Computational Biomedicine
Bacterial Reproduction | Teacher guide

How Can Testing for Corona be Streamlined?

Structure of the unit

- Preliminary stage: Riddles
- Case study: The national enterprise to identify corona-positives in Slovakia
- Students in search of solutions
- Acquaintance with the pooling method to make screening for corona-positives more efficient
- Inquiry activity to examine the efficiency of the method in different epidemiological conditions
- Summary activity

Mathematical content in the unit

- Calculating ratios
- Calculating percentage
- Probability: There are no probability calculations in the unit, or any use of probability equations. In contrast, there is a simulation of a real situation that demonstrates a principle that sometimes contradicts our intuition: The results of an experiment don't always fit with the theoretical probability calculations. For example, if there are 2% corona-positives in the population, there will be population samples with no corona-positives at all, and population samples with more than 2% corona-positives.

Mathematical thinking

- Logical considerations with focus on elimination (finding the solution after eliminating all other possibilities).

Important Messages

Mathematics allows optimization- it can make processes more efficient through finding the best possible solution (in medical and health contexts as well).
Riddles are not only for fun: The idea that constructs the solution to a riddle can be the key to find breakthrough solutions to real problems.

Towards implementing the unit in class

A week before implementation: there are two riddles in the unit. It is recommended to introduce them to the students as homework a week before the first lesson. If the class has a forum, it is best to start with the first riddle. Two days later open the forum to students' suggestions for solutions, and after two more days introduce the second riddle.

Opening lesson: It is recommended to open the first lesson with the video telling the story about the national enterprise to identify corona-positives in Slovakia. Only then, continue to the riddles. The connection between the riddles and corona tests will be done later in the unit.

During the unit: A primary goal of the unit is to give the students the opportunity to think creatively on an unfamiliar problem while using logical considerations, offering their own solution in a simple language and examine other students' considerations. Therefore, it is important to learn in groups which allows many students to participate, and only after the students share their own ideas to introduce the method that was used before the rapid antigen tests were allowed.

A glimpse into Slovakia

In October ,2020 following a significant wave of morbidity during the COVID 19-pandemic ,an innovative idea for coping with the pandemic was proposed in Slovakia ,a small Central European country .At that stage ,there were still no vaccines for the Corona virus.

1. View the clip and respond:
   a. What was the Slovakian government's idea? What was the innovation in contrast to how they coped with the pandemic until then?
   b. Why didn't the Slovakians use PCR tests in the model they employed?

   Although the massive testing, COVID cases continued to rise in Slovakia. Some say this is since the tests did not spot all the carriers and yet people felt free to continue life as usual.

   c. In your opinion, did the Slovakian model indeed fail?

There are those who claim that in the future there will be another pandemic and we must prepare for it based on the world's experience during the COVID-19 pandemic. The assumption is that at the stage where there is still no vaccine for the virus causing the pandemic, isolating infected people is critical in order to flatten the morbidity curve. In this activity you will be asked to propose a method for a country to conduct tests for the virus according to the Slovakian model, but with greater efficiency.

We'll start with riddles

Teachers: The common principle of the riddle and the problem presented in the unit is the idea, that it is not necessary to weigh each coin separately to identify which coin is lighter, and in the same way it is not necessary to test each sample to identify the corona-positives. The difference is that in the riddle we know there is only one coin, but with the corona samples we don't know how many corona-positives there are.
It is important to give the riddles to the students as homework before they start learning the unit. The students would try to answer the riddles without linking them to the topic of the unit, and only in a later stage they would discuss the common principles between the riddle and the content of the unit.

2. Try to solve the following riddles:

B.

You have received **9** coins for examination. It is known that one of them is counterfeit (it is lighter). Suggest a way to discover the counterfeit coin by weighing them on the scale as few times as possible.

A.

You have received **3** coins for examination. It is known that one of them is counterfeit (it is lighter). Suggest a way to discover the counterfeit coin by weighing them on the scale as few times as possible.

Solution to the first riddle: Weighing is needed only once. We will put one coin on each scale arm. If one of them is lighter – then this is the counterfeit coin. If they are even – then the coin that was put aside is the lighter one.

Solution to the second riddle:
This time it is needed to weigh twice:

1. **We will put three coins on each scale arm. If one of the two arms is lighter than the counterfeit coin is among them. If the two arms are even, then the counterfeit coin is among the coins that were left aside.**
2. **Now we have three coins, one of which we are sure is the counterfeit coin. Therefore, we will weigh the same way as in the first riddle, and weighing only once is enough.**

We'll think of ideas while playing

An activity for two players (a player can be one student or a group of students)

With tests for Corona (and with other tests) there is the option to test pooled clusters of samples taken from a **group of subjects**, which are then mixed together.

If among the subjects tested there is not one person who is positive for Corona, **a negative answer is obtained**.

If a positive result is obtained, the conclusion is that among the subjects there is at least one person who is positive for Corona. From this test, it is impossible to know who that person is and so additional clarification is needed.

Our aim in this activity is to become familiar with an efficient method for identifying whether there is anyone positive for Corona and if so, who it is, without checking the entire population.

Teachers: the instructions to the game "Rapid Discovery" are written below.
A set of cards for the game can be found at the end of the unit. It contains marked cards to cut out for actor A, and a page with unmarked cards on which actor B can mark for themselves the answers received from actor A.
As mentioned in the instructions to the game, it is possible to play in parallel, like in the game "Submarines".
It is sufficient to give each pair of students a pair of cards. A pair of students that ends the game brings back the cards and receives a pair of new cards for another round.

Rapid discovery – A game for two players

Player A receives a card – A table representing a group of subjects tested for Corona, such as for example, in Illustration A. Every number in the table represents a tested subject. A red number represents a person positive for Corona.

Player B (or Group B) receives the same table but without any markings to indicate those positive for Corona, and on the card they write information that will help them locate the Corona-positives.

The role of Player B is to discover all the positives in the sample held by Player A in as few steps as possible.

.

Note: The players can play two roles in parallel, like in the game Battleship, and to compete to be the first to discover the positives.

1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	16

Illustration B

1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	16

Illustration A

In each move, Player B asks if there is anyone positive for Corona in a group of subjects, and is answered with a "yes" or a "no."

Each question Player B asks is counted. When Player B knows everyone who is positive for Corona, they announce it.

If they correctly identify all the positives and do not identify any healthy subject as positive, the player earns points:

The player's points are the number of tests saved: 16 minus the number of questions asked until discovery of all the Corona-positive.

Then, places are switched and the game begins again with a new card containing subjects verified for Corona.

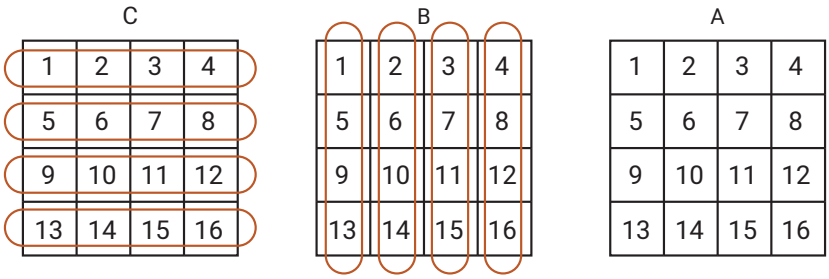
Equipment:

- A set of cards for Player A. Each card has a 16-cell table representing the results of subjects tested. Cells where the number appears in red represent Corona-positive subjects in the sample, as in Illustration A.
- Writing implements and auxiliary tables for Player B, as in Illustration B.

3. a. How did you reduce the number of questions in order to discover those positive for Corona3
   b. Describe the relationship between the method you used to discover the Corona-positive subjects and a possible method for making Corona tests more efficient.
   c. Describe the relationship between the game you played and the solution to the coins riddle.

Pooling using the crisscross method (table method)

In this method, the samples are arranged in a square structure (square table).
In each test cluster, all the tests of the samples in the same column or all the tests from the same row are mixed into one test tube. We will call this test a consolidated test.
The consolidated tests are examined using the PCR method. Due to this method's sensitivity to even a tiny amount of the viral DNA, the material taken from one person can be introduced into more than one test tube.
If the result of the consolidated test of several subjects tested for Corona is negative, no one infected among them since there is no viral DNA in the test.
If the result of the consolidated test is positive it attests to the presence of at least one of the subjects being positive for Corona and as such, additional steps must be taken in order to discover the infected subject(s).
During the activity, we will study how and under what conditions is it possible to effectively use the crisscross method, and also how to calculate the percentage of tests saved.



Which test tubes will be marked for testing?

In this example, samples from 64 people are arranged in a square table..

1	2	3	4	5	6	7	8
9	10	11	12	13	14	15	16
17	18	19	20	21	22	23	24
25	26	**27**	28	**29**	30	31	32
33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48
49	50	**51**	52	**53**	54	55	56
57	58	59	60	61	62	63	64

4

1	2	3	4	5	6	7	**8**
9	10	11	12	13	14	15	16
17	18	19	20	21	**22**	23	24
25	26	27	28	29	30	31	32
33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48
49	50	51	52	53	54	55	56
57	58	59	60	61	62	63	64

3

1	2	3	4	5	6	7	8
9	10	11	12	13	14	15	16
17	18	19	20	21	22	23	24
25	26	**27**	28	**29**	30	31	32
33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48
49	50	**51**	52	53	54	55	56
57	58	59	60	61	62	63	64

2

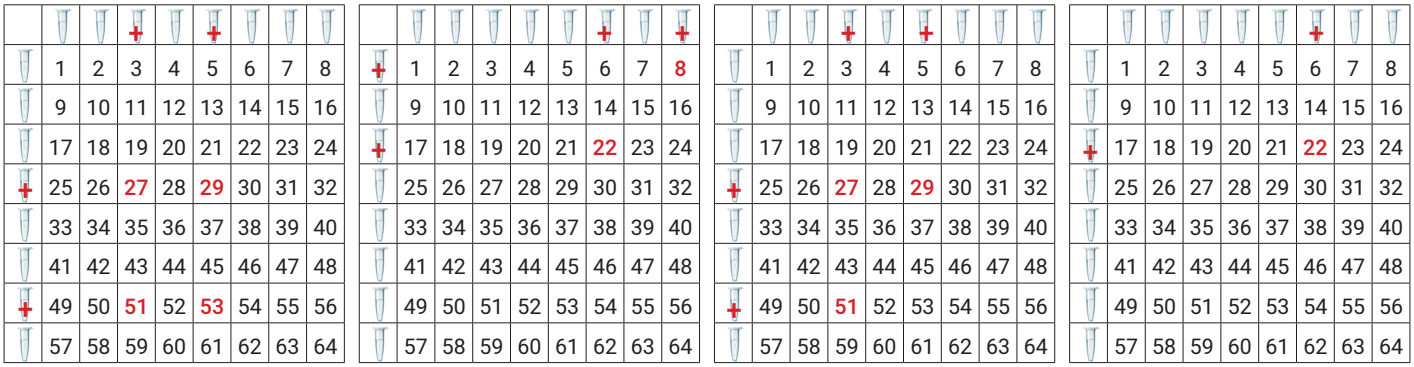
1	2	3	4	5	6	7	8
9	10	11	12	13	14	15	16
17	18	19	20	21	**22**	23	24
25	26	27	28	29	30	31	32
33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48
49	50	51	52	53	54	55	56
57	58	59	60	61	62	63	64

1

The **numbers in red** represent people who are positive for Corona.
Each test tube icon in the top **row** of the table represents a joint test of the entire column beneath it.
Each test tube in the most left-hand **column** of the table represents a joint test of the entire row to the right of it.

4. a. Assuming that the test identifies each consolidated test in which at least one of the subjects is positive for Corona – in which test tubes will a positive result be seen?

Solutions



			+		+		
	1	2	3	4	5	6	7	8
	9	10	11	12	13	14	15	16
	17	18	19	20	21	22	23	24
+	25	26	27	28	29	30	31	32
	33	34	35	36	37	38	39	40
	41	42	43	44	45	46	47	48
+	49	50	51	52	53	54	55	56
	57	58	59	60	61	62	63	64

4

						+		+
+	1	2	3	4	5	6	7	8
	9	10	11	12	13	14	15	16
+	17	18	19	20	21	22	23	24
	25	26	27	28	29	30	31	32
	33	34	35	36	37	38	39	40
	41	42	43	44	45	46	47	48
	49	50	51	52	53	54	55	56
	57	58	59	60	61	62	63	64

3

			+		+			
	1	2	3	4	5	6	7	8
	9	10	11	12	13	14	15	16
	17	18	19	20	21	22	23	24
+	25	26	27	28	29	30	31	32
	33	34	35	36	37	38	39	40
	41	42	43	44	45	46	47	48
+	49	50	51	52	53	54	55	56
	57	58	59	60	61	62	63	64

2

						+		
	1	2	3	4	5	6	7	8
	9	10	11	12	13	14	15	16
+	17	18	19	20	21	22	23	24
	25	26	27	28	29	30	31	32
	33	34	35	36	37	38	39	40
	41	42	43	44	45	46	47	48
	49	50	51	52	53	54	55	56
	57	58	59	60	61	62	63	64

1

b. Identify a pair of illustrations for which, despite the differences in the subjects testing positive for the virus, the pooling test tubes show the same result.

Illustrations 2 and 4. These illustrations demonstrate that it isn't possible in every case to learn unequivocally from the tests which of the samples are the corona-positives and which are not.

We checked consolidated tests using the pooling method – what can be learned from this, and what more needs to be done?

In the following examples, we will present situations in which a test allows the unequivocal determination of whether there are subjects positive for Corona among the 64 patients checked, and who they are, in contrast with situations where there is a need for several additional tests in order to complete the process.

5. a. Look at the groups of subjects in the preceding question. For which of them does the pooling procedure make it possible to determine, unequivocally, who is Corona-positive?
Illustration 1 makes it possible to determine, unequivocally, that the only corona-positive sample in this table is number 22, since only its position is shared by a row and a column that resulted positive in the test.

b. In the following illustrations the results received are presented for the pooled test tubes in the structure with 64 individual samples. A red test tube means that in the pooled test, a row or a column was discovered to contain at least one Corona-positive subject.

On each one of the following illustrations:

Mark all the samples of people who are definitely negative for Corona with a "-" (or with a marker).

Mark all the samples of people who are definitely positive for Corona with a "+" (or with a marker).

Mark all the samples for which it is not possible to draw a conclusion from the existing data and there is a need to re-test with a "?" (or with a marker).

	1	2	3	4	5	6	7	8
	9	10	11	12	13	14	15	16
	17	18	19	20	21	22	23	24
	25	26	27	28	29	30	31	32
	33	34	35	36	37	38	39	40
	41	42	43	44	45	46	47	48
	49	50	51	52	53	54	55	56
	57	58	59	60	61	62	63	64

2

	1	2	3	4	5	6	7	8
	9	10	11	12	13	14	15	16
	17	18	19	20	21	22	23	24
	25	26	27	28	29	30	31	32
	33	34	35	36	37	38	39	40
	41	42	43	44	45	46	47	48
	49	50	51	52	53	54	55	56
	57	58	59	60	61	62	63	64

1

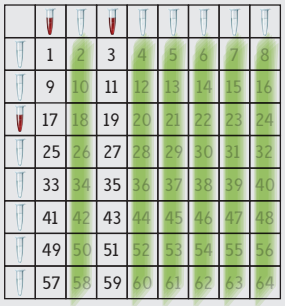
Answer:

In this case, it is possible to conclude that samples 17 and 19 are corona-positive, and all the others are corona-negative.

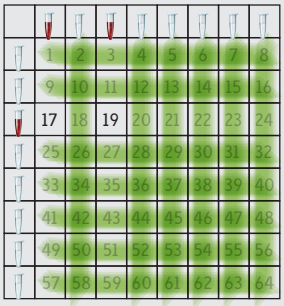
Short explanation: The only row where there is a positive result is the third from above, and the only ones in that row that can be corona-positive are the ones in the columns that were also positive to the test. These are numbers 17 and 19. We know they are both positive since if only one of them was positive then only one column would be tested positive.

	1	2	3	4	5	6	7	8
	9	10	11	12	13	14	15	16
	17	18	19	20	21	22	23	24
	25	26	27	28	29	30	31	32
	33	34	35	36	37	38	39	40
	41	42	43	44	45	46	47	48
	49	50	51	52	53	54	55	56
	57	58	59	60	61	62	63	64

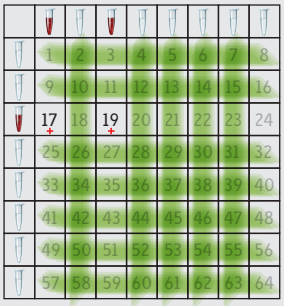
Teachers: A detailed visual explanation of the process that can be performed with the students



First step
A blue test tube in the head of a column indicates unequivocally that in this column there are no corona-positive samples. We can erase all the cells in these columns.

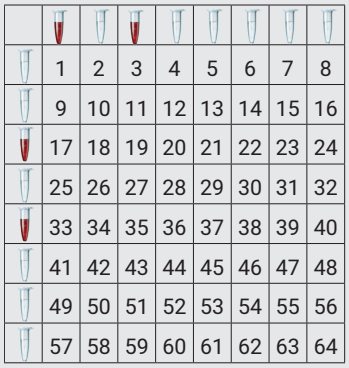


Second step
In the same way we can erase all the cells in rows with blue test tubes.

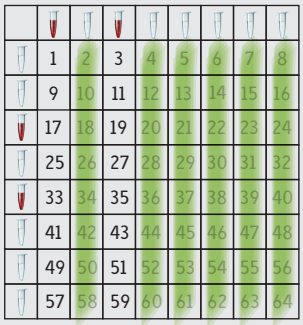


Third step
Only two cells were not erased/How can we know that they both represent corona-positives? If only one of them was positive then only one column would be tested positive

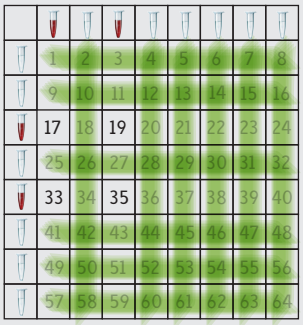
It is important to note that the two samples in question" b "are very similar .The only difference between them is that in the second sample there was a positive result in the fifth row as well.
In this case ,we can be sure that in a row or a column with a blue test tube there are no corona-positive samples .But we have no way to know which of the suspected samples in the third row and which of the suspected samples in the fifth row are corona-positive ,and therefore some more investigation is needed.



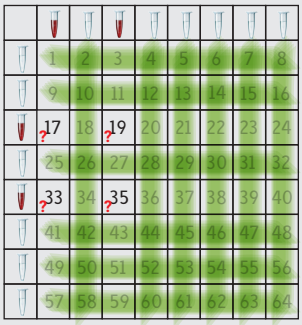
A detailed explanation:



First step
This step is identical to the first step in the former example: A blue test tube in the head of a column indicates unequivocally that in this column there are no corona-positive samples. We can erase all the cells in these columns.



Second step
This step is identical to the second step in the former example: In the same way we can erase all the cells in rows with blue test tubes. This time there are two rows in which one of the samples is corona-positive.



Third step
There are four unmarked cells left. We can be certain that there are at least two corona-positive samples that are not from the same row, but we cannot determine which they are. In addition, there might be three of them that are corona-positive, or even all of them.

c. For each one the following illustrations, determine:
Is it possible to unequivocally determine how many Corona-positives there are among the 64 people tested?
If so, which ones are they?
If not, what other tests should be performed in order to identify with certainty all those positive for Corona?
Tip: You can first mark or highlight all the subjects who are definitely negative for Corona.

Of all the rows, there is a positive test only in the third row. Therefore, only in this row there is a corona-positive sample. The immediate suspected samples are numbers 17, 19 and 21.

It isn't possible that one of them is corona-negative, since if that were the case then one of the columns should have been negative. Therefore, we can be certain that the only corona-positives are numbers 17, 19 and 21.

	1	2	3	4	5	6	7	8
	9	10	11	12	13	14	15	16
	17	18	19	20	21	**22**	23	24
	25	26	27	28	29	30	31	32
	33	34	35	36	37	38	39	40
	41	42	43	44	45	46	47	48
	49	50	51	52	53	54	55	56
	57	58	59	60	61	62	63	64

In this example we cannot be certain which numbers are corona-positive. It is only possible to know that there is a possibility that numbers 17, 19, 25 and 27 are corona-positive and should be tested separately.

	1	2	3	4	5	6	7	8
	9	10	11	12	13	14	15	16
	17	18	19	20	21	**22**	23	24
	25	26	27	28	29	30	31	32
	33	34	35	36	37	38	39	40
	41	42	43	44	45	46	47	48
	49	50	51	52	53	54	55	56
	57	58	59	60	61	62	63	64

In this example we cannot be certain which numbers are corona-positive. It is only possible to know that there is a possibility that numbers 17, 19, 49, 51, 57 and 59 are corona-positive and should be tested separately.

	1	2	3	4	5	6	7	8
	9	10	11	12	13	14	15	16
	17	18	19	20	21	**22**	23	24
	25	26	27	28	29	30	31	32
	33	34	35	36	37	38	39	40
	41	42	43	44	45	46	47	48
	49	50	51	52	53	54	55	56
	57	58	59	60	61	62	63	64

For additional thought:

d. One of the illustrations below describes a result which cannot be obtained through a pooling procedure. Identify the illustration and explain why it describes a situation that doesn't exist in reality.

	1	2	3	4	5	6	7	8
	9	10	11	12	13	14	15	16
	17	18	19	20	21	22	23	24
	25	26	27	28	29	30	31	32
	33	34	35	36	37	38	39	40
	41	42	43	44	45	46	47	48
	49	50	51	52	53	54	55	56
	57	58	59	60	61	62	63	64

2

	1	2	3	4	5	6	7	8
	9	10	11	12	13	14	15	16
	17	18	19	20	21	**22**	23	24
	25	26	27	28	29	30	31	32
	33	34	35	36	37	38	39	40
	41	42	43	44	45	46	47	48
	49	50	51	52	53	54	55	56
	57	58	59	60	61	62	63	64

1

Illustration 1 describes a result which cannot be obtained through a pooling procedure: If there is no positive test result in any of the columns, then there are no corona-positives in the whole sample, and there cannot be positive test results in any of the rows either. Illustration 2 describes a result that can be obtained.

e. Does a test using the pooling procedure, in which all the results of the consolidations are positive, attest to all the subjects being positive for Corona (assuming there are no errors in the test)? **No**
If so, explain why.

If not, provide an example of a table of samples in which the tests of all the pooled results are positive and yet only some of the subjects are positive for Corona.

For example, in a situation where all the tests in the slant of the table from left to right are corona-positive and all the others are corona-negative, all the test tubes will test positive.

A savings plan

In the following table, the numbers in red represent Corona-positive people.

	1	2	3	4	5	6	7	8
	9	10	11	12	13	14	15	16
	17	18	19	20	21	22	23	24
	25	26	27	28	29	30	31	32
	33	34	35	36	37	38	39	40
	41	42	43	44	45	46	47	48
	49	50	51	52	53	54	55	56
	57	58	59	60	61	62	63	64

6. Answer the questions assuming that the test identifies each consolidated test in which at least one of the subjects is positive for Corona.
   a. Which group samples (tubes) will show positive results?
   Answer: see (+) marks in the table

			+		+	+		
	1	2	3	4	5	6	7	8
+	9	10	11	12	13	14	15	16
	17	18	19	20	21	22	23	24
+	25	26	27	28	29	30	31	32
	33	34	35	36	37	38	39	40
	41	42	43	44	45	46	47	48
	49	50	51	52	53	54	55	56
	57	58	59	60	61	62	63	64

   b. Will the result make it possible to unequivocally identify those positive for Corona or will there be a need for additional tests?
   The result will not make it possible: It will be necessary to test separately the samples of numbers 11, 13, 14, 27, 29 and 30 – those that in their row, and in their column, there is at least one corona-positive result.
   c. How many tests will be required until all those positive for Corona in this sample can be unequivocally identified?
   8 tests for columns, 8 tests for the rows, and 6 separate tests. Altogether – 22 tests.
   d. What percentage of tests was saved?
   42 tests were saved, and in percentage: $\frac{42 \text{ X } 100}{64} = 65.5\%$

In the illustrations below groups of subjects tested for Corona are represented on a table of 10 rows x 10 columns.
The samples were produced by a computer program which simulates random samples corresponding to the percentage of those positive in the population.
The examples below simulate a situation in which the percentage of Corona-positive in the population is 3%.

7. For each of the samples:
   a. Mark a "+" above each column in which a consolidated test (a combined-samples test) of the subjects in that column will show a Corona-positive result.
   b. After checking all of the consolidated columns, is there a need for additional consolidated tests?
      If not, explain why.

      If so, write a "+" next to each row in which a consolidated test of that row's subjects will show a Corona-positive result.
   c. After checking all of the consolidated columns and all of the rows, is there a need for additional tests?
      If not, explain why.

      If so, note how many additional tests must be performed in order to know which are positive for Corona among the 100 subjects in the sample.
   d. Complete the table below and calculate the percentage of tests that were saved as a result of using the pooling procedure.

The answers to all of the above questions are in the following table:

Sample number	No. of subjects	Savings in percent	Total tests	No. of addt'l tests	Alerts in rows	Rows tested	Alerts in column	Columns tested
1	100	10	2	10	2	4	24	76% (76 out of 100) Example
2	**100**	**10**	**4**	**10**	**5**	**20**	**40**	**60%**
3	**100**	**10**	**1**	**10**	**1**	**0**	**20**	**80%**
4	**100**	**10**	**4**	**10**	**3**	**12**	**32**	**68%**
5	**100**	**10**	**0**	**0**	**0**	**0**	**10**	**90%**
Total	**500**						**126**	$\frac{(500-126)\ X\ 100}{500} = 74.8\%$

Sampel No. 1

	A	B	C	D	E	F	G	H	I	J	
		+	+								
+	-	+	-	-	-	-	-	-	-	-	A
	-	-	-	-	-	-	-	-	-	-	B
	-	-	-	-	-	-	-	-	-	-	C
	-	-	-	-	-	-	-	-	-	-	D
	-	-	-	-	-	-	-	-	-	-	E
	-	-	-	-	-	-	-	-	-	-	F
+	-	-	+	-	-	-	-	-	-	-	G
	-	-	-	-	-	-	-	-	-	-	H
	-	-	-	-	-	-	-	-	-	-	I
	-	-	-	-	-	-	-	-	-	-	J

Sampel No. 2

	A	B	C	D	E	F	G	H	I	J	
					+	+	+	+			
	-	-	-	-	-	-	-	-	-	-	A
+	-	-	-	-	-	+	+	-	-	-	B
	-	-	-	-	+	-	-	-	-	-	C
+	-	-	-	-	-	-	-	-	-	-	D
	-	-	-	-	+	-	-	-	-	-	E
+	-	-	-	-	-	-	-	-	-	-	F
+	-	-	-	-	-	-	-	+	-	-	G
	-	-	-	-	-	-	-	-	-	-	H
	-	-	-	-	-	-	-	-	-	-	I
+	-	-	-	-	-	-	-	+	-	-	J

Sampel No. 3

A	B	C	D	E	F	G	H	I	J	
-	-	-	-	-	-	-	-	-	+	A
-	-	-	-	-	-	-	-	-	-	B
-	-	-	-	-	-	-	-	-	-	C
-	-	-	-	-	-	-	-	-	-	D
-	-	-	-	-	-	-	-	-	-	E
-	-	-	-	-	-	-	-	-	-	F
-	-	-	-	-	-	-	-	-	-	G
-	-	-	-	-	-	-	-	-	-	H
-	-	-	-	-	-	-	-	-	-	I
-	-	-	-	-	-	-	-	-	-	J

Sampel No. 4

A	B	C	D	E	F	G	H	I	J	
-	-	-	-	-	-	-	-	-	-	A
-	-	+	-	+	-	-	-	-	-	B
-	-	-	-	-	-	-	-	-	-	C
-	-	-	-	-	-	-	-	-	-	D
-	-	-	-	-	-	-	-	-	-	E
-	-	-	-	-	-	-	+	-	-	F
-	-	-	-	-	-	-	-	-	-	G
-	-	-	-	-	-	-	-	-	+	H
-	-	-	-	-	-	-	-	-	-	I
-	-	-	-	-	-	-	-	-	-	J

Sampel No. 5

A	B	C	D	E	F	G	H	I	J	
-	-	-	-	-	-	-	-	-	-	A
-	-	-	-	-	-	-	-	-	-	B
-	-	-	-	-	-	-	-	-	-	C
-	-	-	-	-	-	-	-	-	-	D
-	-	-	-	-	-	-	-	-	-	E
-	-	-	-	-	-	-	-	-	-	F
-	-	-	-	-	-	-	-	-	-	G
-	-	-	-	-	-	-	-	-	-	H
-	-	-	-	-	-	-	-	-	-	I
-	-	-	-	-	-	-	-	-	-	J

We will use the computer in order to estimate the efficiency of this method with a large number of groups of subjects.

Teachers:

This activity is based on two Excell files:

Students' file, which includes a tab "Sampled 10X10 pooled tests". This file creates different samples according to the percentage of Corona carriers in the population.

Teachers' file, which includes two tabs:

"Sampled 10X10 pooled tests": the information in each cell shows whether the sample of that person is corona-negative or corona-positive.

" Alerts 10X10 pooled tests": shows the rows and columns in which there was at least one corona-positive test. This data is closer to the real data received by test pooling, where the tester doesn't know which of the tests in a column or a row is the positive one. This tab offers additional exercise in the decision-making process which of the samples require additional tests, and can serve as a deepening activity, according to the teacher's considerations.

Open the Excel sheet.
Select the “sample 10x10 tests pooled tests” tab
In the box: Percentage of Infected in Population, select 3% and click.
You will receive an additional sample of subjects beneath which is a table similar to the one you completed.
Copy the row to your table.
Repeat this 25 times. To receive a new sample, once again, select 3% and click.
Finally, calculate the cumulative savings in percentages.

Percentage of Infected in Population (Choose from the list)

3

	J	I	H	G	F	E	D	C	B	A
1	-	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	+	-	-
3	-	-	-	-	-	-	-	-	-	-
4	-	-	+	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-	-
6	-	-	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-	-	-
8	+	-	-	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-	-	-	-
10	-	-	-	-	+	-	-	-	-	-

Data Summary

Pool	subjects	percentage of infected	No. of colomns checked	No. of alerts in colomns	No. of lines checked	No. of alerts in rows	No. of clarification tests	Total No. of tests	Savings precentage
1	100	3	10	4	10	4	16	36	64%

Table to be completed – first row as an example

Sample number	No. of subjects	Savings in percent	Total tests	No. of addt'l tests	Alerts in rows	Rows tested	Alerts in column	Columns tested
1	100	10	2	10	2	4	24	76% (76 out of 100)
2	100							
3	100							
4	100							
5	100							
6	100							
7	100							
8	100							
9	100							
10	100							
11	100							
12	100							
13	100							
14	100							
15	100							
16	100							
17	100							
18	100							
19	100							
20	100							
21	100							
22	100							
23	100							
24	100							
25	100							
Total	**2,500**							

How does the efficiency of the test change as a function of the percentage of morbidity? – Inquiry activity

At the beginning of the activity, we encountered various situations in which there was a need to streamline the Corona tests.

We became familiar with a procedure to obtain information about a large number of subjects without checking each sample separately.

In this part, we will conduct an inquiry activity that will help us to provide information to decision-makers, dealing with different situations of morbidity, information that will help them in their deliberations. Divide into groups, with each group choosing a different percentage of morbidity, and collect your data in the table.

Percentage of morbidity: _____

Sample number	No. of subjects	Savings in percent	Total tests	No. of additional tests	Alerts in rows	Rows tested	Alerts in column	Columns tested
1	100							
2	100							
3	100							
4	100							
5	100							
6	100							
7	100							
8	100							
9	100							
10	100							
11	100							
12	100							
13	100							
14	100							
15	100							
16	100							
17	100							
18	100							
19	100							
20	100							
21	100							
22	100							
23	100							
24	100							
25	100							
Total	**2,500**							

Learning from experience to prepare for the next pandemic

The knowledge you acquired in the activity on pooling procedures for testing can help governmental authorities to much more efficiently handle morbidity in the next pandemic.

This video clip presents an interview with Israelis developing Corona tests while thinking about the future.

8. Suggest a way in which a country would be able to carry out tests for a virus using the Slovakian method, but more efficiently. As is fitting for scientists who understand the complexity of reality in a pandemic, make the following clear to the decision-makers:
    a. The stages of the model you are proposing.
    b. Why the model will be more effective than the one carried out in Slovakia.
    c. The type of test on which the model will rely.
    d. The limitations of the model: To which situations of the pandemic's spread will the model you are proposing be appropriate, and when, in your opinion, will it be less appropriate?

Your recommendation can be in the form of a video, a presentation, or any other creative way you choose so as to garner the decision-makers' attention for the model you are proposing.

Unmarked game cards for actor B

1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
5	6	7	8	5	6	7	8	5	6	7	8	5	6	7	8
9	10	11	12	9	10	11	12	9	10	11	12	9	10	11	12
13	14	15	16	13	14	15	16	13	14	15	16	13	14	15	16

1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
5	6	7	8	5	6	7	8	5	6	7	8	5	6	7	8
9	10	11	12	9	10	11	12	9	10	11	12	9	10	11	12
13	14	15	16	13	14	15	16	13	14	15	16	13	14	15	16

1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
5	6	7	8	5	6	7	8	5	6	7	8	5	6	7	8
9	10	11	12	9	10	11	12	9	10	11	12	9	10	11	12
13	14	15	16	13	14	15	16	13	14	15	16	13	14	15	16

1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
5	6	7	8	5	6	7	8	5	6	7	8	5	6	7	8
9	10	11	12	9	10	11	12	9	10	11	12	9	10	11	12
13	14	15	16	13	14	15	16	13	14	15	16	13	14	15	16

1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
5	6	7	8	5	6	7	8	5	6	7	8	5	6	7	8
9	10	11	12	9	10	11	12	9	10	11	12	9	10	11	12
13	14	15	16	13	14	15	16	13	14	15	16	13	14	15	16

Series of game cards for actor A

1	2	3	4
5	**6**	7	8
9	**10**	11	12
13	14	15	16

1	**2**	3	4
5	6	7	8
9	10	**11**	12
13	14	15	16

1	2	3	4
5	6	**7**	8
9	10	11	12
13	14	15	16

1	2	**3**	4
5	**6**	7	8
9	10	11	12
13	14	**15**	16

1	2	3	4
5	6	7	8
9	10	11	12
13	**14**	15	16

1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	**16**

1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	16

1	2	3	4
5	**6**	7	8
9	**10**	**11**	12
13	14	15	16

1	2	3	4
5	6	7	**8**
9	10	11	12
13	14	15	16

1	2	3	**4**
5	6	7	8
9	10	11	12
13	**14**	15	16

1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	16

1	2	3	4
5	**6**	7	8
9	**10**	**11**	12
13	14	15	16

1	**2**	3	4
5	6	7	**8**
9	10	11	12
13	14	15	16

1	2	3	4
5	6	7	8
9	**10**	11	12
13	14	15	**16**

1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	16

1	2	**3**	4
5	**6**	7	8
9	10	11	12
13	14	**15**	16

1	2	3	4
5	6	7	**8**
9	10	11	12
13	14	15	16

Series of game cards for actor A - continuation

1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	16

1	2	3	**4**
5	6	7	8
9	10	11	12
13	14	15	16

1	2	3	4
5	6	7	8
9	10	11	**12**
13	14	15	16

1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	16

1	2	3	4
5	6	7	8
9	10	11	12
13	14	**15**	16

1	2	3	4
5	6	7	8
9	10	11	**12**
13	14	15	**16**

1	**2**	3	4
5	6	7	8
9	10	11	12
13	14	15	16

1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	16

1	2	3	**4**
5	6	**7**	8
9	10	11	12
13	14	15	16

1	2	3	4
5	6	7	8
9	**10**	11	12
13	14	15	16

1	2	3	4
5	**6**	7	8
9	10	**11**	12
13	14	15	16

1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	16

1	**2**	3	4
5	6	7	8
9	10	11	12
13	**14**	15	16

1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	16

1	**2**	3	4
5	6	7	**8**
9	10	11	12
13	14	15	16

1	2	**3**	4
5	6	7	8
9	10	11	12
13	14	**15**	16

1	2	**3**	4
5	6	7	8
9	10	11	12
13	14	15	16