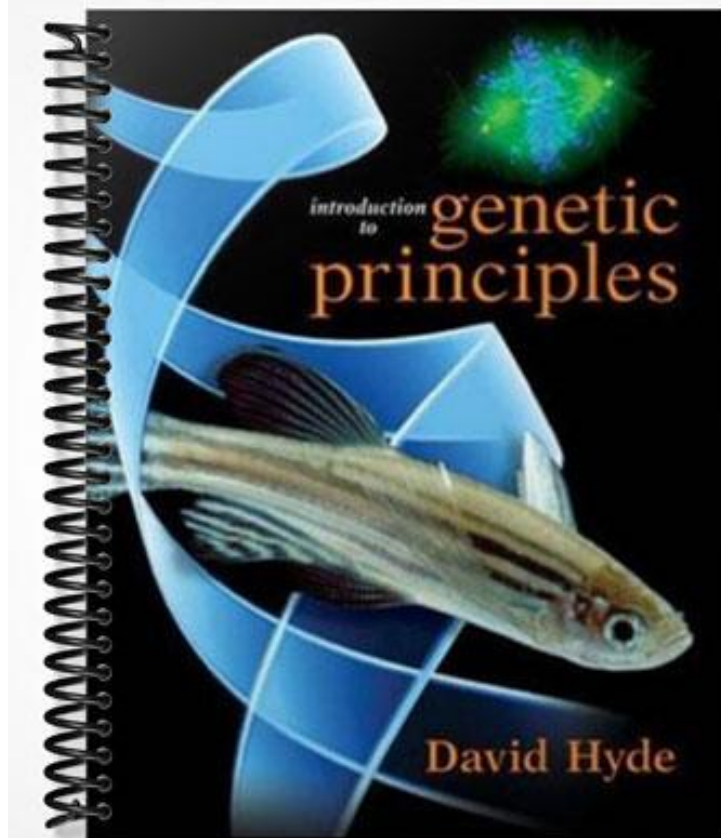introduction to genetic principles

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Chapter 02
Mendelian Genetics

Multiple Choice Questions

1. One of the reasons that Mendel used peas in his experiments was that
A. The genetics of peas was already well understood
B. The chromosome number was well known at the time
C. They were often self-pollinating
D. There were only three varieties to choose from, making the experiments simple
E. Nothing else could be grown in Brno at that time

Difficulty: Easy

2. The F1 generation showed
A. Segregation of alleles
B. Which phenotype was dominant
C. A 3:1 ratio
D. What a backcross could do
E. The difference between a backcross and a testcross

Difficulty: Easy

3. The "phenotype" of an organism is its
A. Physical characteristics
B. Genetic make-up
C. Number of chromosomes
D. Ratio of dominant to recessive traits
E. Ancestral background

Difficulty: Easy

4. The genotype of an organism is its
A. Physical characteristics
B. Genetic make-up
C. Number of chromosomes
D. Ratio of dominant to recessive traits
E. Ancestral background

Difficulty: Easy

5. An organism with the genotype *Aa* is said to be
A. Homozygous
B. Homomorphic
C. Heteromorphic
D. Heterozygous
E. Pure breeding

Difficulty: Easy

6. In peas the allele for tall plants can be represented by *D* and the allele for dwarf plants can be represented by *d.* In Mendel's F_2 cross using tall *vs.* dwarf plants, the results of the cross *Dd* X *Dd* approximated which ratio?
A. 4 tall: 1 dwarf
B. 1: 1
C. 1 dwarf: 3 tall
D. 3 tall: 1 dwarf
E. 4 dwarf: 1 tall

Difficulty: Easy

7. Using *D* for tall plants and *d* for dwarf plants, a 1:1 ratio is obtained in which of the following crosses?
A. *Dd* X *dd*
B. *DD* X *dd*
C. *DD* X *Dd*
D. *DD* X *DD*
E. *Dd* X *Dd*

Difficulty: Moderate

8. Mendel's law of segregation refers to
A. Gametes uniting at random
B. Two genes distributing themselves randomly into various reproductive cells
C. There being two different alleles for a given trait
D. Reproductive cells receiving one and only one copy of each gene for each characteristic when they are formed
E. The fact that there are discrete "hereditary determinants or factors" (genes) that determine inherited characteristics

Difficulty: Easy

9. "Genes for different characters are distributed independently of each other into reproductive cells." This statement summarizes which of Mendel's laws?
A. Law of unit factors
B. Law of independent assortment of genes
C. Law of segregation of alleles
D. Gametes unite at random
E. Each characteristic is determined by two copies of the gene for that characteristic

Difficulty: Easy

10. Based on the law of independent assortment of genes, an organism with the genotype *AaBb* should form the following reproductive cells and their ratios:
A. *AB* 1: *Ab* 1: *aB* 1: *ab* 1
B. *AA* 1: *aa* 1: *BB* 1: *bb* 1
C. *AB* 9: *Ab* 3: *aB* 3: *ab* 1
D. *AABB* 1: *AABb* 1: *AaBB* 1: *aabb* 1
E. *AABB* 9: *AABb* 3: *AaBB* 3: *aabb* 1

Difficulty: Moderate

11. In peas, the allele *W* codes for round seeds, the allele *w* codes for wrinkled seeds, the allele *G* codes for yellow seeds and the allele *g* codes for green seeds. In the cross *WwGg* X *wwGg*, of 1,600 offspring, how many should have round, yellow seeds?
A. 200
B. 300
C. 400
D. 600
E. 900

Difficulty: Moderate

12. In *Drosophila melanogaster* the allele w codes for white eyes, while the allele *w+* codes for wild-type (brick-red) eyes. The allele *W* codes for wrinkled wings, while the allele *W+* codes for wild-type wings. Which of the following genotypes produces flies with white eyes and wild-type wings?
A. *w+w W+W*
B. *ww WW*
C. *ww W+W+*
D. *w+w+ WW*
E. *w+w WW*

Difficulty: Moderate

13. If an event is impossible, its probability is
A. 1.0
B. Greater than 0.95
C. Less than 0.5
D. Less than 0.05
E. Zero

Difficulty: Easy

14. If you draw one card from a standard deck of playing cards what is the probability of drawing a face card? (Face cards consist of kings, queens and jacks in each suit).
A. 1/52
B. 4/52
C. 8/52
D. 3/13
E. 81/52

Difficulty: Easy

15. There are 12 face cards in a deck of standard playing cards and 20 even numbered cards (2, 4, 6, 8, 10 in each suit). In one draw, what is the probability of drawing an even numbered card or a face card?
A. 0.231
B. 0.089
C. 0.385
D. 0.615
E. 1.000

Difficulty: Easy

16. There are 12 face cards in a deck of standard playing cards and 20 even numbered cards (2, 4, 6, 8, 10 in each suit). If you draw one card, look at it, then replace it and then draw another card, what is the probability that you would draw a face card and then an even numbered card?
A. 0.231
B. 0.089
C. 0.385
D. 0.615
E. 1.000

Difficulty: Easy

17. If it is possible for either event A or event B to happen, but both cannot happen simultaneously, the events are said to be
A. Mutually exclusive
B. Independent
C. Impossible
D. Improbable
E. Random

Difficulty: Easy

18. In *Drosophila melanogaster*:

allele	codes for	allele	codes for
st+	wild-type eye color	*W+*	wild-type wings
st	scarlet eye color	*W*	wrinkled wings

In the cross *st+st W+W* X *stst W+W,* of 2,000 offspring, how many will have scarlet eyes and wrinkled wings?
A. 125
B. 250
C. 375
D. 750
E. 1,125

Difficulty: Moderate

19. In humans, as in most mammals, albinism is inherited as a simple recessive trait. If a woman and her husband are both heterozygous for albinism, what is the probability that, if they have five children, the children will have these phenotypes?
Child 1 - albino, child 2 - normal, child 3 - normal, child 4 - albino, child 5 - normal?
A. 0.0010
B. 0.0264
C. 0.2373
D. 0.2500
E. 0.7500

Difficulty: Moderate

20. Which of the following is a true breeder?
A. Organism 1 = *AABBCCDD*
B. Organism 2 = *aabbccdd*
C. Organism 3 = *AAbbCCdd*
D. Organisms 1 and 2 only
E. All three organisms

Difficulty: Moderate

21. When studying a genetic cross, the second generation following the initial cross is identified by which of the following?
A. P generation
B. F_1
C. F_2
D. F_3
E. P_3

Difficulty: Easy

22. A true-breeding line of green pod pea plants is crossed with a true-breeding line of yellow pod plants. All of their offspring have green pods. From this information it can be stated that the green color is _____ to the yellow color.
A. Recessive
B. Dominant
C. Subservient
D. Blended
E. None of the answers are correct

Difficulty: Easy

23. When Mendel crossed two plants that were heterozygous for a single trait what was the phenotypic ratio of their offspring?
A. 1:2:1
B. 9:3:3:1
C. 3:1
D. 7:4
E. It varied depending on the trait

Difficulty: Easy

24. When Mendel crossed two plants that were heterozygous for a single trait what was the genotypic ratio of their offspring?
A. 1:2:1
B. 9:3:3:1
C. 3:1
D. 1:1
E. It varied depending on the trait

Difficulty: Easy

25. An individual who has two identical alleles for a trait is called
A. Haploid
B. Homozygous
C. Heterozygous
D. Isozygous
E. Hemizygous

Difficulty: Easy

Short Answer Questions

26. In Venusian warthogs, the following genes are known and these genes assort independently.

For feather color,	*S* produces paisley feathers,	*s* produces striped feathers
For the number of snouts,	*F* produces four,	*f* produces five

A male and female warthog are both heterozygous for both genes. The happy couple have 288 wartpiglets (prolific little things, aren't they?). Of those, how many would be expected to have paisley fur and five snouts?

54.

27. A Venusian warthog geneticist makes the following cross:

aa Bb Cc dd Ee Ff Gg hh X *Aa Bb Cc Dd Ee Ff gg Hh*

These genes assort independently.

This geneticist would like to obtain wartpiglets with *either* of the following genotypes (a blank after an allele means that it does not matter if the other allele is dominant or recessive):

A_ B_ C_ D_ E _ff gg hh **OR** *A_ bb Cc dd E _ff G_ hh*

33/4096 = 0.008.

28. For *Drosophila melanogaster* with the following genotype, list the possible gametes the fly can produce: *se+se bb ca+ca e+e+*

se+ b ca+ e+
se+ b ca e+
se b ca+ e+
se b ca e+.

 You have done an extensive experiment with *Drosophila melanogaster* in which you have investigated the inheritance of sepia eyes (*se*) vs. wild-type eyes (*se+*) and black body (*b*) vs. wild-type body (*b+*). In one cross you have obtained the following results:

se+se b+b X *sese b+b*

Offspring:		
	wild-type eyes, wild-type body	289
	wild-type eyes, black body	105
	sepia eyes, wild-type body	323
	sepia eyes, black body	90
	TOTAL	807

29. How many flies with sepia eyes and wild-type body should be expected from this cross?

303.

30. If you run a chi-square test to test for independence, what will the degrees of freedom be?

3.

31. In a chi-square test, what will the chi-square value be?

3.323.

32. In that chi-square test, the p value will lie between what two values?

0.2 and 0.5.

33. Can the null hypothesis of independence be rejected from these data?

No.

In tomatoes, the allele for tall plants (*D*) is dominant to that of dwarf plants (*d*), the allele for red fruit (*R*) is dominant to the allele for yellow fruit (*r*) and the allele for smooth stems (*H*) is dominant to the allele for hairy stems (*h*). You make the following cross:
Dd Rr Hh X *Dd rr Hh*
and obtain the following offspring:

Plant height	Fruit Color	Stems	
tall	red	smooth	248
tall	red	hairy	103
tall	yellow	smooth	280
tall	yellow	hairy	82
dwarf	red	smooth	100
dwarf	red	hairy	18
dwarf	yellow	smooth	75
dwarf	yellow	hairy	38

34. How many of these plants would be expected to be dwarf, red and smooth?

88.

35. How many of these plants would be expected to be tall, red and hairy?

88.

36. In a chi-square test, how many degrees of freedom will there be?

7.

37. In a chi-square test, what will be the chi-square value?

15.284.

38. In a chi-square test, the p value will lie between what two values?

0.05 and 0.01.

39. Can the null hypothesis be rejected in this experiment?

Yes.

40. In this experiment, the numbers of which phenotype came closest to the expected value?

tall, yellow and hairy.

Essay Questions

41. Gregor Mendel used peas to study inheritance. What would be the advantages of using an organism such as peas as opposed to, say humans?

Peas are inexpensive to grow, they have heritable variation, they are self-pollinating, their life cycle is short, they can produce a large number of progeny and people can do directed cross-breeding.

42. How do Mendel's laws of Segregation of Alleles and Independent Assortment of Genes differ?

Segregation of Alleles refers to the two copies of a single gene going into different reproductive cells at their formation. Independent Assortment of Genes is concerned with the alleles of two or more genes randomly going to various reproductive cells without regard to where the alleles of other genes go.

43. What is the difference between a test cross and a back cross?

In a back cross the F_1 hybrid is crossed back to one of its parents (or an organism with the same genotype as one of its parents). In a test cross, the F_1 hybrid is crossed to an organism that is homozygous recessive for all the genes in question. A back cross may be also be a test cross if the experiment is set up for that possibility.

44. In an experiment in which the null hypothesis is that two genes are assorting independently, you obtain a probability value of 0.20. It would be incorrect to say that the experiment proved that the null hypothesis was true. Why is that and what would be the correct way of expressing the meaning of the test?

No probability value of a chi-square test can prove that an hypothesis is correct, because more data might yield a p value of less than 0.05. The correct way of expressing the conclusion is "the chi-square test supports the null hypothesis" or "the null hypothesis cannot be rejected, based on the results of the chi-square test."

45. How do you think the assortment of two genes would be affected if they were very close to each other on the same chromosome?

This material has not yet been covered, but an insightful student should be able to guess that the two genes would not assort independently.