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Example of solved examinatiiom tasks:

Task №1. A heterozygous pea plant that is tall with yellow seeds, *TtYy*, is allowed to self-fertilize. What is the probability that an offspring will be either tall with yellow seeds, tall with green seeds, or dwarf with yellow seeds?

Answer: This problem involves three mutually exclusive events, and sowe use the sum rule to solve it. First, we must calculate the individual probabilities for the three phenotypes. The outcome of the cross can be determined using a Punnett square.

Cross: *TtYy x TtYy*

♀ \ ♂	**TY**	**Ty**	**tY**	**ty**
TY	TTYY Tall, yellow	TTYy Tall, yellow	TtYY Tall, yellow	TtYy Tall, yellow
Ty	TTYy Tall, yellow	TTyy Tall, green	TtTy Tall, yellow	Ttyy Tall, green
tY	TtYY Tall, yellow	TtYY Tall, yellow	ttYY Dwarf, yellow	ttYy Dwarf, yellow
ty	TtYy Tall, yellow	Ttyy Tall, green	ttYy Dwarf, yellow	ttyy Dwarf, green

P tall with yellow seeds = 9/(9 + 3 + 3 + 1) = 9/16

P tall with green seeds = 3/(9 + 3 + 3 + 1) = 3/16

P dwarf with yellow seeds = 3/(9 + 3 + 3 + 1) = 3/16

Sum rule: 9/16 + 3/16 + 3/16 = 15/16 = 0.94 = 94%
We expect to get one of these three phenotypes 15/16, or 94%, of the time.

Task №2. As described in this chapter, a human disease known as cystic fibrosis is inherited as a recessive trait. Two unaffected individuals have a first child with the disease. What is the probability that their next two children will not have the disease?

Answer:

N = common allele
n = cystic fibrosis allele

♀ \ ♂	**N**	**n**
N	NN	Nn
n	Nn	nn

The probability of a single unaffected offspring is
P unaffected = 3/(3 + 1) = 3/4
To obtain the probability of getting two unaffected offspring in a row (i.e., in a specified order), we must apply the product rule.
3/4 × 3/4 = 9/16 = 0.56 = 56%
The chance that their next two children will be unaffected is 56%.
An unaffected couple has already produced an affected child. To be affected, the child must be homozygous for the disease allele and thus has inherited one copy from each parent. Therefore, because the parents are unaffected with the disease, we know that both of them must be heterozygous carriers for the recessive disease-causing allele. With this information, we can calculate the probability that they will produce an unaffected offspring. Using a Punnett square, this couple should produce a ratio of 3 unaffected : 1 affected offspring.

Task №3. A pea plant is heterozygous for three genes (*Tt Rr Yy*), where *T* =tall, *t* = dwarf, *R* = round seeds, *r* = wrinkled seeds, *Y* = yellow seeds, and *y* = green seeds. If this plant is self-fertilized, what are the predicted phenotypes of the offspring, and what fraction of the offspring will occur in each category?

Answer: You could solve this problem by constructing a large Punnett square and filling in the boxes. However, in this case, eight different male gametes and eight different female gametes are possible: *TRY*, *TRy*, *TrY*, *tRY*, *trY*, *Try*, *tRy*, and *try*. It would become rather tiresome to construct and fill in this Punnett square, which would contain 64 boxes. As an alternative, we can consider each gene separately and then algebraically combine them by multiplying together the expected phenotypic outcomes for each gene. In the cross *Tt Rr Yy* × *Tt Rr Yy*, the following

Punnett squares can be made for each gene:

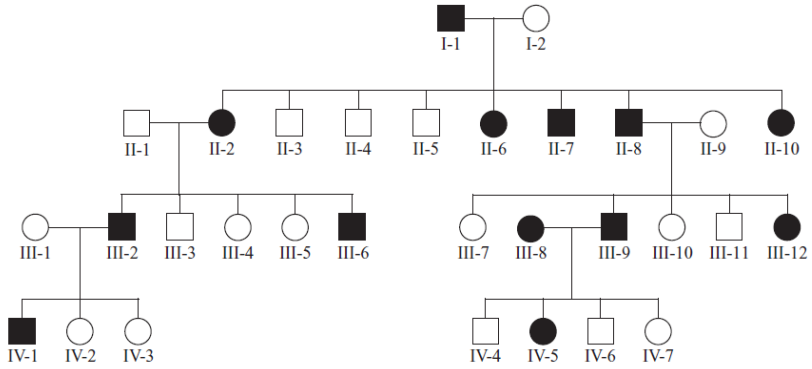
♀ \ ♂	**TRY**	**TRy**	**TrY**	**tRY**	**trY**	**Try**	**tRy**	**try**
TRY	TTRRYY	TTRRYy	TTRrYY	TtRRYY	TtRrYY	TTRrYy	TtRRYy	TtRrYy
TRy	TTRRYy	TTRRyy	TTRrYY	TtRRYy	TtRRYy	TTRryy	TtRRyy	TtRryy
TrY	TTRrYY	TTRrYy	TTRrYY	TtRrYY	TtrrYY	TTrrYy	TtRrYy	TtrrYy
tRY	TtRRYY	TtRRYy	TtRrYY	ttRRYY	ttRrYY	TtRrYy	ttRRYy	ttRrYy
trY	TtRrYY	TtRrYy	TtrrYY	ttRrYY	ttrrYY	TtrrYy	ttRrYy	ttrrYy
Try	TTRrYy	TTRryy	TTrrYy	TtRrYy	TtrrYy	TTrryy	TtRryy	Ttrryy
tRy	TtRRYy	TtRRyy	TtRrYy	ttRRYy	ttRrYy	TtRryy	ttRryy	ttRryy
try	TtRrYy	TtRrYy	TtrrYy	ttRrYy	ttrrYy	Ttrryy	ttRryy	ttrryy

Instead of constructing a large, 64-box Punnett square, we can use two similar ways to determine the phenotypic outcome of this trihybrid cross. In the multiplication method **,** we can simply multiply these three combinations together:
(3 tall +1 dwarf)(3 round + 1 wrinkled)(3 yellow + 1 green)
This multiplication operation can be done in a stepwise manner. First, multiply (3 tall + 1 dwarf) by (3 round + 1 wrinkled). (3 tall + 1 dwarf)(3 round + 1 wrinkled) = 9 tall, round + 3 tall, wrinkled + 3 dwarf, round, + 1 dwarf, wrinkled
Next, multiply this product by (3 yellow + 1 green).
(9 tall, round + 3 tall, wrinkled + 3 dwarf, round + 1 dwarf, wrinkled)
(3 yellow + 1 green) = 27 tall, round, yellow + 9 tall, round, green +
9 tall, wrinkled, yellow + 3 tall, wrinkled, green + 9 dwarf, round, yellow
+ 3 dwarf, round, green + 3 dwarf, wrinkled, yellow + 1 dwarf,
wrinkled, green
Even though the multiplication steps are also somewhat tedious, this approach is much easier than making a Punnett square with 64 boxes, filling them in, deducing each phenotype, and then adding them up!

Task №4. The pedigree shown below concerns a human disease known as familial hypercholesterolemia. This disorder is characterized by an elevation of serum cholesterol in the blood. Though relatively rare, this genetic abnormality can be a

contributing factor to heart attacks. At the molecular level, this disease is caused by a defective gene that encodes a protein called low- density lipoprotein receptor (LDLR). In the bloodstream, serum cholesterol is bound to a carrier protein known as low-density lipoprotein (LDL). LDL binds to LDLR so that cells can absorb cholesterol. When LDLR is defective, it becomes more difficult for the cells to absorb cholesterol.

This explains why the levels of LDL blood cholesterol remain high. Based on the pedigree, what is the most likely pattern of inheritance of this disorder?



Answer: The pedigree is consistent with a dominant pattern of inheritance. An affected individual always has an affected parent. Also, individuals III-8 and III-9, who are both affected, produced unaffected offspring. If this trait was recessive, two affected parents should always produce affected offspring. However, because the trait is dominant, two heterozygous parents can produce homozygous unaffected offspring.

The ability of two affected parents to have unaffected offspring is a striking characteristic of dominant inheritance. On average, we would expect that two heterozygous parents should produce 25% unaffected offspring. In the family containing IV-4, IV-5, IV-6, and IV-7, three out of four offspring are actually unaffected. This higher-than-expected proportion of unaffected offspring is not too surprising because the family is a very small group and may deviate substantially from the expected value due to random sampling error.

Task № 5. About 70 percent of all Caucasians can taste the chemical phenylthiocarbamide, and the remainder cannot. The ability to taste this chemical is determined by the dominant allele *T*, and the inability to taste is determined by the recessive allele *t*. If the population is assumed to be in Hardy–Weinberg equilibrium, what are the genotype and allele frequencies in this population?

Solution

Because 70 percent are tasters (*TT* and *Tt*), 30 percent must be nontasters (*tt*). This homozygous recessive frequency is equal to q^2; so, to obtain *q*, we simply take the square root of 0.30:

$q = \sqrt{0.30} = 0.55$

Because $p + q = 1$, we can write $p = 1 - q$; $1 - 0.55 = 0.45$.
Now we can calculate
$p^2 = (0.45)^2 = 0.20$, the frequency of *TT*
$2pq = 2 \times 0.45 \times 0.55 = 0.50$, the frequency of *Tt*
$q^2 = 0.3$, the frequency of *tt*.

Task № 6. A young 15 year old man has recurrent attacks of fever with an increase in temperature up to 40° C. He got ill, while being in one of the African countries with his parents. The patient has anemia, enlarged liver and spleen. What should be done to make the diagnosis? Is this patient an epidemic hazard in Krasnoyarsk?
Answer: For diagnosis it is necessary to conduct a study of blood smear. Presumably the patient has malaria. This patient is not an epidemic hazard in Krasnoyarsk because it is not habitat of malarias vector – Anopheles mosquito.

Task № 7. Employees of a pig farm with acute intestinal disorders were examined. What preliminary diagnosis can be made on the basis of their profession? Show one of the life forms of the parasite that can invade people of this profession.
Answer: Based on symptoms, it can be assumed balantidiasis disease. It relates to antpropozoonozis, pigs are also sick. Diagnosis is based on detection of balantidiums cysts. This stage is also invasive.

Task №8. High prevalence of enterobiasis was revealed in the children's group. Can the disease be got rid of without medical treatment? Which population groups are most susceptible to enterobiasis infection and why?
Answer: The enterobiasis disease causes pinworm. Most susceptible to disease children, as a way of infection - fecal-oral, and children are not accustomed to the rules of personal hygiene. Cures possible since the short life cycle of pinworms - 2 weeks, and if we exclude the re-infection, the disease disappears.

Task №9. What tapeworms can be transmitted using the same cutting boards for raw meat and foods that are not subject to heat treatment?
Answer: When used pork is possible pork tapeworm infection (*Taenia solium*). Infective stage - cysticerci. With the use of beef - bovine tapeworm (*Taenia saginata*), invasive stage - cysticerci. At the use of fish is possible infection fish tapeworm – diphyllobothriasis (*Diphyllobothrium latum*), invasive stage - plerocercoid.

Task №10. Geologists ate bear meat for a week. Ten days later, all felt bad. The disease occured acutely, with fever, muscle pains, swelling of the eyelids. What disease can be suspected? What test should be done to confirm the diagnosis?

Answer: Presumably it is trichinosis. To confirm the diagnosis it is necessary to conduct a biopsy of muscle (trichinelloscope). The diagnostic stage - larva in muscles. The way of infection - oral, alimentary.

Утверждены на заседании кафедрального совещания.

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