**Introduction to Genetics**
FALL 2023
EXAM II

1. The labeled parts of the eukaryotic chromosome shown above could be labeled as:

    A) A= Centromere; B=Euchromatin; C= Telomere; D= Heterochromatin; E= Centromere
    B) A=Telomere; B= Euchromatin; C=Centromere; D= Euchromatin; E= Heterochromatin
    C) A= Heterochromatin; B= Centromere; C= Telomere; D= Euchromatin; E= Heterochromatin
    D) A=Telomere; B= Heterochromatin; C=Centromere; D= Heterochromatin; E= Telomere
    E) A=Telomere; B= Heterochromatin; C= Centromere; D= Heterochromatin; E= Euchromatin

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Questions 2-5 refer to the cell shown on the right, which is from a diploid
    organism, 2n=4**:**
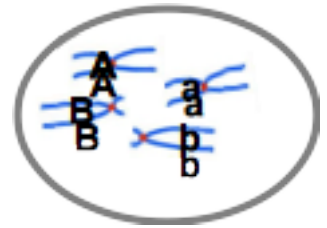
2. The cell shown on the right is from a diploid organism, 2n=4. If the cell
appears as shown, what stage of meiosis is the cell likely to be in?

    A) Prophase I   B) Prophase II   C) Anaphase I   D) Anaphase II   E) Telophase II

3. The cell shown on the right is from a diploid organism, 2n=4. At what stage of meiosis
would the centromeres of each chromosome separate and get pulled apart?

    A) Prophase I   B) Prophase II   C) Anaphase I   D) Anaphase II   E) Telophase II

4. The cell shown on the right is from a diploid organism, 2n=4. If the cell appears as shown,
how many double stranded DNA molecules are present in the cell?

    A) 1   B) 2   C) 4   D) 8   E) 16

5. The cell shown on the right is from a diploid organism, 2n=4. If there is only one gene on
each chromosome, and the organism is hybrid at all loci, how many genotypically
distinct gametes can the organism produce?

    A) 1   B) 2   C) 4   D) 8   E) 16

Questions 6 – 7 refer to a brown (B) long eared (L) mouse of unknown genotype that appears *dominant* for both of these single gene traits.

6. You decide to perform a testcross to determine the genetic makeup of the unknown mouse. The genotype of the tester mouse that you use in your cross to determine this is:

A) BBLL   B) BBll   C) bbLL   D) BbLl   E) bbll

7. Following the testcross, you find that 50% of the mice are brown with long ears and 50% are brown with short ears. What is the genotype of the original unknown parent mouse.

A) BBLl   B) BBll   C) BbLl   D) bbLL   E) bbLl

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8.   A testcross between a trihybrid with and its corresponding *tester* would be expected to produce how many distinct genotypes

A) 3   B) 6   C) 8   D) 36   E) 64

9. A cross between two monohybrids would be expected to produce how many distinct genotypes

A) 1   B) 2   C) 3   D) 4   E) 8

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Questions **10-13** refer to the following family.
        A male and female are both heterozygous for the autosomal recessive allele for albinism. They have four children.

10. What is the probability that their oldest child has albinism?
        A) ~0.079   B) ~0.105   C) 0.250   D) ~0.316   E) ~0.422

11. What is the probability that *only* their oldest child has albinism?
        A) ~0.079   B) ~0.105   C) 0.250   D) ~0.316   E) ~0.422

12. What is the probability that only one of their four children has albinism?
        A) ~0.079   B) ~0.105   C) 0.250   D) ~0.316   E) ~0.422

13. If none of the children have albinism, and the couple decides to have a fifth child, what is the probability that child number 5 will have albinism?

        A) ~0.079   B) ~0.105   C) 0.250   D) ~0.316   E) ~0.422

Questions **14-17** refer to the following cross.

A plant of genotype *CC dd* is crossed to a plant of genotype *cc DD*. The F_1 progeny is then testcrossed with a *cc dd* plant.

14. If the genes are unlinked, the percentage of plants with genotype *cc dd* in the F_2 progeny will be
    A) 12.5%   B) 25 %   C) 37.5%   D) 50%   E) 75%

15. If the genes are unlinked, the percentage of plants in the F_2 progeny with genotype *Cc dd* progeny will be
    A) 12.5%   B) 25 %   C) 37.5%   D) 50%   E) 75%

16. If the genes are 25 map units apart, the percentage of plants in the F_2 progeny with genotype *cc dd* progeny will be
    A) 12.5%   B) 25 %   C) 37.5%   D) 50%   E) 75%

17. If the genes are 25 map units apart, the percentage of plants in the F_2 progeny with genotype *Cc dd* progeny will be
    A) 12.5%   B) 25 %   C) 37.5%   D) 50%   E) 75%

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Questions **18-19** refer to the following cross.
H U G E are four dominant genes controlling tomato size that are located on different chromosomes. A cross is carried out between Plant 1 with genotype-Hh Uu gg ee and Plant 2 of genotype-Hh Uu GG Ee.

18. What percentage of the progeny are expected to be phenotypically identical to Plant 2?
    A) 0   B) 1/8   C) 9/32   D) 9/64   E) 9/128

19. What percentage of the progeny are expected to be genotypically identical to Plant 2?
    A) 0   B) 1/8   C) 9/64   D) 3/8   E) 3/4

You isolate six pure-breeding pea plants having mutations that produce wrinkled peas instead of the normal smooth peas. To determine if these mutations all occurred in the same gene, you cross each plant and examine the peas produced by the progeny. The results are summarized in the chart to the right.
"S" means the plants produced normal smooth peas.
"W" means the plants produced wrinkled peas.

|	a	b	c	d	e	f
a	W	W	S	W	S	S
b		W	S	W	S	S
c			W	S	W	S
d				W	S	S
e					W	S
f						W

20. The mutations in plant c and plant e:

A) *complement* each other and are likely to be in *different* genes
B) *do not complement* each other and are likely to be in *different* genes
C) *complement* each other and are likely to be in *the same* gene
D) *do not complement* each other and are likely to be in *the same* gene
E) are an example of incomplete dominance

21. How many different genes are presented in mutants a-f?

A) 1
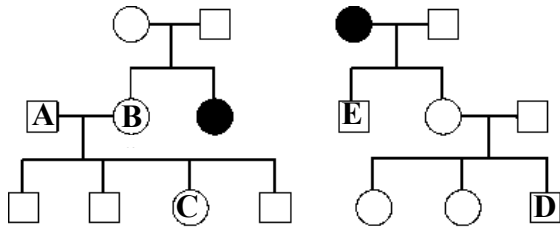B) 2
C) 3
D) 4
E) 5

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22. The following pedigree depicts the inheritance of a rare hereditary disease affecting muscles:
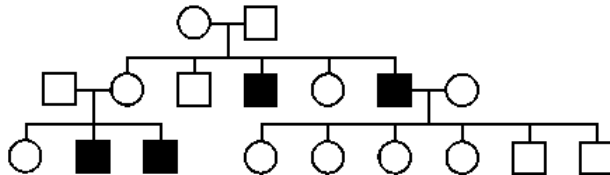
What is the *most* likely mode of inheritance of this disease?

A) Autosomal dominant
B) Autosomal recessive
C) X-linked dominant
D) X-linked recessive
E) Y-linked

Questions **23-27** refer to the following pedigree involving a rare disease:

23. What is the *most* likely mode of inheritance of this disease?
   A) Autosomal dominant
   B) Autosomal recessive
   C) X-linked dominant
   D) X-linked recessive
   E) Y-linked

24. What is the genotype of **B**?
   A) AA   B) Aa   C) 1/3 chance that it is Aa   D) 1/2 chance that it is Aa   E) 2/3 chance that it is Aa

25. What are the genotypes of **D**'s parents?
   A) Aa;AA   B) AA;aa   C) Aa;aa   D) Aa;Aa   E) Could be either Aa;AA or Aa;Aa

26. What is the probability that **C** is a carrier of the disease?
   A) 1/4   B) 1/3   C) 1/2   D) 2/3   E) 4/9

27. If individuals C and D have a child, what is the probability that the child will have the disease?
   A) 1/4   B) 1/6   C) 1/12   D) 1/24   E) 1/36

Questions **28-33** refer to the following cross.

Two dominant alleles in mice both affect the appearance of the tail. *Shorty (S)* produces mice with short tails and *hairy* (*H*) produces mice with hairy tails. A testcross was carried out between a dihybrid male *Ss Hh* and tester female *ss hh* that produced the following baby mice:

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Phenotype              Genotype        Progeny
Short hairy tail         Ss Hh              5
Long bald tail           ss hh              5
Short bald tail          Ss hh             15
Long hairy tail          ss Hh             15
Total                                      40
```

28. If the genes are unlinked, what would the expected number of short bald tail mice have been?

    A) 5   B) 10   C) 20   D) 30   E) 40

29. Based on these phenotypes, a Chi-square analysis to test the hypothesis that the *shorty* and *hairy* genes sort independently would have how many degrees of freedom in the analysis?

    A) 0   B) 2   C) 3   D) 4   E) 20

30. The Chi-square value from the hypothesis that the *shorty* and *hairy* genes sort independently is

    A) 2.0   B) 2.5   C) 10.0   D) 13.3   E) 25.0

31. The probability (the P value chart is on the last page) from your Chi-square analysis is

    A) ~0.0015   B) ~0.02   C) ~0.15   D) ~0.5   E) ~0.6

32. Based on this data and your Chi-square analysis, what does this P value allow you to say?

    A) we cannot reject the hypothesis that the *shorty* and *hairy* genes sort independently
    B) we reject the hypothesis that the *shorty* and *hairy* genes sort independently
    C) we cannot reject the hypothesis that the *shorty* and *hairy* genes are linked
    D) we reject the hypothesis that the *shorty* and *hairy* genes are linked
    E) we accept the hypothesis that the *shorty* and *hairy* genes are linked

33. *Based on your analysis*, what were the parental chromosomes in the dihybrid male?

    A) *SH sh*   B) *SH SH*   C) *sh sh*   D) *sH Sh*   E) A or D could be correct

6
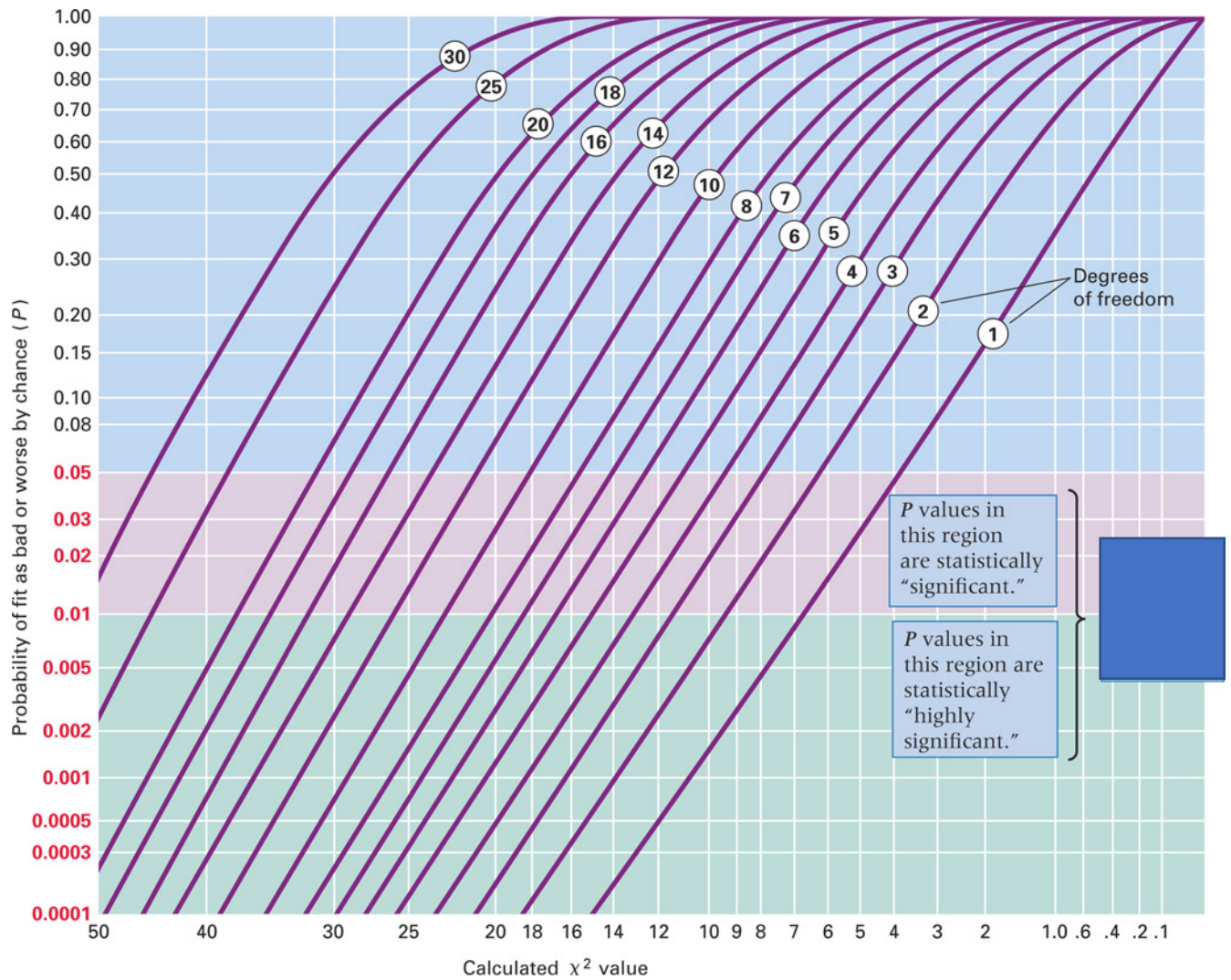
Potentially Useful formulas

For n trials, the probability that A, having probability p, is realized s times and B, having probability q, is realized t times is equal to $(n!)/(s!t!) \times (p^s q^t)$

% Recombinants = (# recombinants) / (# total progeny) x 100%

map distance = (# recombinants) / (# total progeny) x 100

Coefficient of coincidence = Observed double recombinants / Expected double recombinants
Interference = 1 – Coefficient of coincidence

$$\chi^2 = \sum (\text{observed} - \text{expected})^2 / \text{expected}$$