NONALLELIC GENE INTERACTIONS

POLYGENIC INHERITANCE

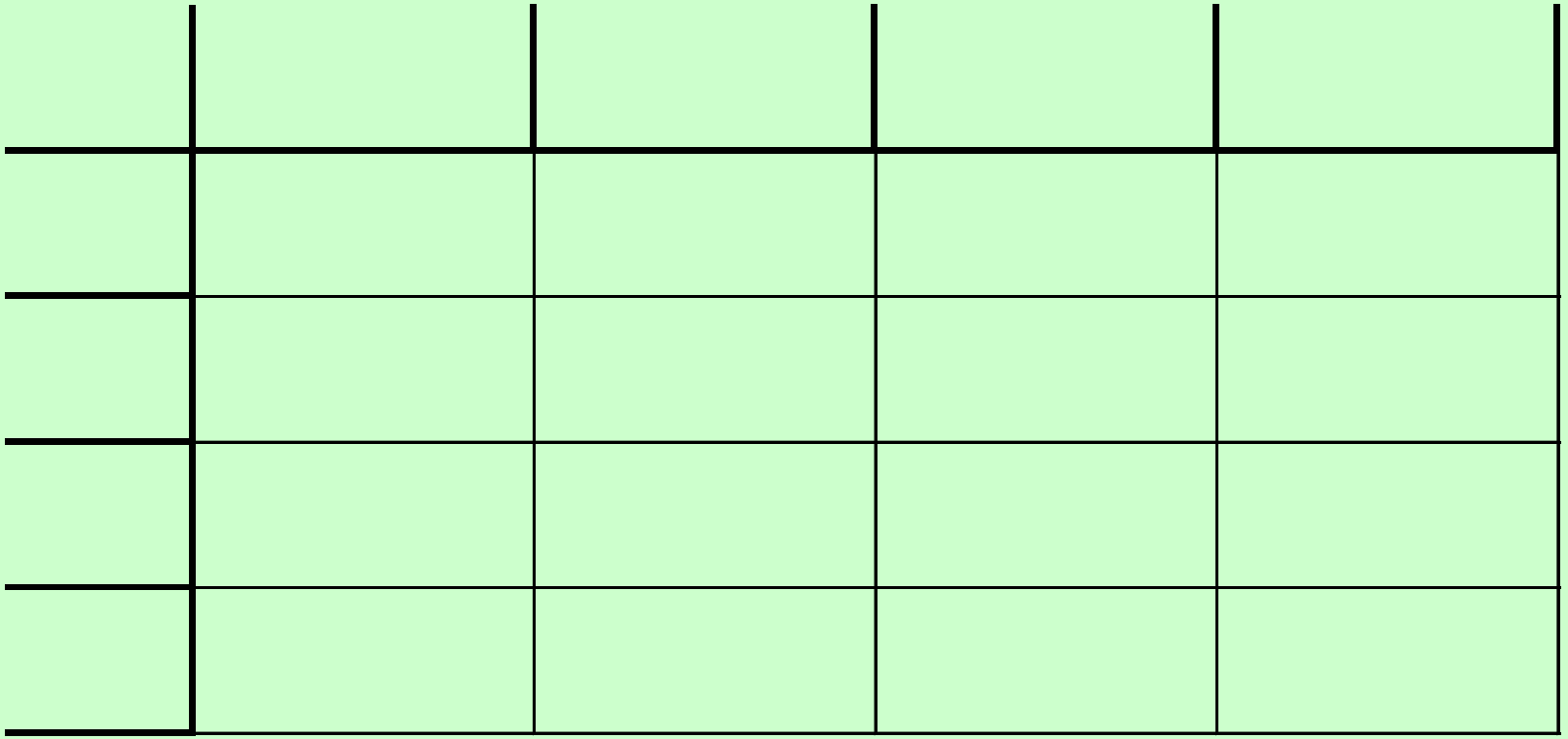
1st year, 2nd semester, week 13
May 12, 13, and 14, 2008

Albinism – coat colour in the rat

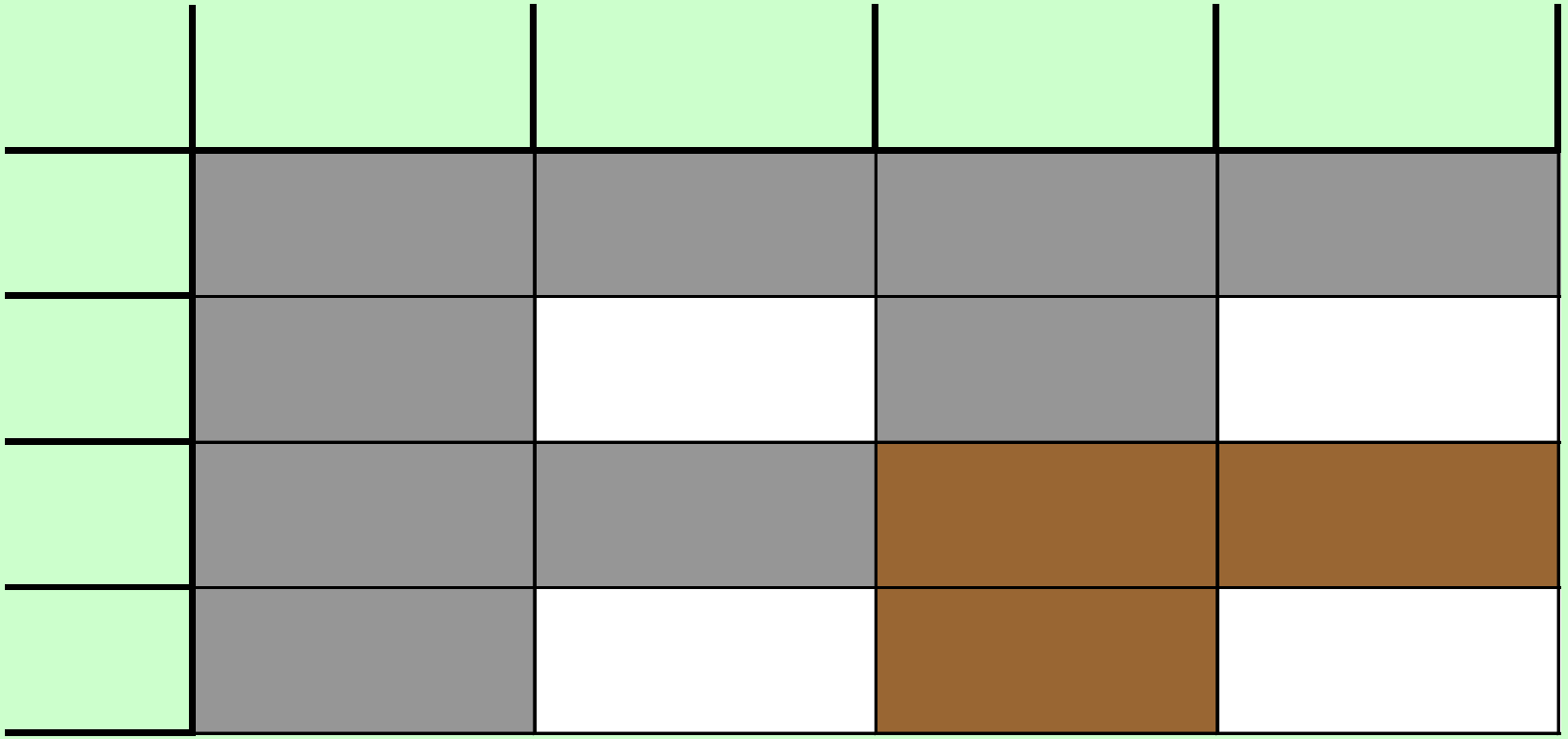
Task 1/p. 95 *KrOt*

P	♀ **SHR**	**x**	♂ **BN**	
genotype	***ccBB***		***CCbb***	
phenotype	**albino**		**brown**	
gametes	***cB***		***Cb***	
F_1	**(SHR x BN)**			
genotype	***CcBb***			
phenotype	**black**			
gametes	***CB***	***Cb***	***cB***	***cb***
F_2	**(SHR x BN)**			
genotype				
phenotype				

Albinism – coat colour in the rat



Albinism – coat colour in the rat



Albinism – coat colour in the rat

	BC	***Bc***	***bC***	***bc***
BC	***BBCC*** **black**	***BBCc*** **black**	***BbCC*** **black**	***BbCc*** **black**
Bc	***BBCc*** **black**	***BBcc*** **albino**	***BbCc*** **black**	***Bbcc*** **albino**
bC	***BbCC*** **black**	***BbCc*** **black**	***bbCC*** **brown**	***bbCc*** **brown**
bc	***BbCc*** **black**	***Bbcc*** **albino**	***bbCc*** **brown**	***bbcc*** **albino**

Albinism – coat colour in the rat

Task 1/p. 95 *KrOt*

P ♀ **SHR** x ♂ **BN**

genotype	***ccBB***	***CCbb***
phenotype	**albino**	**brown**
gametes	***cB***	***Cb***

F_1 **(SHR x BN)**

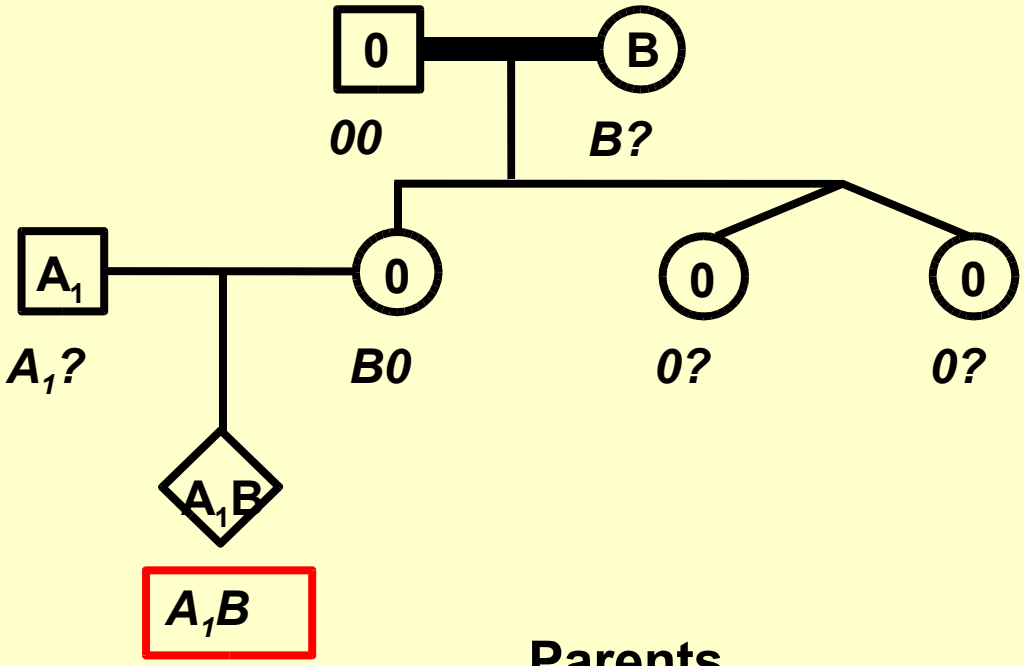
genotype		***CcBb***		
phenotype		**black**		
gametes	***CB***	***Cb***	***cB***	***cb***

F_2 **(SHR x BN)**

genotype	***9 C-B-***	***: 3 C-bb***	***: 4 ccB-, ccbb***
phenotype	**black**	**brown**	**albino**

Bombay phenotype in the AB0 system

Task 3/p. 96 KrOt



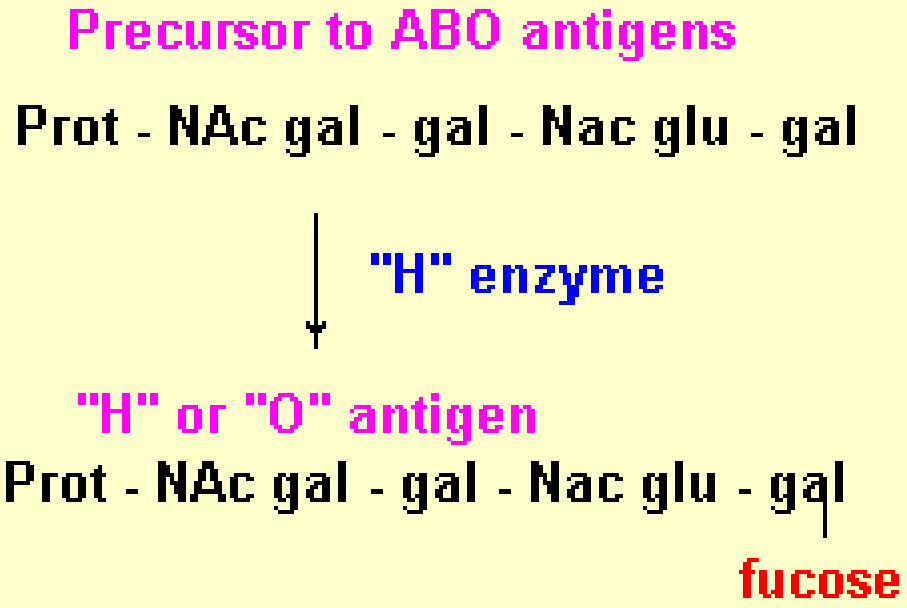
Mother's parents

gametes	*H0*	*h0*
HB	*HHB0* gr. B	*HhB0* gr. B
hB	*HhB0* gr. B	*hhB0* gr. 0, anti-H
H0	*HH00* gr. 0	*Hh00* gr. 0
h0	*Hh00* gr. 0	*hh00* gr. 0, anti-H

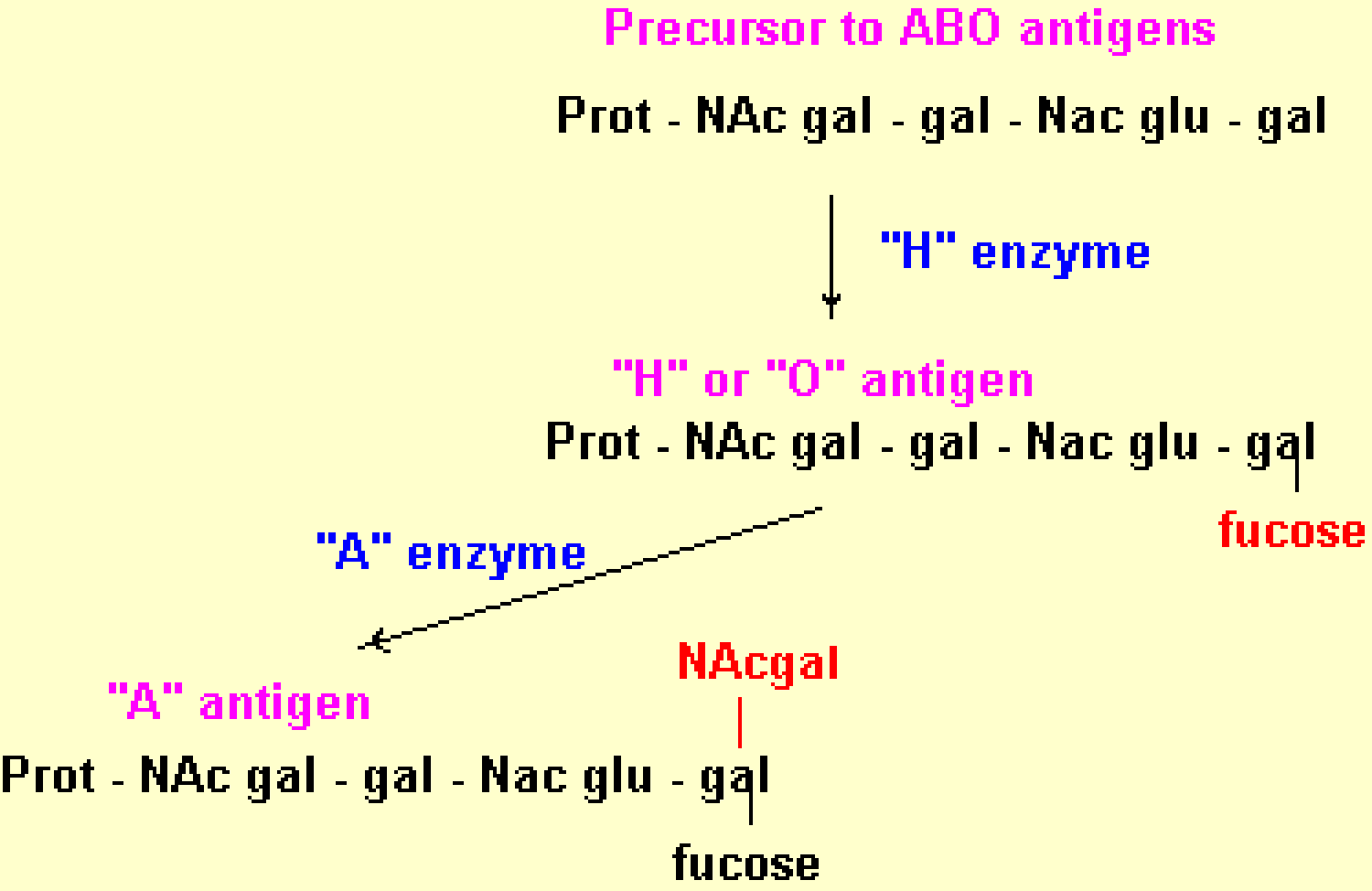
Parents

gametes of father / *of mother*	*HA 1*	*H0*
hB	*HhA 1B* gr. A1B	*HhB0* gr. B
h0	*HhA 10* gr. A1	*Hh00* gr. 0

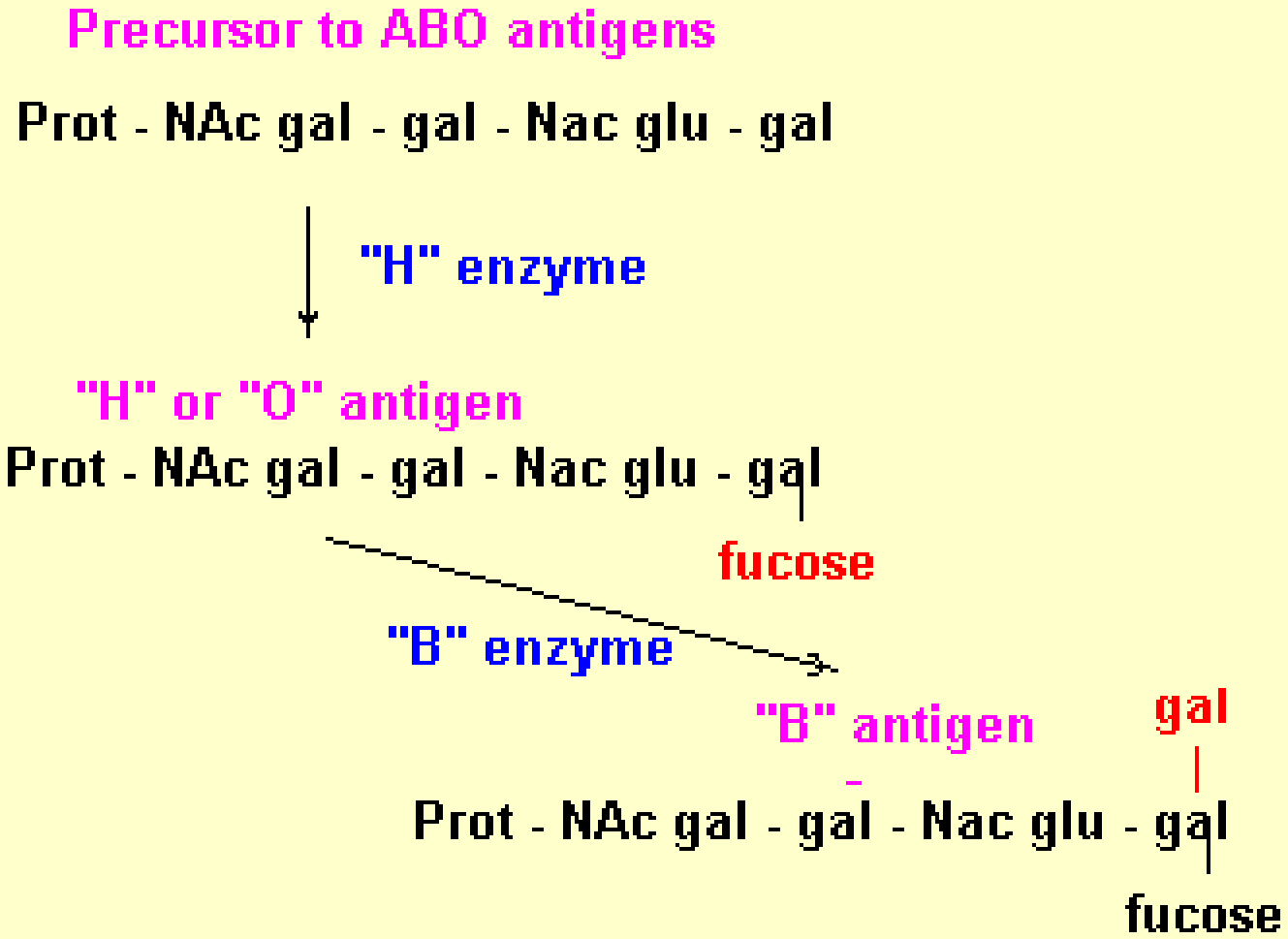
Bombay phenotype in the AB0 system



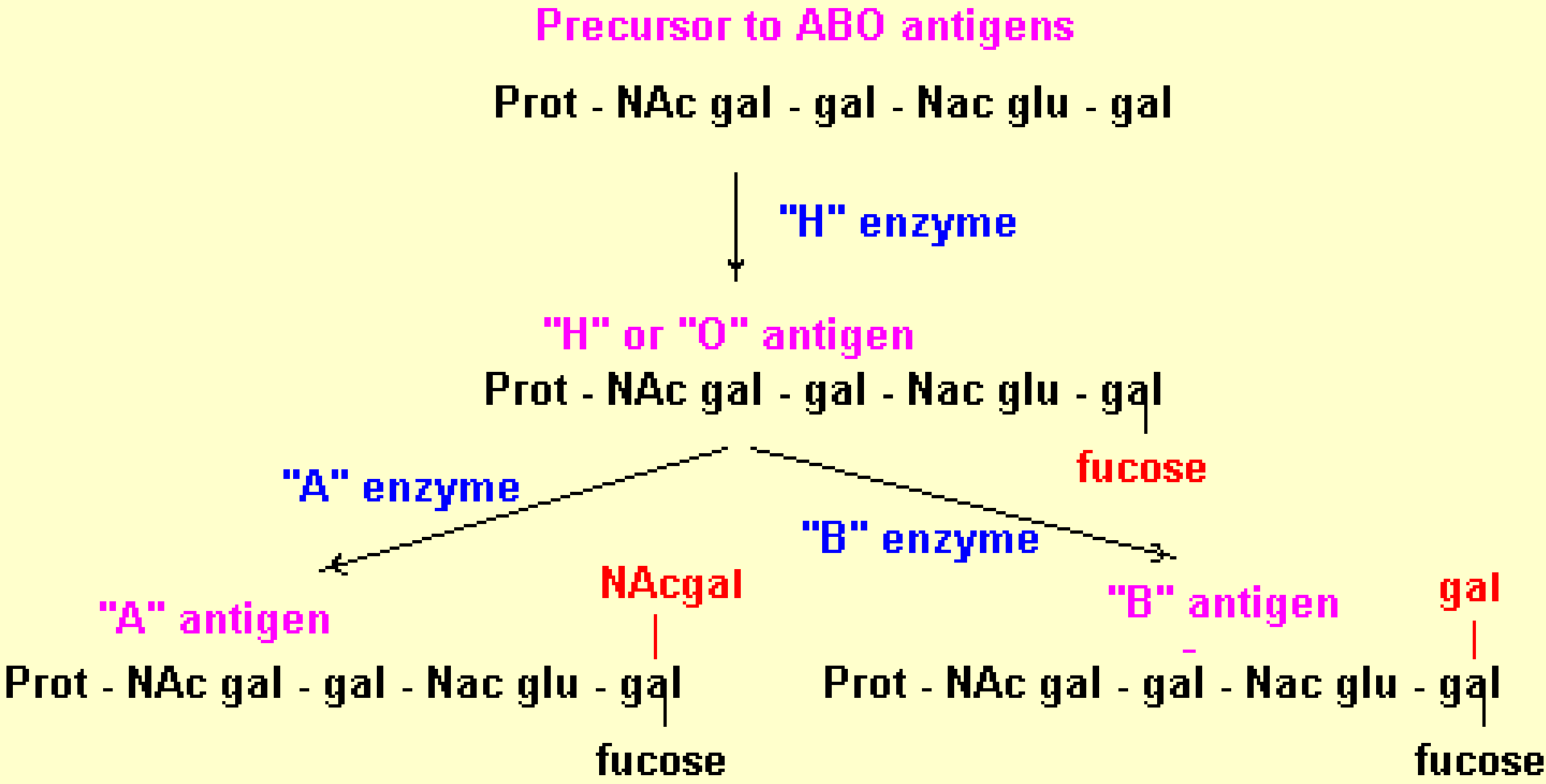
Bombay phenotype in the AB0 system



Bombay phenotype in the AB0 system



Bombay phenotype in the AB0 system

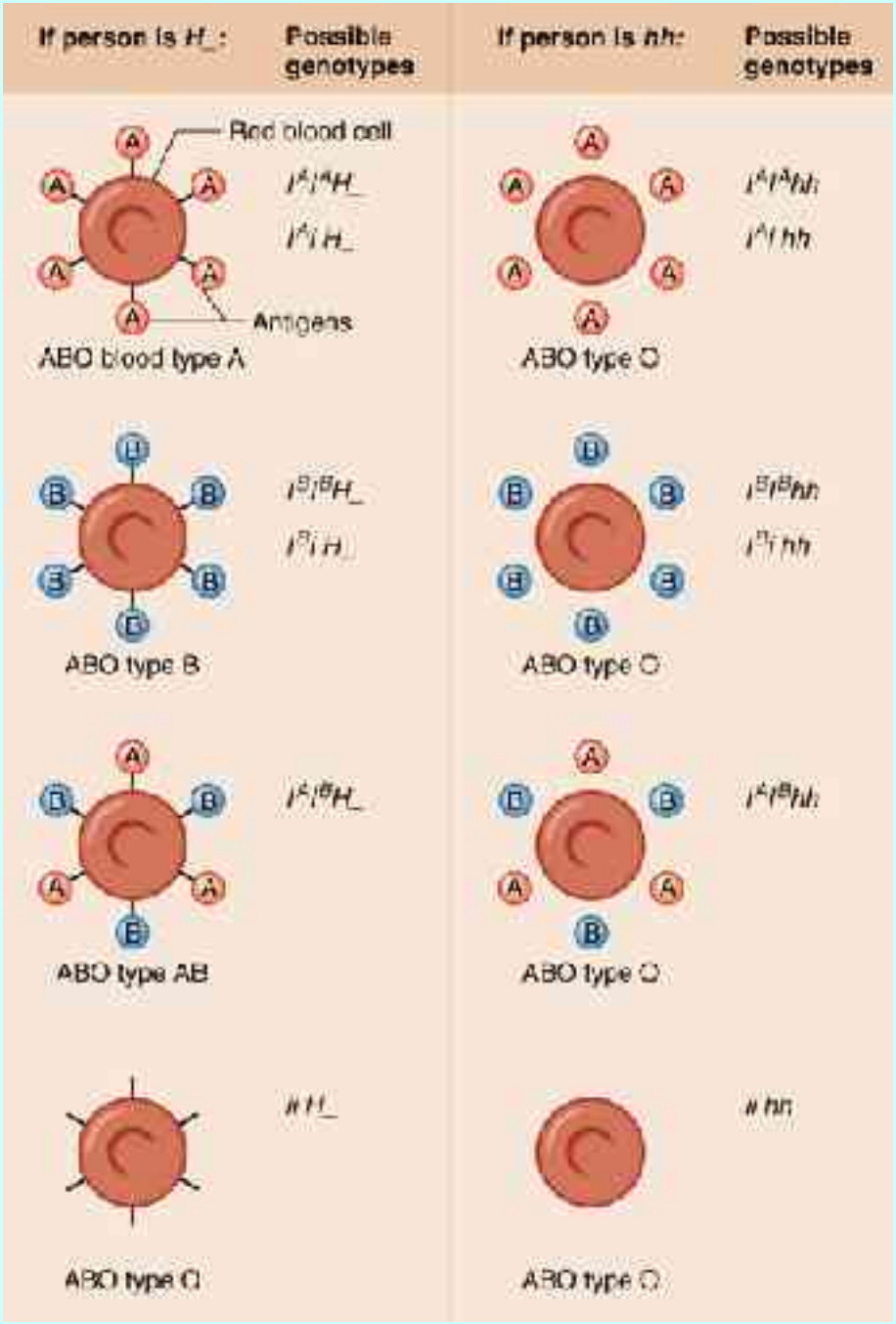


Supplementarity, recessive epistasis, example of metabolic pathway.

H and *AB0* loci as recessive epistasis

Homozygocy for alleles of one gene affects the expression of a second gene.

- H gene (*FUT1*) is epistatic to the AB0 gene.
- H substance is attached to the cell surface.
- *hh* genotype = no H substance (antigen).
- RBC of all AB0 genotypes appear as type 0.



Interaction of nonallelic genes

Duplicity genes

Phenotypic ratios	Genotypes	
F_2 15 : 1 Bc_1 3 : 1	A*** : aaaa	noncumulative with dominance
9 : 6 : 1 1 : 2 : 1	A*A* : A*aa + aaA* : aaaa	cumulative with dominance
1 : 4 : 6 : 4 : 1 1 : 2 : 1	Regardless of order of active alleles	cumulative without dominance

	AAAA		AAAa		AAaa		Aaaa		aaaa
F_2	1	:	4	:	6	:	4	:	1
Bc					1	:	2	:	1

Segregation ratios
Pascal's triangl

n	$(1 + 1)^n$	Total
1	1 1	2
2	1 2 1	4
3	1 3 3 1	8
4	1 4 6 4 1	16
5	1 5 10 10 5 1	32
6	1 6 15 20 15 6 1	64
7	1 7 21 35 35 21 7 1	128
8	1 8 28 56 70 56 28 8 1	256

Polygenic inheritance – body height

Task 3/p. 93 KrOt

a) 200 cm

b) ***F*** $_2$ ***generation*** **5 genes with additive effect without dominance**

No. of active alleles	0	1	2	3	4	5	6	7	8	9	10
Body height (cm)	150	155	160	165	170	175	180	185	190	195	200
Rate	1	10	45	120	210	252	210	120	45	10	1

g) **1 : 4 : 6 : 4 : 1**

1 : 2 : 1

1

$A_1a_1A_2a_2$	x	$A_1a_1A_2a_2$	
$A_1A_1a_2a_2$	x	$A_1a_1A_2a_2$	
$A_1A_1a_2a_2$	x	$A_1A_1a_2a_2$	
$A_1A_1a_2a_2$	x	$a_1a_1A_2A_2$	

All of them 160 cm = 2 active alleles

Polygenic inheritance – body height

Task 3/p. 93 KrOt

No. of active alleles	0	1	2	3	4	5	6	7	8	9	10
Body height	150	155	160	165	170	175	180	185	190	195	200
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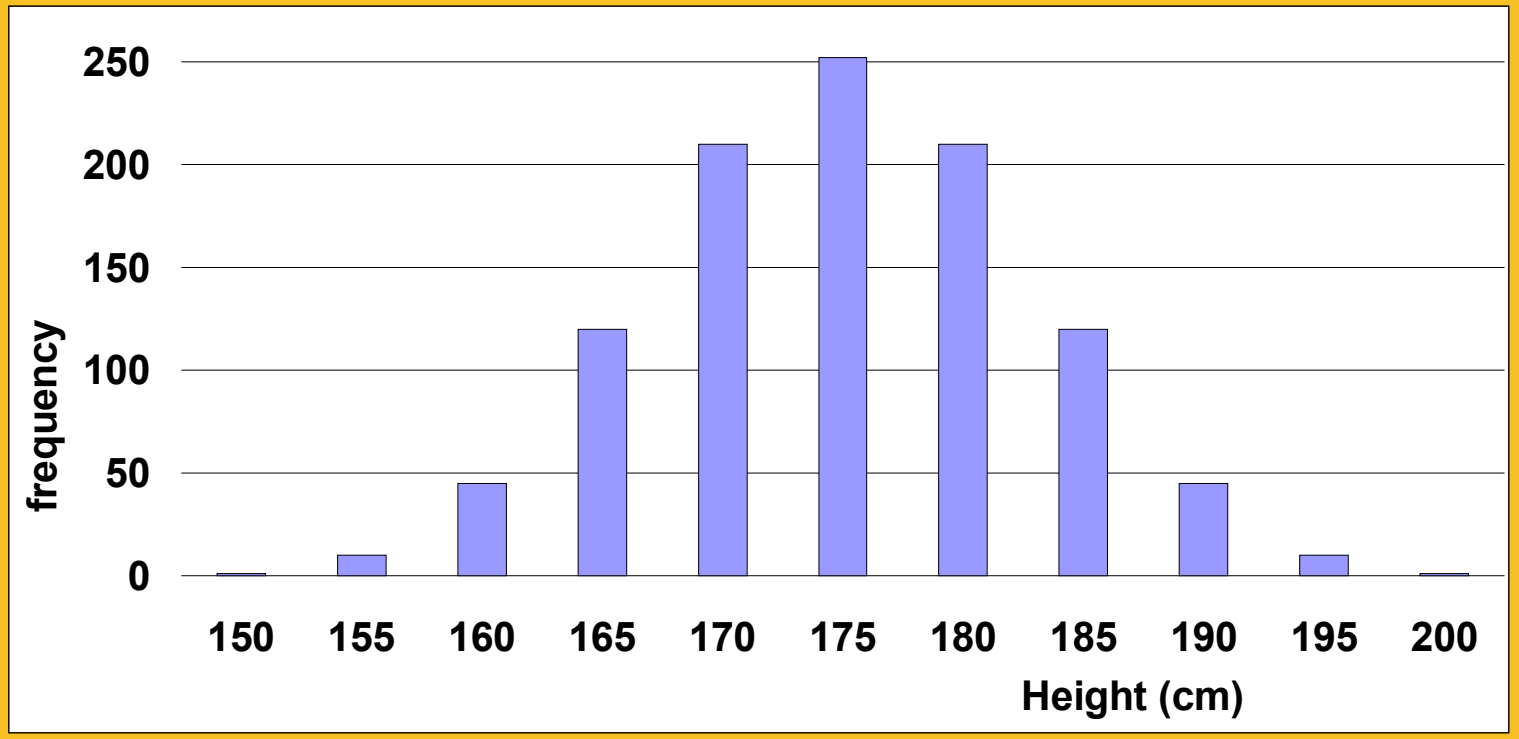


160 cm = 2 active alleles

possible genotypes: $A_1A_1a_2a_2$****, $A_1a_1A_2a_2$******, $a_1a_1A_2A_2$******

Recurrence risk estimates for diseases with multifactorial etiology

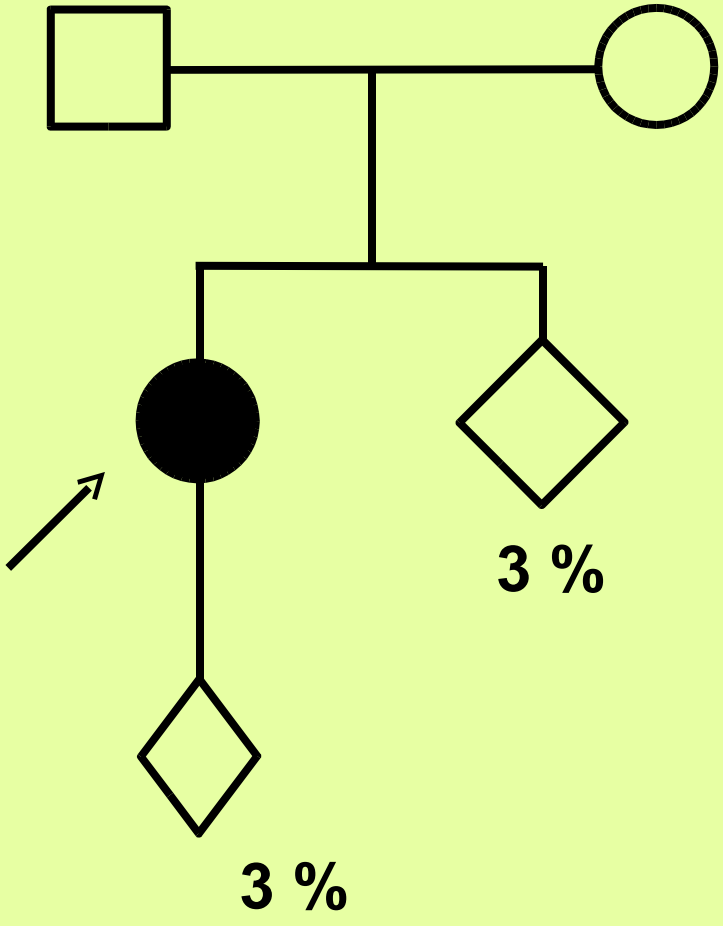
$$reccur.risk_{I.dg.rel.} \doteq \sqrt{popul.incidence}$$

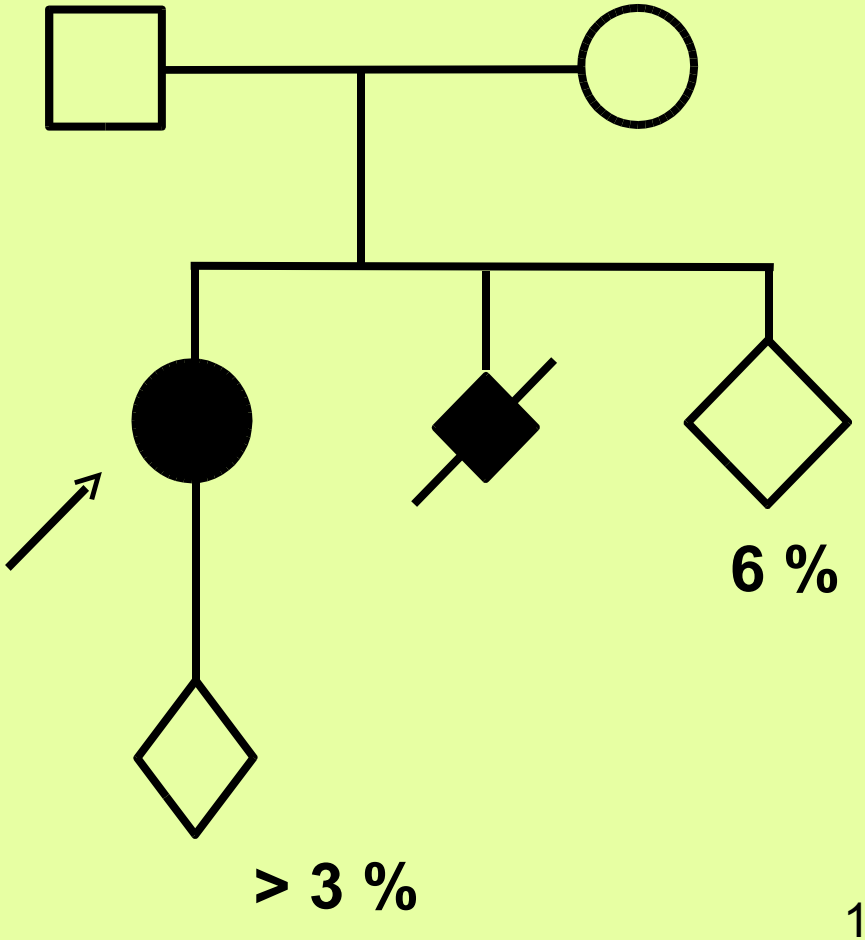
1. Altho
   distin
2. The recurrence risk to first-degree relatives is approximately the square root of the population risk (incidence) – Edwards' formula
3. The risk is sharply lower for second-degree than for first-degree relatives, but it declines less rapidly for more remote relatives.
4. The risk is higher when more than one family member is affected – for first-degree relatives, the value calculated from Edwards' formula is multiplied by 2, 3 etc.
5. The more severe the malformation, the greater the risk
6. If a multifactorial trait is more frequent in one sex than in the other, the risk is higher for relatives of patients of the less susceptible sex.
7. An increased risk when the parents are consanguineous (multiple factors with additive effects may be involved)
8. Strongly affected by the environmental factors

Neural tube defect reccurence risk

Task 9/p. 94 KrOt

Congenital malformation with multifactorial ethiology and polygenic inheritance, population frequency ca 0,0009





Home work:

Task 1/p. 92 KrOt

Task 8/p. 94 KrOt

Recurrence risk estimates for diseases with multifactorial etiology

1. Although the disorder is obviously familial, there is no distinctive pattern of inheritance within family
2. The recurrence risk to first-degree relatives is approximately the square root of the population risk (incidence) – Edwards' formula
3. The risk is sharply lower for second-degree than for first-degree relatives, but it declines less rapidly for more remote relatives.
4. The risk is higher when more than one family member is affected – for first-degree relatives, the value calculated from Edwards' formula is multiplied by 2, 3 etc.
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8. Strongly affected by the environmental factors