Round summary:

Select a **scenario** card.

Deal **risk** cards to all players.
(1st round 6, following rounds 1 card)
Players choose the best fitting **risk** card.
Players show and **explain** their card.
Players vote on the best **risk** card.
Winning player collects a **point token**.
Place the chosen **risk** card next to the **scenario** card.

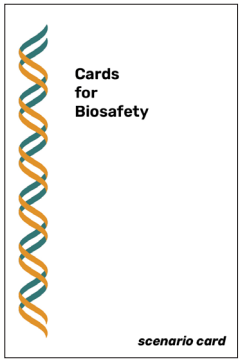
Deal **measure** cards to all players.
(1st round 6, following 1 card)
Players choose the best fitting **measure** card.
Players show and **explain** their choices.
Players vote on the best **measure** card.
Winning player collects a **point token**.
Place the chosen **measure** with the **scenario** and **risk**.

Discuss round.
Repeat.

Scenario explainer

You can find information on scenario cards in this booklet. Some of the scenarios are further explained. If needed, you can use the information to explain the scenario to your players.
We advise to wait until after you played the round to allow players to think of broader risks.

Make sure all your players understand the scenario equally.



1. Fundamental lab research on mutations in the SARS-CoV-2 virus

To better understand mechanisms and impact of mutations in the SARS-CoV-2 virus spike protein that will help in developing new effective vaccines in the future.

So far, mutants of the SARS-CoV-2 virus do not seem to affect the effectiveness of available vaccines (07-01-2021). These vaccines, however, are designed for triggering the immune system after recognition of a specific spike protein. New mutants may cause changes in the viral spike protein, resulting in a virus-vaccine mismatch, which can lead to reduced vaccine effectiveness. Better understanding of the mechanisms that lead to and effects of mutations in the SARS-CoV-2 virus could help to anticipate rapid design of new vaccines

Source: *The Conversation. (2020, December 22). What a Mutating Coronavirus Means for Vaccine Effectiveness. Snopes. https://www.snopes.com/news/2020/12/22/what-a-mutating-coronavirus-means-for-vaccine-effectiveness/*

18. Sensitive communication of high risk experiment results via email

During international collaboration, techniques and results are communicated via email. These technique and results include high-risk laboratory experiments at BSL-3 level.

As part of an international collaboration, in which experiments are carried out in a high-risk laboratory at BSL-3 level, techniques and results are mainly communicated via email. This is performed both with colleagues within and outside of the organisation.

17. Fire department starts extinguishing fire without lab supervision

The fire department is dispatched in the middle of the night after the fire alarm went off. They start fire extinguishing procedures immediately.

The supervisor is not present when the fire department start their work. The fire department does not know what items are stored or tested on in the lab or how to handle them.

2. Modification of bacteria for degradation of PET in the environment

To help solving world-wide pollution of oceans with macro and micro plastics.

We produce about 360 million tons of plastic every year (2018), creating one of the world's biggest environmental problems – plastic pollution. A vast part of this pollution consists of PET (Polyethylene Terephthalate) wrappers and bottles. Since PET is non-biodegradable it accumulates in the environment.
In 2016 Japanese biologists newly discovered Ideonella sakaiensis 201-F6, a bacterium that secretes PETase (PET-digesting enzyme), which allows the bacterium to grow on PET as a major carbon and energy source. By genetically modifying the PETase active site to make it more like a cutinase -an enzyme that breaks cutine molecules (waxy polymers) and releases monomers and oligomers- researchers managed to create an enzyme that is much better at degrading the plastic than the natural kind.

Source: *Harry P. et al. (2018). Characterization and engineering of a plastic-degrading aromatic polyesterase. Proceedings of the National Academy of Sciences. https://www.pnas.org/content/115/19/e4350*

3. Modification of a non-conventional yeast using CRISPR-Cas9

For more cost efficient and sustainable production of fine chemicals, oils and recombinant proteins.

Owing to its distinguished tolerance of harsh cultivating conditions and convenient genetic manipulation, Saccharomyces cerevisiae has become the most outstanding cell factory for manufacturing of vast chemicals, biofuels and natural products. Due to complications in engineering non-conventional yeasts with 'conventional recombinant DNA technologies' their use has been limited. Modern gene editing technologies such as CRISPR-Cas9 offers new possibilities for engineering such non-conventional yeasts. The yeast Ogataea polymorpha, for instance, is not only recognized as a promising cell factory for producing heterologous protein, but also a model organism in studying the methanol metabolism. Furthermore, O. polymorpha has great potential in industrial application field due to its characteristics of thermostability and fast growth.

Source: *Cai, P., Gao, J. & Zhou, Y. (2019). CRISPR-mediated genome editing in non-conventional yeasts for biotechnological applications. Microb Cell Fact 18, 63 (2019). https://doi.org/10.1186/s12934-019-1112-2*

16. Police officer enters high-risk lab unprotected

A forced lock to a high containment laboratory is investigated. It looks like a burglary. The police investigating the scene enters the lab unprotected.

Security Staff detect a forced lock, which gains access to a high-containment laboratory. When the police arrive, an unprotected officer enters the laboratory to investigate what looks like a possible burglary and might be exposed to high-risk pathogens.

15. Confidential report is taken home on a USB

An employee decides to work from home on a confidential report. The sensitive information is home with them on an USB drive.

You don't know who will have access to this house or even the USB and computer. Will this be the only copy of the report?

4. Testing modified tobacco plants with improved photosynthesis in the field

To study the effects of photosynthesis modifications to increase yields in a model plant.

The efficiency of photosynthesis in plants is low: No more than 0.5-1% of sunlight energy is converted. Increasing the efficiency in plants is seen as a possibility to yield plants.
US researches introduced genetic constructs that tweaked the photosynthesis in plants. Due to the tweak a toxic chemical called glycolate is made in the plant. To get rid of the glycolate plants transform it which reduced the efficiency up to 50 percent. The researchers therefore gave the plants genetic instructions to keep the glycolate in one cellular compartment and transform it there. The genetically engineered tobacco plants grew 40 % more biomass than unaltered plants under typical farming conditions in a field.

Sources: *Photosynthesis 2.0. Plant power for the future. https://edepot.wur.nl/504631 Carolyn Wilke (2020). Genetically Engineered Tobacco Does Photosynthesis More Efficiently. The Scientist, 4 January 2019, https://www.the-scientist.com/news-opinion/genetically-engineered-tobacco-does-more-efficient-photosynthesis-65286*

5. Inoculate honeybees against deadly mites and viruses

Use genetically engineered bacteria to protect honeybees from a deadly trend known as colony collapse due to varroa mites and deformed wing virus.

Vorroa mites and deformed wing virus often come together. The virus is spreads by the mites when they feed on bees. This makes the bees more vulnerable to pathogens in the environment.
An US research team has developed a bacteria which lives in the honey bees' gut. The bacteria promotes a helpful RNA interference (RNAi) response to the viruses in bees. At the same time the bacteria triggers a lethal RNAi response in the mites. The bees who were treated with the strain of bacteria were 36.5% more likely to survive to day 10.
The experminets occurred under strict biocontainment protocols. The researchers think the risk of the bacteria escaping into the wild and infection other insects is low. However, further research is needed to determine the effectiveness and safety in an agricultural setting.

Sources: *The University of Texas. (2020, January 30). Bacteria Engineered to Protect Bees from Pests and Pathogens. UT news. https://news.utexas.edu/2020/01/30/bacteria-engineered-to-protect-bees-from-pests-and-pathogens/*
Test Biotech. (2020, July 9). 'Indirect' genetic engineering of honey bees. TestBiotech. https://www.testbiotech.org/en/news/indirect-genetic-engineering-honey-bees

14. Non-pathogenic strain has developed pathogenic properties

When discussing the results of an experiment, a non-pathogenic bacterial stain has developed pathogenic properties. This gives new insights into genetic factors.

The new discovery gives insight in genetic factors of bacteria. They could help in research on how to better prevent sickness and diseases. However, it could also be used to research how to abuse the bacteria and the diseases it can bring.

Source: *Bureau Biosecurity. (2021, May 19). Biosecurity scenario 'Onverwachte wetenschappelijke resultaten'. Rijksinstituur voor Volksgezondheid en Milieu. https://www.bureaubiosecurity.nl/nieuws/biosecurity-scenario-onverwachte-wetenschappelijke-resultaten*

13. SARS-CoV-2 research team is strengthened with new employees due to pandemic

A new employee from outside the EU makes long days and continues work in the weekends. Neither direct colleagues nor supervisor are aware of how often this person works alone.

One of the new employees is from outside the EU. This person makes long days, also in the weekends to work on the project. Neither direct colleagues nor supervisor are aware of how often this person works alone and what the exact activities are.

Sources: *Bureau Biosecurity. (2021, February 8). Biosecurity scenario 'Overwerk'. Rijksinstituur voor Volksgezondheid en Milieu. https://www.bureaubiosecurity.nl/nieuws/biosecurity-scenario-overwerk*

6. Gene editing of chicken cells in the lab

To apply in chicken breeding and prevent outbreaks of bird flu in chicken farming. This will limit the chance of new human flu virus varieties developing.

Bird flu is a major threat to farmed chickens worldwide, with severe strains killing up to 100 per cent of birds in a flock. In rare instances, certain variations of the virus can infect people and cause serious illness.

Scientists at Imperial College London have used gene-editing techniques to stop the bird flu virus from spreading in chicken cells grown in the lab. The team prevented the virus from taking hold by deleting a section of chicken DNA inside lab-grown cells. They used gene-editing techniques to remove the section of DNA responsible for producing ANP32A. This molecule is 'hijacked' by flu viruses to replicate themselves. They found the virus was no longer able to grow inside cells with the genetic change.

Sources: *Long, Jason S. et.al. (2019). Species specific differences in use of ANP32 proteins by influenza A virus. eLife 2019;8:e45066, https://elifesciences.org/articles/4506*

7. Gene drives in rats, possums and weasels

To get rid of invasive mammals that pose a threat to native birds in New Zealand.

New Zealand does not have any native mammals, except for some bats and marine mammals. Other mammals have been introduced by humans. Without natural enemies, these species have spread rapidly. The new mammals feed on birds and pose threat to native birds. Conventional methods to eradicate incisive mammals have low success rates and environmental disadvantages.
Island Conservation from California is pursuing a gene drive that results in mice only having male offspring. Mouse geneticists at the University of Adelaide fashioned CRISPR into a "selfish gene" designed to transmit itself to nearly all of a mouse's offspring, rather than just half, as would be expected.

Sources: *O'Donnell Colin F. J., B. Kay Clapperton and Joanne M. Monks. (2014). Impacts of introduced mammalian predators on indigenous birds of freshwater wetlands in New Zealand. New Zealand Journal of Ecology (2015) 39(1): 19-33*
Island Conservation. (2018). Open Letter: Research on Gene Drive Technology can Benefit Conservation and Public Health, https://www.islandconservation.org/open-letter-research-gene-drive-technology-benefit-conservation-public-health/
Cohen, Jon. (2018). 'Gene drive' passes first test in mammals, speeding up inheritance in mice. Science, July 10, 2018, https://www.sciencemag.org/news/2018/07/gene-drive-passes-first-test-mammals-speeding-inheritance-mice

12. Develop a vaccine by genetic modification

Modify the African Swine Fever Virus in High Containment Unit in Lelystad. ASFV can cause a highly contagious and serious disease in pigs and is therefore classified in pathogenicity class 4.

COGEM advised to do this work in a ML-III lab.
It is importanted to ensure that the virus is contained within the lab and fumes are disposed of correctly.

Source: *Schaap S. (2017, August 17). Advies inschaling werkzaamheden gg-African swine fever virus in de HCU. Cochem. https://cogem.net/app/uploads/2019/07/170817-01-Advies-werkzaamheden-ggASFV-in-de-HCU-van-WUR.pdf*

11. Create chimeric viruses by combining noroviruses from various animals

To study disease course, multiplication and host specificity of norovirus. Combinations of the virus comes from humans, mice and pigs, among other things.

Human norovirus is a highly contagious virus that causes stomach flu in approximately half a million people in the Netherlands every year. Usually, the symptoms disappear after about two to three days. In pigs and mice, an infection usually proceeds without symptoms. There is currently no vaccine or antiviral drug available against the norovirus.

COGEM considers the risks for humans and the environment to be negligible if the in vitro laboratory activities and the activities in association with laboratory animals take place at ML-II or DM-II level, respectively, following a number of additional measures

Source: *Cogem. (2015, January 1). Inschaling van werkzaamheden met genetisch gemodificeerde norovirussen. https://cogem.net/publicatie/inschaling-van-werkzaamheden-met-genetisch-gemodificeerde-norovirussen/*

8. Genetically modified T cells for immunotherapy

Recognise a patient's cancer cells and fight the cancer when returned to the patient.

T cell therapy is research as part of the fight against cancer. The T cell are genetically modified to target cancer cells. There are two types of T cell therapy. Chimeric Antigen Receptor Therapy (CAR-T). The CAR-T cells recognize markers on cancer cells and destroy them. Each new generation of CAR-T cells is stronger by adding costimulatory factors, which amplify the transmitted signal.
COGEM observes that GM T cell therapy can present a potential risk to third parties in specific cases. Exposure to GM T cell via donated tissues, organs or stem cells, across the placenta and via beeastfeeding can present a potential risk. The consequences can be serious, but are hard to predict and depend on the type of genetic modification to the T cell.

Sources: *Heymach, John et.al. (2018). Clinical Cancer Advances 2018: Annual Report on Progress Against Cancer From the American Society of Clinical Oncology. Journal of Clinical Oncology 36, no. 10 (April 01, 2018) 1020-1044.*
COGEM. (2019). Immunotherapy with genetically modified T cells: unintended exposure and potential risks. Policy reports | 27.02.2019 | CGM/190227-0, https://cogem.net/en/publication/immunotherapy-with-genetically-modified-t-cells-unintended-exposure-and-potential-risks/

9. Engineering metabolism of plants for specific root exudates

To promote plant growth on acid soils that suffer from aluminium toxicity stress.

Aluminium toxicity stress inhibits root growth. It occurs in soils which contain aluminium and are strongly acidic. Soil acidification can develop naturally, but can be accelerated by intensive and productive farming practices that use ammonium-based fertilizers.
In the late 1990's, experiments were done to create genetically engineering 'microbe-optimized plants', to reduce the impact of the toxic soil. Overexpression of the citrate synthase gene from bacteria in tobacco resulted in a partial alleviation of aluminium toxicity stress.
However, due to the complexity of interactions between plants, microbes, soil and climate conditions, the genetic engineering has never progressed beyond experiments. More than 20 years later there are tools and resources that can be applied to introduce complex heterologous pathways. Such tool and recourses would allow for building synthetic genome clusters from microbiomes to enable the stacking and shuffling o disease resistance and stress tolerance traits between crop plants.

10. Engineering soil bacterium to become a microbial cell factory

Engineer the Pseudomanus putida bacterium to produce isoprenoids (such as lycopene) which can be used in pharmaceuticals, cosmetics, nutrition, colourants and biofuel.

In his 2011 report, prof. Van Belkum from Erasmus MC classified Pseudomonas putida as a pathogen. However, COGEM considers the organism to be non-pathogenic and therefore recommends experiments in a ML-I lab.

Source: *Zoeteman, B.C.J. (2011, December 20). Advies classificatie niet-pathogene bacteriën. Cochem. https://cogem.net/app/uploads/2019/07/111220-02-advies-classificatie-niet-pathogene-bacterien.pdf*