RLP-BIOA · RLP Biology A — Cells, Energy and Heredity

Unit 4: Inheritance and Variation of Traits

Practice Workbook. The same problems, in the same order, as the Practice sections of the online lessons.

Name _____ Period _____

Lesson 4.1 — Phenomenon: Why Do Corn Kernels Come in Ratios?

FLUENCY

1. In pea plants, where purple flowers (A) are dominant to white (a), and in a trait where A (dominant) masks a (recessive), cross AA × Aa. Give the genotype ratio and the probability of the dominant phenotype.

2. In corn, where purple kernels (A) are dominant to yellow (a), and in a trait where A (dominant) masks a (recessive), cross Aa × aa. Give the genotype ratio and the probability of the dominant phenotype.

3. In a hypothetical mouse population, where dark fur (A) is dominant to light fur (a), and in a trait where A (dominant) masks a (recessive), cross AA × aa. Give the genotype ratio and the probability of the dominant phenotype.

4. A body cell of a corn plant has 20 chromosomes. How many chromosomes are in its pollen (gametes)?

APPLICATION

5. In a hypothetical pedigree, two unaffected parents have a child with a recessive trait. What is the probability that their next child has the trait? That the next two children both have it?

6. In the same hypothetical family, an unaffected sibling wonders about being a carrier. What is the probability?

7. Mendel's F_2 peas had 6,022 yellow and 2,001 green seeds. Find the ratio and the expected counts under $3:1$.

CHALLENGE

8. Two parents heterozygous for two unlinked traits are crossed (AaBb × AaBb). What fraction of offspring show both recessive phenotypes, and what is the phenotype ratio?

9. A purple-kernel plant of unknown genotype is crossed with a yellow (pp) plant. Describe the two possible outcomes and what each tells you.

REVIEW

10. Transcribe and translate the template TAC GGA CTT CTC ATT.

Lesson 4.2 — Counting Kernels: Testing Mendel's Ratios With Chi-Square

FLUENCY

1. An ear from Pp × Pp has 400 kernels. Find the expected numbers of purple and yellow kernels.

2. A dihybrid ear (PpSs × PpSs) has 640 kernels. Find the expected count in each of the four phenotype classes.

3. How many degrees of freedom does a chi-square test have for (a) a 3 : 1 ratio and (b) a 9 : 3 : 3 : 1 ratio? Give the critical value at the 0.05 level for each.

APPLICATION

4. An ear has 362 purple and 138 yellow kernels. Test the 3 : 1 model with chi-square at the 0.05 level.

5. A dihybrid ear gives 298, 102, 74 and 38 kernels. Test the 9 : 3 : 3 : 1 model.

6. Mendel's yellow and green seeds (6,022 and 2,001) gave $\chi^2 \approx 0.015$. What does this tell you, and why do some statisticians find such close fits surprising?

CHALLENGE

7. An ear has 290 purple and 210 yellow kernels. Test 3 : 1 and then 1 : 1, and state which cross best explains the data.

REVIEW

8. In 250 root tip cells, 4 are in anaphase. Using a 24-hour cycle, estimate anaphase length in minutes.

Lesson 4.3 — Where Does New Variation Come From? The Meiosis and Mutation Argument

FLUENCY

1. How many chromosome combinations can independent assortment produce in gametes for an organism with 3 pairs of chromosomes?

2. How many combinations for 23 pairs (humans)?

3. Name the three sources of new heritable variation in HS-LS3-2.

4. Does crossing over happen in meiosis I or meiosis II?

APPLICATION

5. Two human parents each make 8,388,608 chromosome combinations in their gametes. How many combinations are possible in a child, before crossing over?

6. If about one uncorrected error occurs per billion bases copied, and a body cell copies about 6.2 billion bases before dividing, about how many new changes arise per division?

7. A chromosome carries AB and its homolog ab. Which gamete chromosomes are possible (a) without crossing over and (b) with one crossover between the genes?

CHALLENGE

8. Evaluate the claim: “Organisms mutate when they need to, so bacteria exposed to an antibiotic create resistance mutations.” Use what you know about the causes of mutation.

REVIEW

9. An ear from a test cross (Pp × pp) has 214 purple and 186 yellow kernels. Is it consistent with 1 : 1?

Lesson 4.4 — Continuous Variation: Measuring Bean Seeds

FLUENCY

1. For the data 3, 10, 10, 14, 15, 22, 31, 35, 36: find the mean, median, range and interquartile range. (Find the quartiles as the medians of the lower and upper halves, leaving out the overall median when the count is odd.)

2. For the data 8, 9, 16, 16, 22, 30, 32, 32, 40, 40: find the mean, median, range and interquartile range. (Find the quartiles as the medians of the lower and upper halves, leaving out the overall median when the count is odd.)

3. For the data 10, 12, 12, 16, 22, 25, 27, 37, 39, 39: find the mean, median, range and interquartile range. (Find the quartiles as the medians of the lower and upper halves, leaving out the overall median when the count is odd.)

4. In a two-gene additive model (AaBb × AaBb), give the ratio of offspring with 0, 1, 2, 3 and 4 adding alleles.

APPLICATION

5. Bean lengths have mean 15.15 mm and standard deviation 0.98 mm. Between which lengths do about 68% and about 95% of beans fall, if the distribution is roughly normal?

6. Illustrative data: sunny plants' beans average 15.94 mm (SD 0.45) and shady plants' beans 14.43 mm (SD 0.37), from the same seed stock. Find the difference in means and compare it with the SDs. What does it suggest?

7. In the three-gene model (AaBbCc × AaBbCc), what fraction of offspring are at either extreme (0 or 6 adding alleles)?

CHALLENGE

8. Plant height in a field of 200 corn plants is roughly normal with mean 165 cm and standard deviation 7 cm (illustrative). About how many plants are between 151 and 179 cm? Explain why a trait like this is almost always polygenic and environmental.

REVIEW

9. A pulse falls from 150 bpm to 110 bpm in 3 minutes after exercise, with a resting rate of 70 bpm. What percentage of the rise was recovered?

Unit 4 checkpoint

1. Which cross gives a 3 : 1 phenotype ratio?
   A. PP × pp
   B. Pp × Pp
   C. Pp × pp
   D. pp × pp
2. From Pp × Pp, an ear of 600 kernels should have about _____ yellow (pp) kernels.

3. Why does each gamete carry only one allele of each gene?
   A. Mitosis removes one allele
   B. Meiosis separates homologous chromosomes
   C. The recessive allele is destroyed
   D. Gametes are made before DNA is copied

4. Observed 140 purple and 60 yellow; expected 150 and 50. χ² = _____ (two decimals).

5. True or false: With 1 degree of freedom, a χ² of 2.67 means we reject the 3 : 1 model at the 0.05 level.

6. A 9 : 3 : 3 : 1 test has how many degrees of freedom?
   A. 1
   B. 2
   C. 3
   D. 4

7. Which mutation can be passed to offspring?
   A. A UV-caused mutation in a skin cell
   B. A mutation in a cell that becomes an egg or sperm
   C. A mutation in a muscle cell
   D. Any mutation

8. An organism with 5 pairs of chromosomes can make _____ combinations by independent assortment.

9. True or false: Crossing over occurs between homologous chromosomes during meiosis I.

10. A histogram of seed lengths shows a single, symmetric peak with many intermediate values. The best explanation is:
    A. One gene with complete dominance
    B. Many genes with small effects plus environmental effects
    C. A single mutation
    D. Measurement error only

11. In a normal distribution, about what percentage of values lie within one standard deviation of the mean?
    A. 50%
    B. 68%
    C. 95%
    D. 99.7%