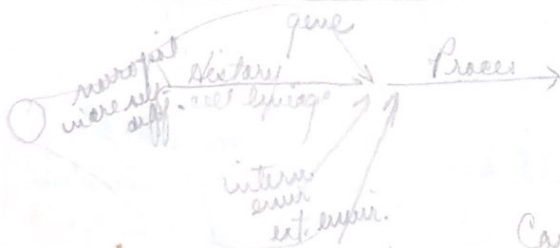
Protoplasm guided by enzymes

Complex form as result of simple conditions

Genes don't determine all details, just few

Envir. probably determines early axis, quant. → qual.

Ultimate analysis in terms of genes cause envir. resolves itself.



constraints

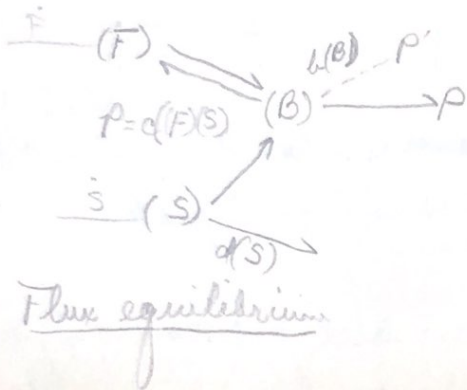
# Dominance

## Evolut:

favorable <sup>mutations</sup> tend to become Domin, b/c better alleles copy in better

## Physiol:

- 1) Presence & Absence
- 2) Inactivation - proven by hybrid in 4 chromosome, can put several recessives in & more recessives have, nearer to wild type



Reaction depends on activity of unit of enzyme & substrate.

Inactive phase tend to be recessive & Active Dominant with all degrees of partial dominance.

R<sub>i</sub> governed by min. unit of agent or substrate.

Catalyst in defect gives prop. effect of phenot. accdg unit of catalyst.  
Substrate " " " "

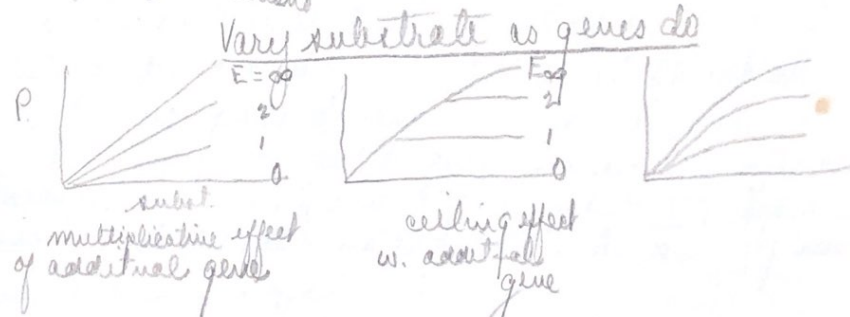
- neomorph - brachyura - mice heterozygote of 2 lethal = normal (act on normal substrate)
- antimorph = pearl w. eosin - uses up substrate in non-effective direction (makes eosin white in white mice)
- amorph = " " white - an absence of enzyme or substrate (does not use up substrate)
- hypermorph = W<sup>Russian</sup> more enzyme or substrate than types
- hypomorph = w<sup>e</sup> less " " " "
- type I = W normal unit

Mellic series W<sup>R</sup> W<sup>Russ</sup> w<sup>e</sup> w<sup>e</sup> w<sup>P</sup> w<sup>P</sup> ww

C <sup>F</sup> F - Red	P <sup>B</sup> B - 100 black
C <sup>ff</sup> f - Yellow	P <sup>b</sup> b - 50 brown
C <sup>d</sup> dF - "	pp <sup>B</sup> B - 21 pink
C <sup>d</sup> d <sup>d</sup> - Cream	pp <sup>b</sup> b - 17 "

eye color

C<sup>d</sup> C<sup>d</sup>, C<sup>r</sup>, C<sup>a</sup> albino





## Nature Gene Action Inter-Cellular Char's

Concrete ex. of relat' gene + observed char

### General

- 1) size differ in rabbits to 8-cell stage
- 2) sulphhydryl conc. traced to early cell " in Polish dwarf / Belgian goats storage rate affected

### Localized Effects

- 1) Pigment spots - neural crest
- 2) teeth, dactyls, - special bristles
- 3)

### General to local

- 1) dwarf mice - pituitary
- 2) recessive defective mice - oversecretion of II ventric + meehan
- 3) ocephalic mutants - defect ant. med. plate

### Local to General

- 1) short-tail mouse
  - 2) polydactyl g.p.
  - 3) creeper foal.
- } heterozygous = local, but homo - get general effect! local of letra depends on threshold



# Cytoplasmic Heredity

I

Pl. gr. algae & bacteria no nuclear div. & no evidence of any sorting of mater.

## Criteria

### A. Mendel

① Mend. ratios & ② linkage tests

### B. Non-Mendel

① neg. ratios, not interpret. x-same basis

② reciprocal crosses not alike even after repeated backcross

③ char. transmissible in germ line, but only they cell divisions <sup>to 8 years!</sup> <sub>rule out disease</sub> <sup>but</sup> <sub>imm</sub>

non-segregating heredity

, Allotetraploidy

② Apparent blending - segreg. by inbreeding.

## Intra-Plant Cases:

### Species

- ① Chlorophyll plastid effects indicate plastids may be self-perpetuating however, some " " are mendelian OK.
- ② Pollen sterility was not attached to any of 10 x-homes so = cytoplasmic cases due disease, not under control of mitosis.

## Animal Cases:

no good intra-specifics

## Interspecific Plant

① In *Oenothera* (Hookeri & Lamarckiana)

Lamarck. plastids self-perpet. entities & would not become adjusted to Hookeri nuclear complex.

② In beans Major & minor varieties combined, lethal showed some minor cytoplasmic factor was self-perpetuating.

disharmonies between nucleus & cytoplasm.

## Animals

Heldrhopf's *Reynaudia*

Recip. crosses between races → many types in char. carry thru F<sub>2</sub>

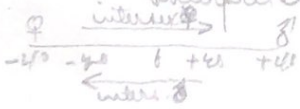
classified races as strong, neutral, & weak ♂

found 2 series of intercrosses ♂ → ♀ & ♀ → ♂ series.

Recip. crosses bet. S & W races gave ratios of N♀IF N♂IF which indicated same factor was passed down in maternal line.

Because ♀ mother = heterogametic couldn't be sure chromosomal or cytoplasm ruled out chromosomal by getting ♀'s with S cytoplasm & W chromosomes & crossed to strong ♂ & got 1/1 ratio instead of 1/2 ♂'s so = cytoplasm.

Interpretation in terms of opposing quantity tendencies



a general property of the ♀ cytoplasm virus infection adjusted to chromosome

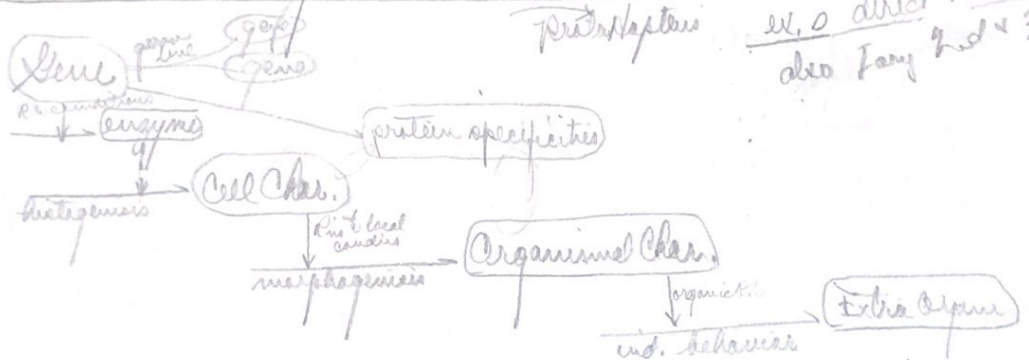
(over)

merogones only  $F_1$

But for most reciprocal crosses don't show any diff. In species crosses there's a tremendous degree of diff. of nucleus as well as cytoplasm.

In majority of cases nucleus determines overwhelmingly the species and genus characters.

Relation Between Genes & Adult Characters



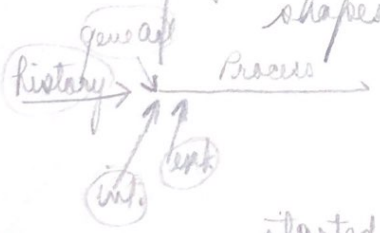
In most cases gene action is at many removes from observed character effect. Deal w. cell characters or better enzymes or better still w. immunological specificities.

Ultimately all char.s are dependent on gene activity

Many examples of genes affecting cells char., enzymes, & specificities. Genes → enzymes which guide rate of metabolism & diff. kinds of cell metabolism.

Protoplasm of cell guided along a particular channel (of all possible ones) by repression of enzymes - one leads to another.

A very complex 3-dim. form, as result of simple conditions. Genes don't determine all details, just few constraints shapes of protozoa, base cells, nerve pattern, epithelium.



Ultimate analysis in terms genes

logically need only  $\left. \begin{matrix} \text{surv.} - \text{inter} \\ \text{ant.} - \text{part} \\ \text{dorsal} - \text{vent.} \end{matrix} \right\} \text{products in quantitative}$   
 started by environment, then gene action get any degree of complexity  
 Cases of inter-cellular char.s - represses enzymes, specificities -