

School of Health Sciences

## WRITTEN EXAMINATION

Course **Genetics**

Examination **Salstentamen**

Course code **BM136G**

Credits for written examination **4 hp**

Date **20230824**

Examination time **08.15-12.30**

Examination responsible **Katarina Ejeskär**

Teachers concerned **Katarina Ejeskär, Homa Tajsharghi**

Aid at the exam/appendices **Calculator**

Other

### Instructions

- ☐ Take a new sheet of paper for each teacher.
- ☐ Take a new sheet of paper when starting a new question.
- ☒ **Write only on one side of the paper.**
- ☒ **Write your name and personal ID No. on all pages you hand in.**
- ☒ **Use page numbering.**
- ☒ **Don't use a red pen.**
- ☒ Mark answered questions with a cross on the cover sheet.

### Grade points

For E: 50% correct on each learning objective (6+6+4), 50% of total points, 16p.

For D: 50% correct on each learning objective, 60% of total points, 19p.

For C: 50% correct on each learning objective, 70% of total points, 22p.

For B: 50% correct on each learning objective, 80% of total points, 25p.

For A: 50% correct on each learning objective, 90% of total points, 28p.

**Examination results should be made public within 18 working days**

*Good luck!*

Total number of pages **8**

**Written exam: Genetics BM136G VT23, 4 hp, 20230824**

This exam has 3 different parts, and you need to pass all of them to pass the exam (minimum 50% correct per part).

For E: 50% correct on each learning objective (6+6+4), 50% of total points, 16p.

For D: 50% correct on each learning objective, 60% of total points, 19p.

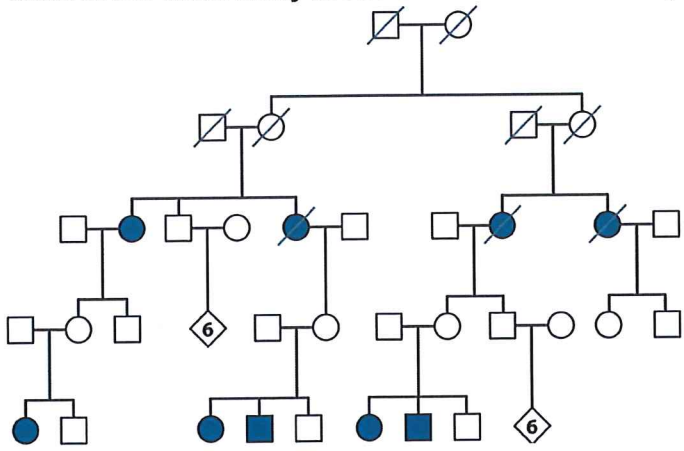
For C: 50% correct on each learning objective, 70% of total points, 22p.

For B: 50% correct on each learning objective, 80% of total points, 25p.

For A: 50% correct on each learning objective, 90% of total points, 28p.

You can answer multiple choice questions and short answers directly on this paper. Other questions on separate sheets of paper.

Learning objective 1: Describe principles for inheritance and pedigrees, and make calculations on these (12 p)	HT/KE
<p>1- What is the most likely mode of inheritance in the pedigree below?</p> <p>Figure 3.6 Human Molecular Genetics, 4ed. (© Garland Science)</p> <p>A. autosomal dominant B. autosomal recessive C. sex-linked dominant D. sex-linked recessive E. mitochondrial</p>	<p>1p</p>

<p>2- What is the most likely mode of inheritance in the pedigree below?</p> 	1p
<p>3- Briefly define the terms Heteroplasmy and Homoplasmy.</p>	2p
<p>4- Describe what a point mutation is and name the three types of DNA mutations.</p>	2p
<p>5- A pea plant is heterozygous at the independent loci for flower color (<math>Pp</math>) and seed color (<math>Yy</math>). What types of gametes can it produce?</p> <p>A. two gamete types: <math>pY</math> and <math>Py</math>          B. two gamete types: <math>pp</math> and <math>PP</math>          C. four gamete types: <math>pP</math>, <math>Yy</math>, <math>pY</math>, and <math>Py</math>          D. four gamete types: <math>pY</math>, <math>py</math>, <math>PY</math>, and <math>Py</math>          E. one gamete type: <math>PpYy</math></p>	1p
<p>6- If a geneticist were to closely examine the DNA sequence of <u>one</u> of the chromosomes in a chromosome pair from one of your muscle cells, that chromosome would be found to be:</p> <p>A. genes derived from your father <u>or</u> from your mother.          B. a mix of genes derived from your mother <u>and</u> father.          C. derived entirely from genes from just one of your grandparents.          D. a mix of genes derived from all four of your grandparents.          E. a mix of genes derived from just two of your grandparents – either your two grandmothers or your two grandfathers.</p>	1p

7-

John and Martha are contemplating having children, but John's brother has cystic fibrosis (a rare autosomal recessive disease) and Martha's father also have cystic fibrosis.

Draw a pedigree and genotypes of each individual describing this, also calculate what is the probability that John and Martha's first child will have cystic fibrosis.

2p

8-

In maize, the dominant A allele inhibits leaf color. The dominant E allele gives blue leaves whereas the recessive e allele gives green leaves. You are making a dihybrid cross of the maize plants by crossing two heterozygous plants with each other.

A) What result would you expect? Do a punnet square and show the distribution of the different phenotypes and genotypes in F<sub>1</sub>. (1p)

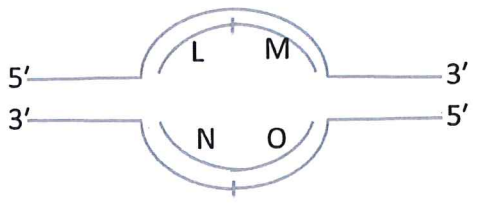
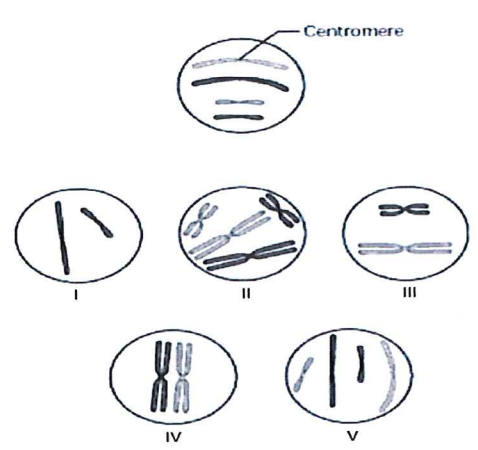
B) When making the cross you actually got 294 colorless, 76 blue and 30 green. Use the chi-square test to determine if these results fit your hypothesis. The chi-square table can be found below. (1p)

2p

Percentage Points of the Chi-Square Distribution

Degrees of Freedom	Probability of a larger value of $\chi^2$								
	0.99	0.95	0.90	0.75	0.50	0.25	0.10	0.05	0.01
1	0.000	0.004	0.016	0.102	0.455	1.32	2.71	3.84	6.63
2	0.020	0.103	0.211	0.575	1.386	2.77	4.61	5.99	9.21
3	0.115	0.352	0.584	1.212	2.366	4.11	6.25	7.81	11.34
4	0.297	0.711	1.064	1.923	3.357	5.39	7.78	9.49	13.28
5	0.554	1.145	1.610	2.675	4.351	6.63	9.24	11.07	15.09
6	0.872	1.635	2.204	3.455	5.348	7.84	10.64	12.59	16.81
7	1.239	2.167	2.833	4.255	6.346	9.04	12.02	14.07	18.48
8	1.647	2.733	3.490	5.071	7.344	10.22	13.36	15.51	20.09
9	2.088	3.325	4.168	5.899	8.343	11.39	14.68	16.92	21.67
10	2.558	3.940	4.865	6.737	9.342	12.55	15.99	18.31	23.21
11	3.053	4.575	5.578	7.584	10.341	13.70	17.28	19.68	24.72
12	3.571	5.226	6.304	8.438	11.340	14.85	18.55	21.03	26.22
13	4.107	5.892	7.042	9.299	12.340	15.98	19.81	22.36	27.69
14	4.660	6.571	7.790	10.165	13.339	17.12	21.06	23.68	29.14
15	5.229	7.261	8.547	11.037	14.339	18.25	22.31	25.00	30.58
16	5.812	7.962	9.312	11.912	15.338	19.37	23.54	26.30	32.00
17	6.408	8.672	10.085	12.792	16.338	20.49	24.77	27.59	33.41
18	7.015	9.390	10.865	13.675	17.338	21.60	25.99	28.87	34.80
19	7.633	10.117	11.651	14.562	18.338	22.72	27.20	30.14	36.19
20	8.260	10.851	12.443	15.452	19.337	23.83	28.41	31.41	37.57

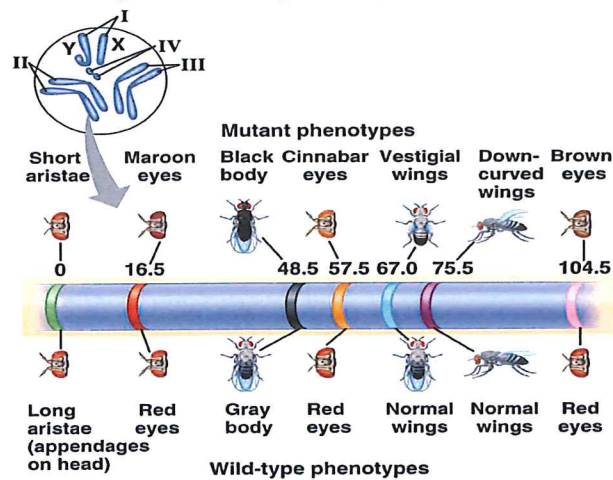


Learning objective 2: Describe mitosis, meiosis, recombination and linkage analysis, their produced effects on the next generation, and make calculations on these (12 p)	MADC /KE
<p>9- Consider the replication bubble diagrammed at the right. Which letters represent the following places/enzyme location?</p>  <p>A. Leading strands. B. Okazaki fragments. C. Lagging strands. D. RNA primase.</p>	2p
<p>10- In a diploid cell with four chromosome pairs (<math>2n = 12</math>), how many sister chromatids will be found in a nucleus at the prophase of mitosis?</p> <p>A. 6 B. 24 C. 8 D. 16</p>	1p
<p>11- The unlettered circle at the top of the accompanying figure shows a diploid nucleus with four chromosomes that have not yet replicated. The circles labeled I to V show various conformations of these chromosomes.</p>  <p>Which chromosomal configuration would be observed in one daughter cell after telophase of mitosis?</p> <p>A. II    B. III    C. IV    D. V</p>	1p

<p>12- Which of the following processes occurs in meiosis but not in mitosis?</p> <ul style="list-style-type: none"> <li>A. Chromosome replication</li> <li>B. Synapsis of chromosomes</li> <li>C. Alignment of chromosomes at the metaphase plate</li> <li>D. Condensation of chromosomes</li> </ul>	<p>1p</p>
<p>13- In humans, the gene for red-green color blindness (R=normal, r=color blind) and hemophilia (H=normal, h=hemophilia) are both X-linked and only 2 map units apart. Suppose a healthy woman has four sons, and two are color blind and have hemophilia and two have neither hemophilia nor color blindness. What is the probable genotype of their mother?</p> <ul style="list-style-type: none"> <li>A. RH/RH</li> <li>B. rh/rh</li> <li>C. RH/rh</li> <li>D. Rh/rH</li> <li>E. Rh/RH</li> <li>F. rH/rh</li> </ul>	<p>1p</p>
<p>14- Two different true-breeding lines of corn were crossed and resulted in a phenotypically wild-type F<sub>1</sub> that was heterozygous for three alleles that determine the recessive phenotypes: <i>a</i> (anther), <i>b</i> (brachytic) and <i>f</i> (fine). The F<sub>1</sub> was testcrossed with a tester that was homozygous recessive for the three genes and obtained the following phenotypes:</p> <ul style="list-style-type: none"> <li>398 brachytic</li> <li>428 anther, fine</li> <li>82 completely wild-type</li> <li>55 anther, brachytic, fine</li> <li>18 fine</li> <li>15 anther, brachytic</li> <li>2 anther</li> <li>2 brachytic, fine</li> </ul> <p>What were the genotypes for the two initial true-breeding lines used (show both alleles for both lines)? (1p)</p>	<p>1p</p>

15-

What is the expected recombination frequency between the genes for down-curved wings and vestigial wings? The map shows map units.



1p

16-

Alleles *G* and *g* occur at a locus that is located on the same chromosome as a locus with alleles *H* and *h*. An organism heterozygous for both genes is crossed with an organism with genotype *gh/gh*, and the following progenies are produced:

Genotype	Number of progeny
GH/ <i>gh</i>	80
Gh/ <i>gh</i>	20
gH/ <i>gh</i>	205
gh/ <i>gh</i>	80

- a) What is the genotype of the heterozygous parent? (1p)
- b) What is the map distance between gene *G* and *H* (in map units)? (1p)

2p

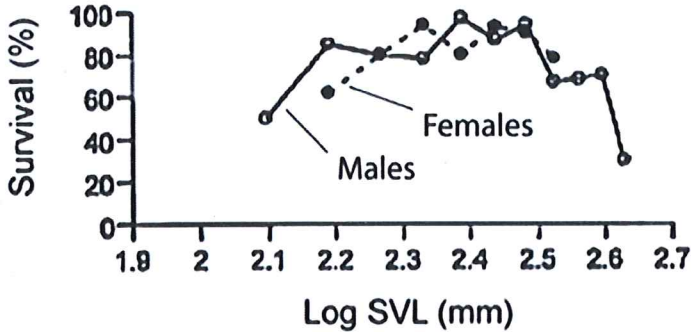
17-

If a plant with genotype *Ab/aB* is crossed to *ab/ab*, what percentage of the progeny will be *aB/ab* if the two genes are:

- a) completely linked (no crossing-over at all) (1p)
- b) 20 map units apart? (1p)

(Describe with possible genotypes and a Punnett square.)

2p

Learning objective 3: Explain the main concept as well as the use of simpler models in population genetics (8 p)	MADC
18- In a Hardy Weinberg population, the frequency of the A allele is 0.6. What is the frequency of heterozygote genotype Aa? Show the calculations in your answer.	2p
19- Cystic fibrosis is a genetic disorder in humans where the person has two homozygous recessive alleles for the gene. If the disease is left untreated, it causes severe health problems in the individual. If 9 in 10,000 newborn babies have the disease, what are the expected frequencies of the dominant (A) and recessive (a) alleles according to the Hardy-Weinberg equation? Show the calculations in your answer.	2p
<p>20- Two researchers measured the snout-to-vent (anus) length of Galápagos marine iguanas (lizards) and observed the percent survival of different-sized animals, all of the same age. The graph shows the log snout-vent length (SVL, a measure of overall body size) plotted against the percent survival of these different size classes for males and females.</p>  <p>(Data from M. Wikelski and L. Michael Romero. Body size, performance and fitness in Galapagos marine iguanas. Integrative and Comparative Biology 43:376-386 [2003].)</p> <p>Based on the data in the figure, what type of selection for body size appears to be occurring in these marine iguanas?</p> <p>A. directional selection.  B. stabilizing selection.  C. disruptive selection.  D. You cannot determine the type of selection from the above information.</p>	1p



21	<p><b>Over time, humans have steadily increased their movements across the continents of the Earth. Which of the following results has most likely been derived from these movements?</b></p> <ul style="list-style-type: none"> <li>A. increased nonrandom mating.</li> <li>B. increased geographic isolation.</li> <li>C. increased genetic drift.</li> <li>D. increased gene flow.</li> </ul>	1p
22-	<p><b>Which of the following statements about genetic variation is accurate?</b></p> <ul style="list-style-type: none"> <li>A. Genetic variation is created by the direct action of natural selection.</li> <li>B. Genetic variation arises in response to changes in the environment.</li> <li>C. Genetic variation must be present in a population before natural selection can act upon the population.</li> <li>D. Genetic variation tends to be reduced when diploid organisms produce gametes.</li> </ul>	1p
23-	<p><b>Adult male humans generally have deeper voices than adult female humans. Which of the following processes was most likely occurring given that the fossil records of apes and humans alike show a trend toward decreasing larynx size in adult females and increasing larynx size in adult males?</b></p> <ul style="list-style-type: none"> <li>A. sexual dimorphism was evolving over time in these species.</li> <li>B. intrasexual selection seems to have occurred in these species.</li> <li>C. stabilizing selection was occurring in these species concerning larynx size.</li> <li>D. selection was acting more directly upon genotype than upon phenotype.</li> </ul>	1p