



› Convolutional Neural Network for the Classification of SARS-CoV-2 and Primer Creation

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> Outline

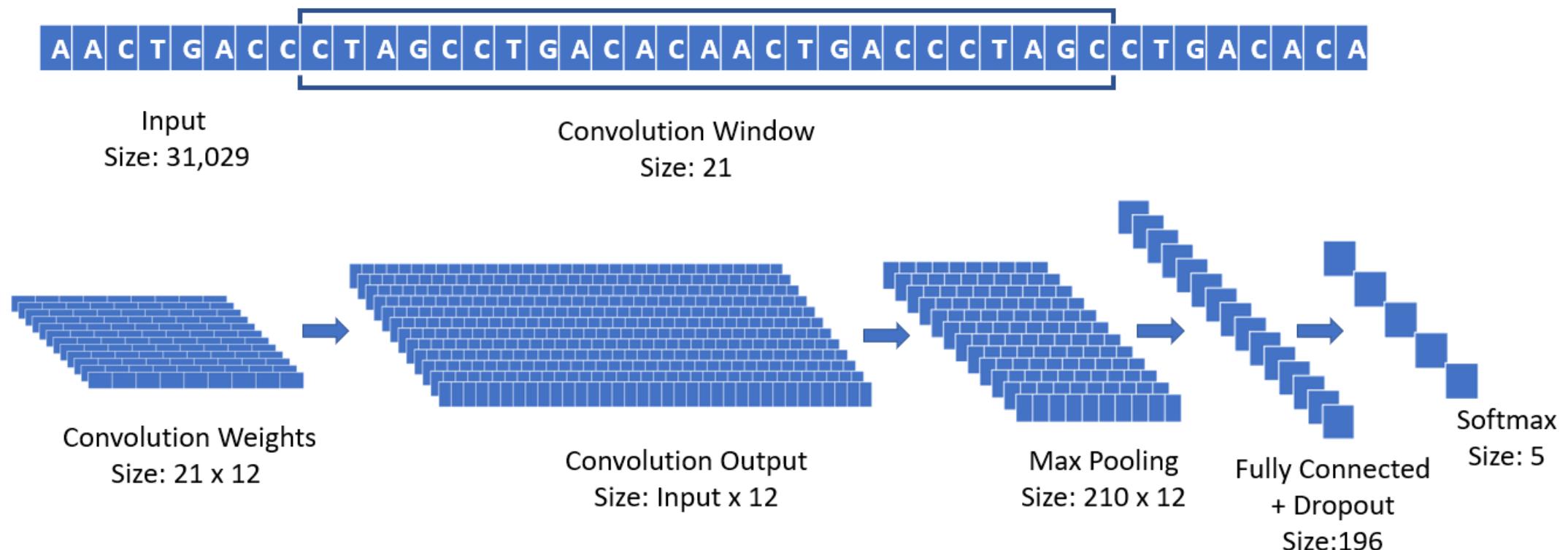
- Application
- Formalization
- Classification results
- Extracting information from filters
- A new primer

> Application

- Separate genomic samples of SARS-CoV-2 from others
 - SARS-CoV-2 belongs to the Coronavirus family
 - Lots of “relatives” that are genomically similar
 - For example, the regular flu!
- During the pandemic, collective effort to share data
 - Open repositories with genomic sequences from all the world
 - Fast and reliable genomic sequences from high-throughput

> Formalization

- Basically a classification problem
 - Input: sequence of variable size (RNA, cDNA)
 - Output: class

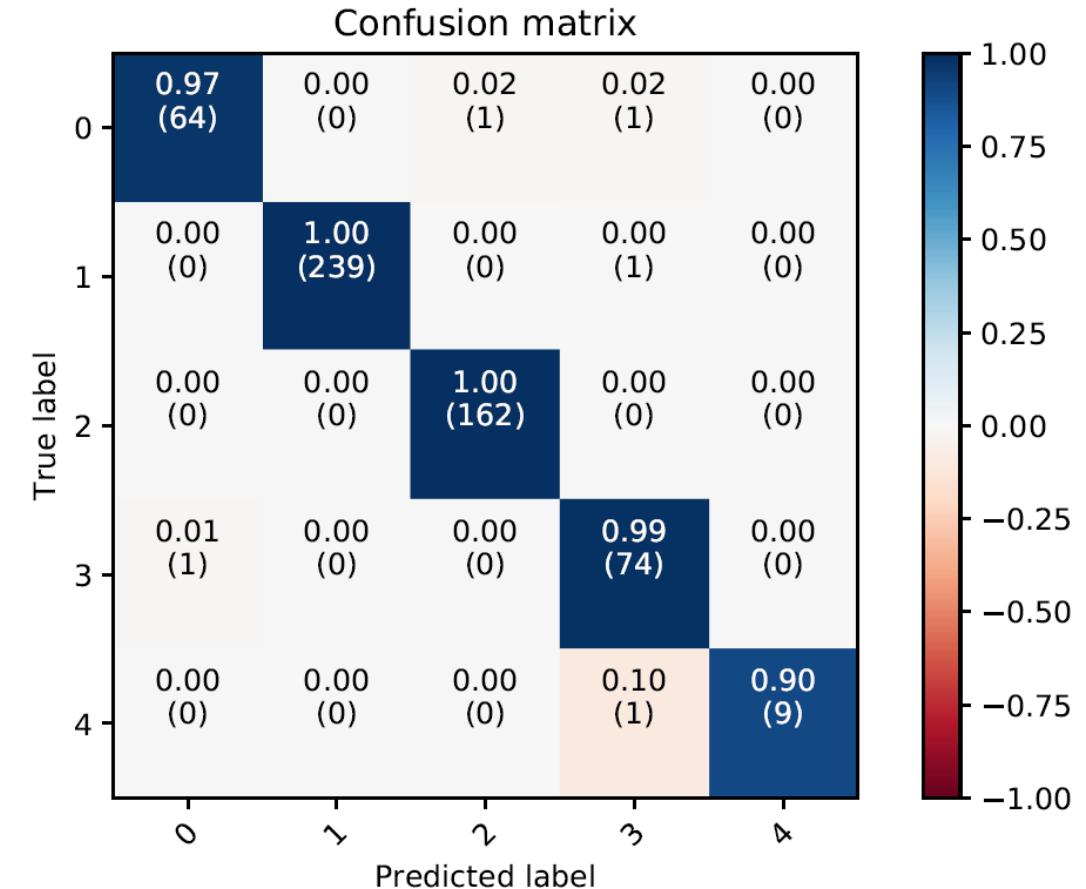
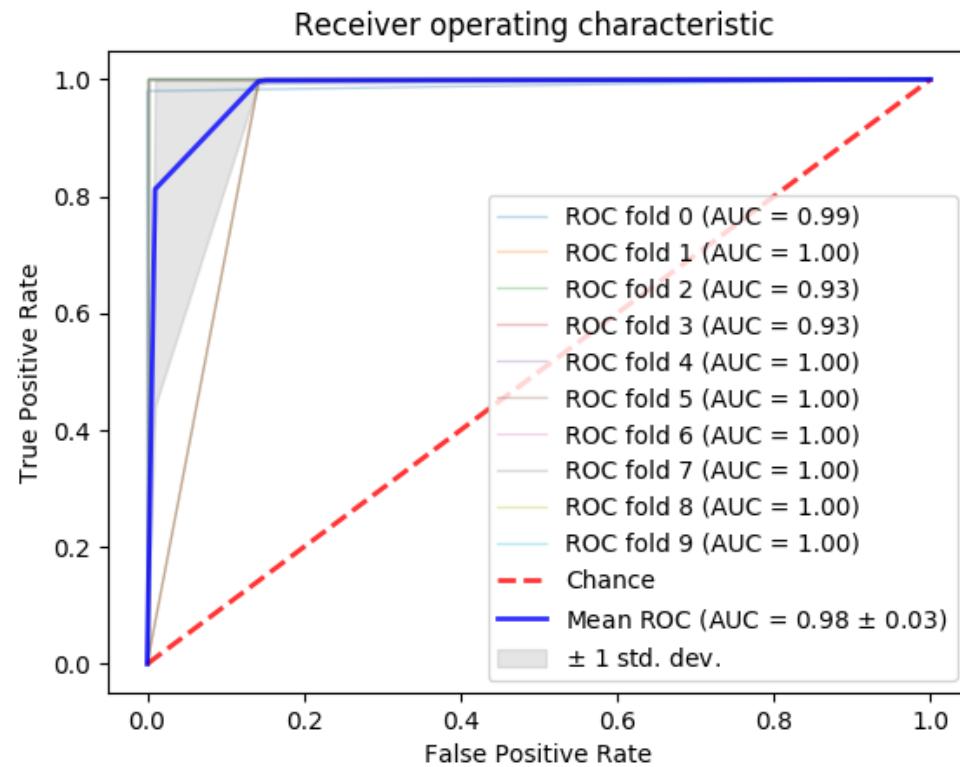


> Formalization

- Data: a few hundred samples

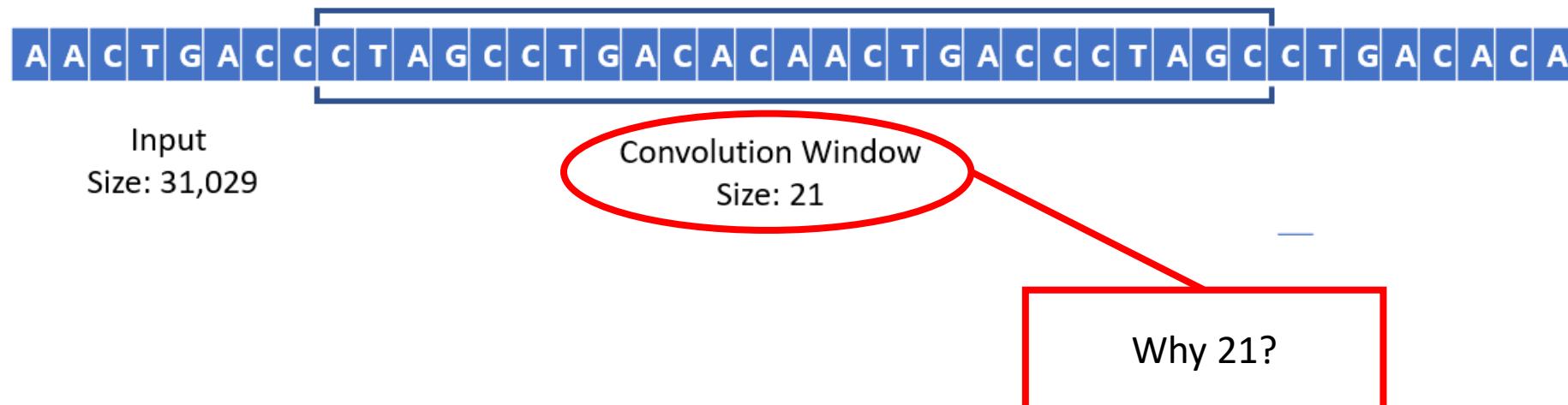
Organism	Label	Number of Samples
SARS-CoV-2	0	66
MERS-CoV	1	236
HCoV-OC43	2	136
HCoV-229E	2	22
HCoV-EMC	2	6
HCoV-4408	2	2
HCoV-NL63	3	58
HCoV-HKU1	3	17
SARS-CoV	4	7
SARS-CoV P2	4	1
SARS-CoV HKU-39849	4	1
SARS-CoV GDH-BJH01	4	1

> Classification results



> Classification results

- Good! But can we do something more?
 - Visualization tell us **where** filters are maximally activated in sample
 - By looking at **recurring patterns** for classification of SARS-CoV-2

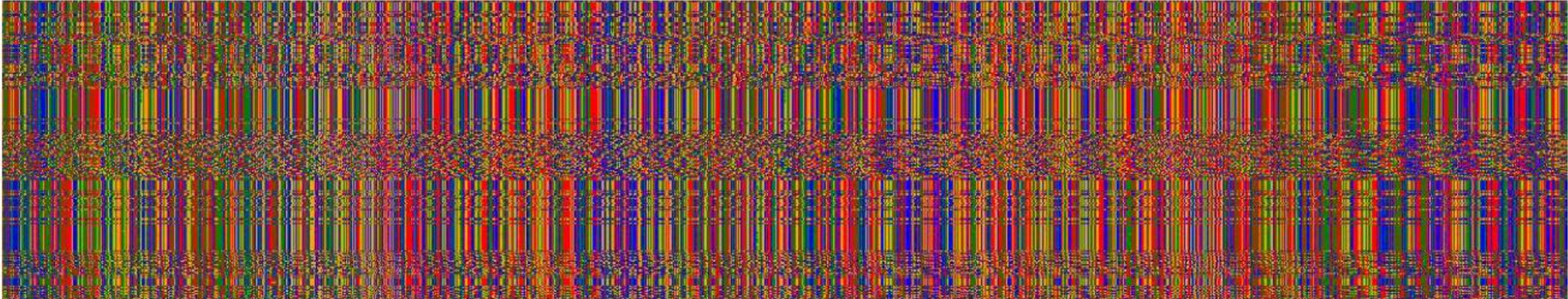


> Filter activations

SARS-CoV-2

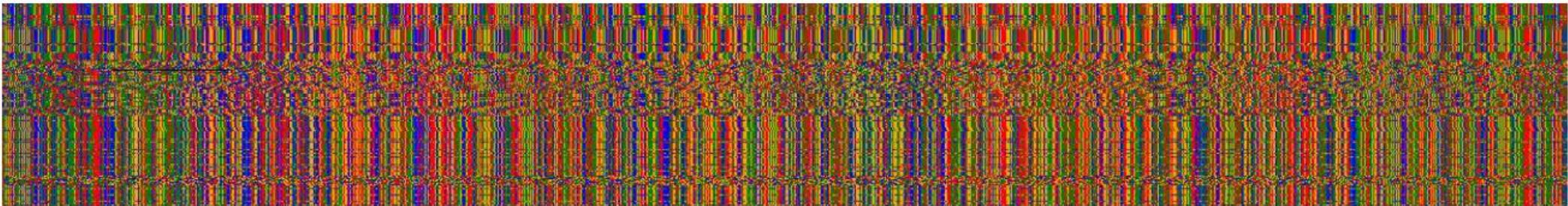


MERS-CoV



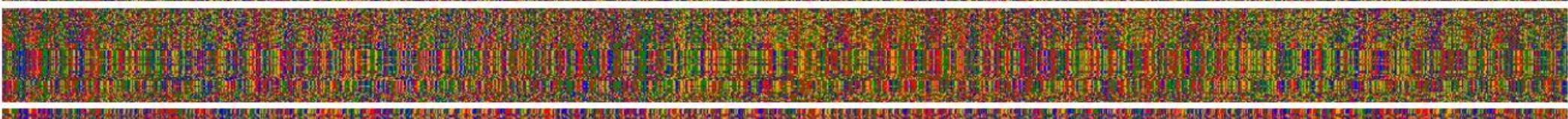
HCoV-OC43

HCoV-229E



HCoV-NL63

HCoV-HKU1



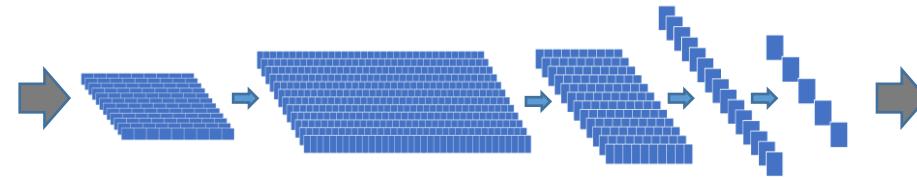
SARS-CoV-1

bps

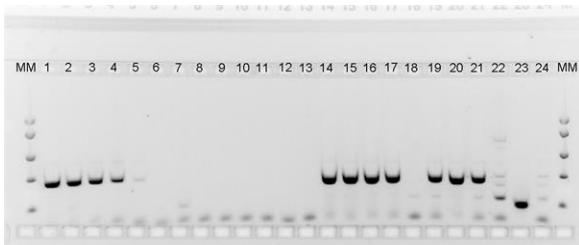
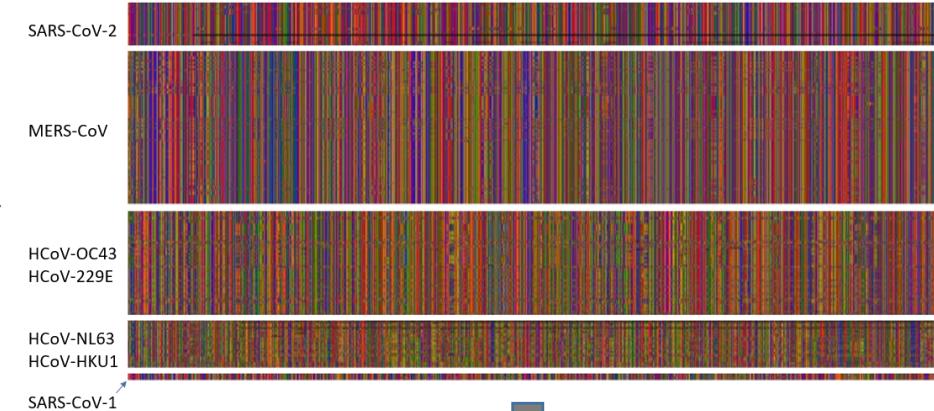
> Extracting information from filters

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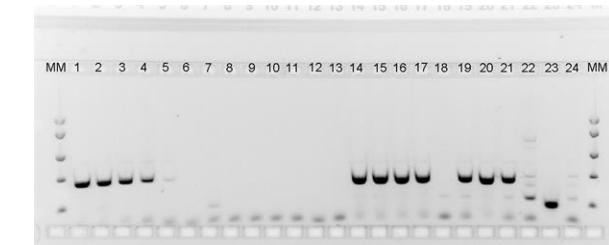
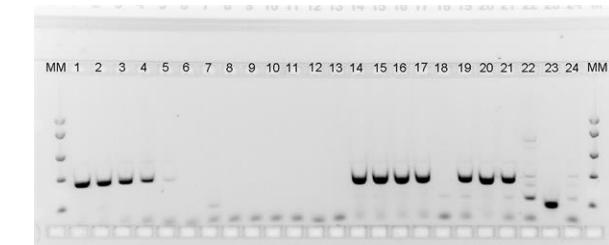
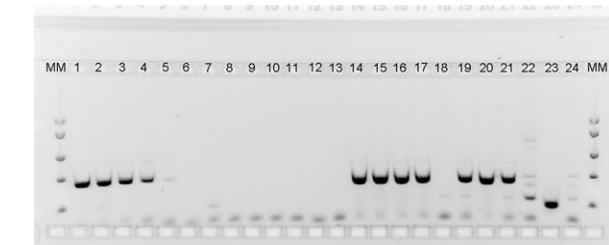
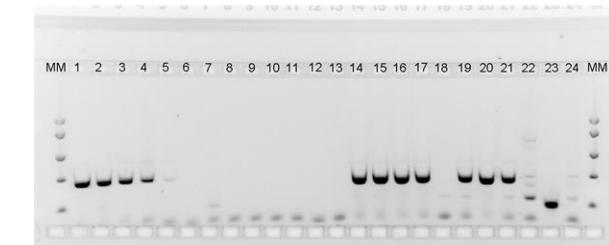
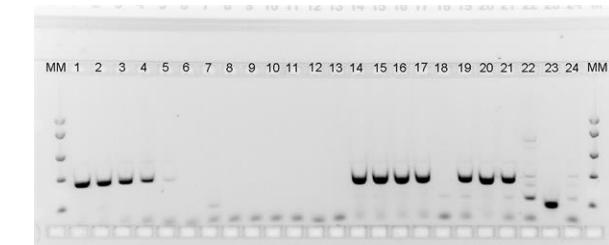
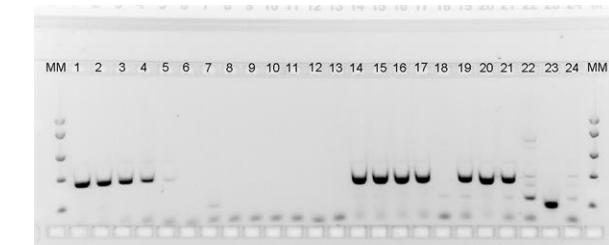
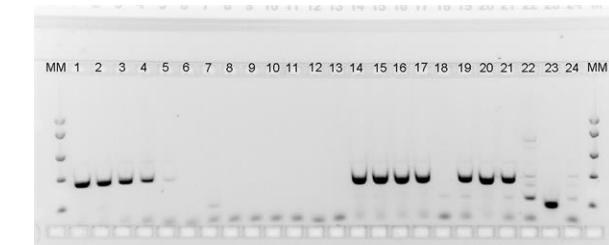
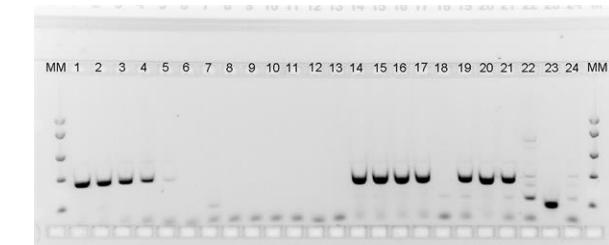
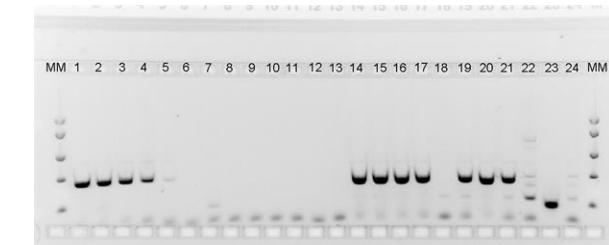
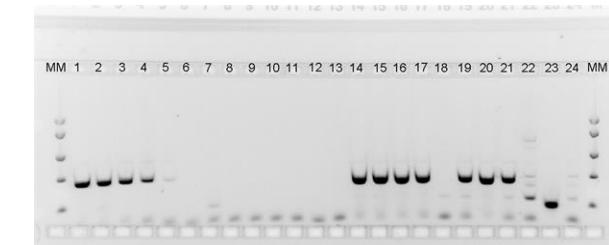
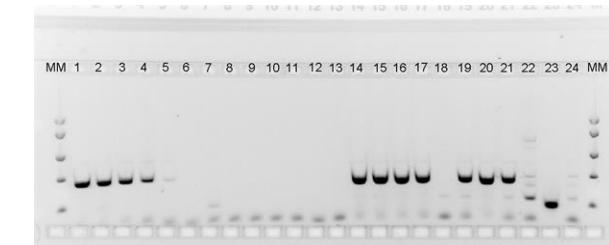
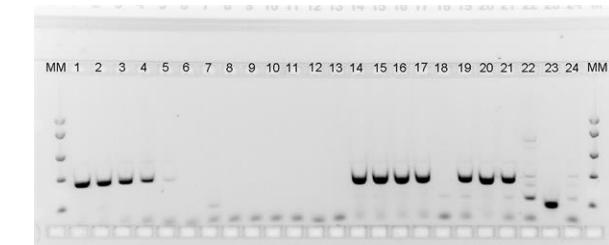
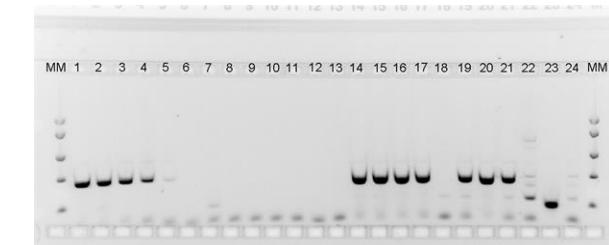
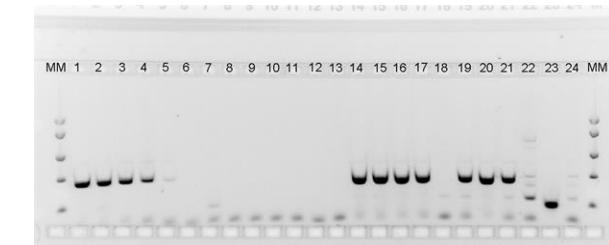
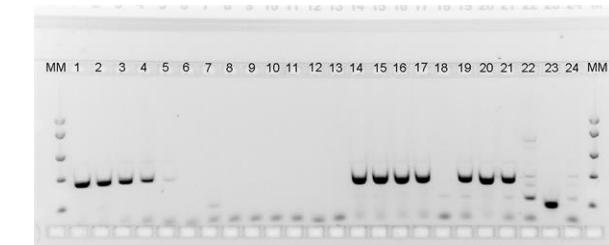
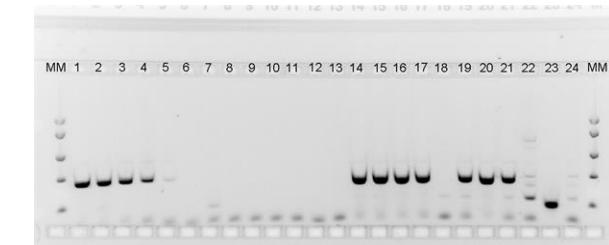
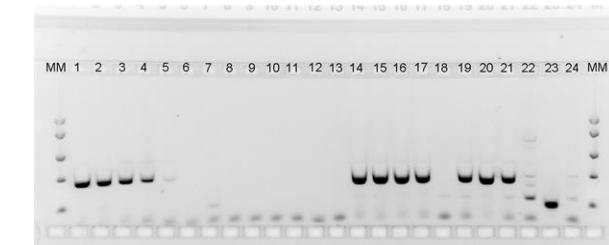
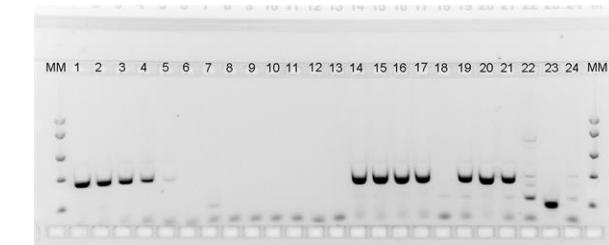
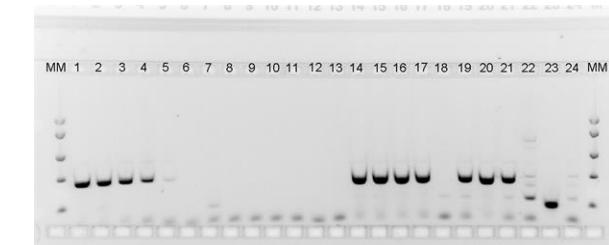
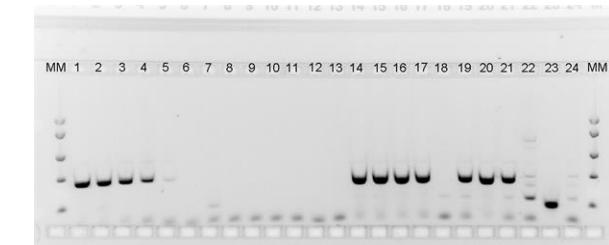
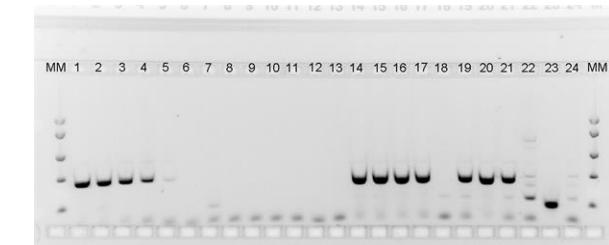
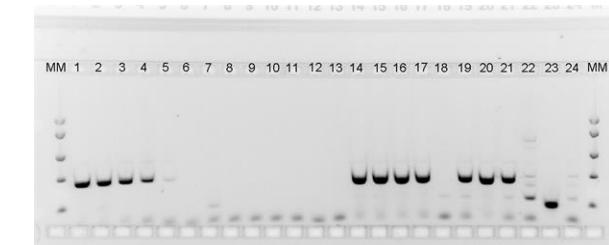
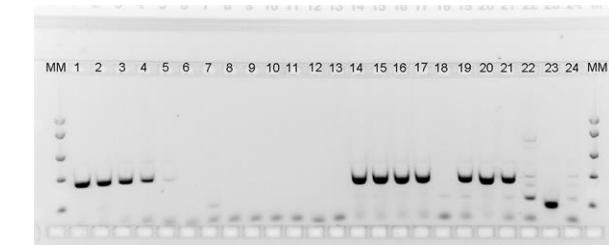
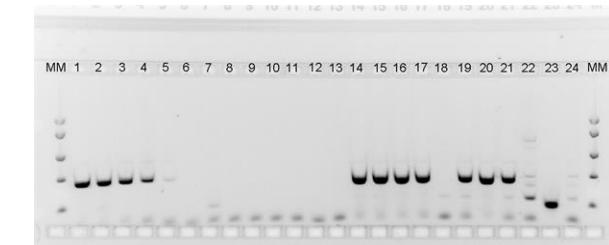
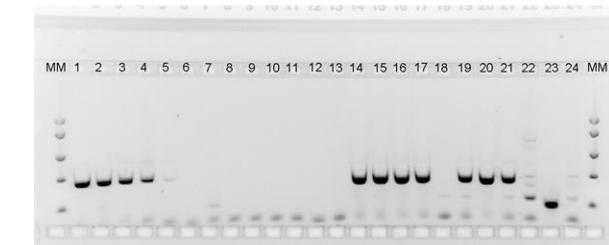
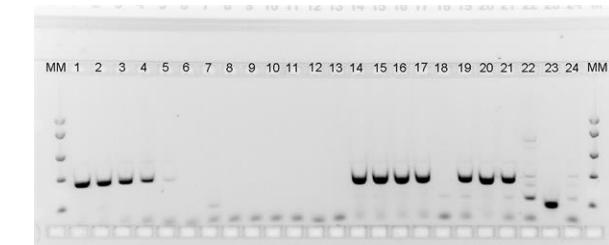
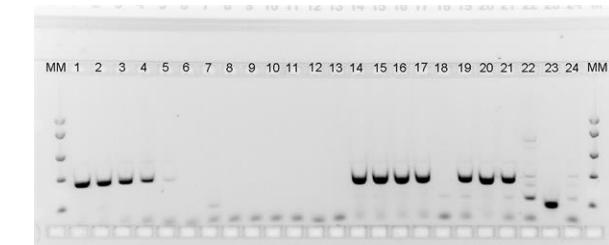
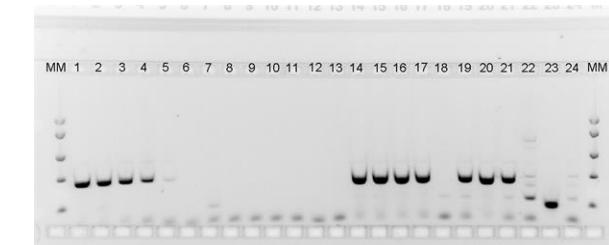
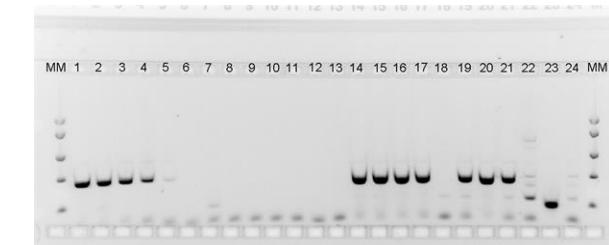
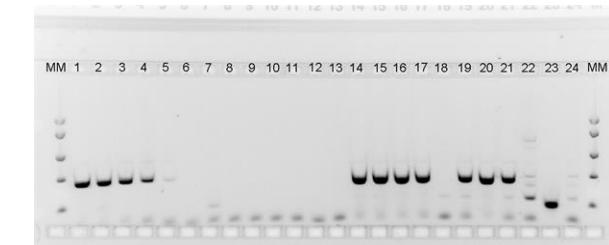
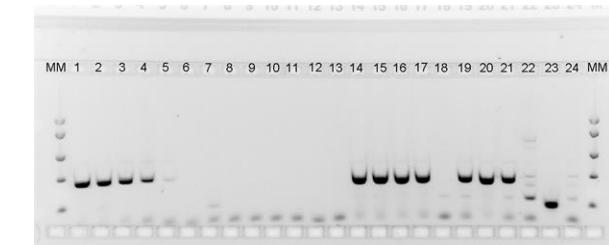
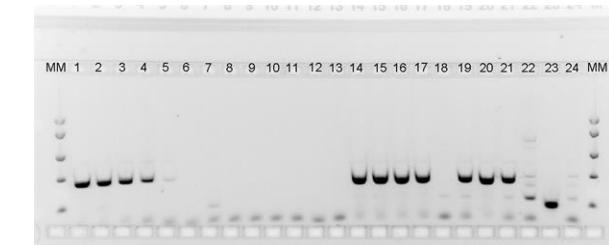
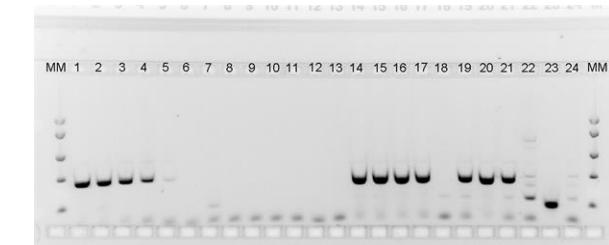
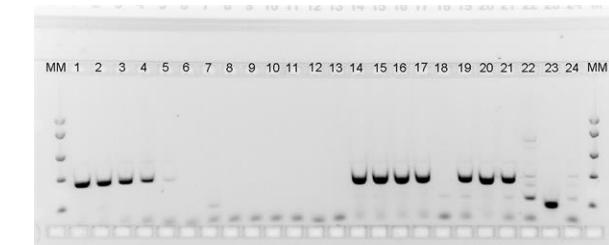
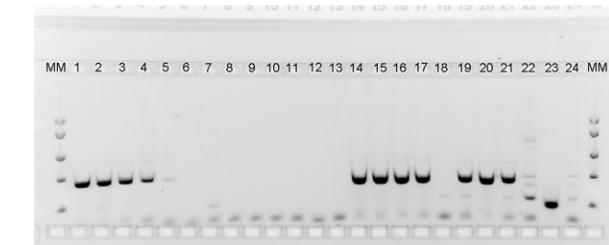
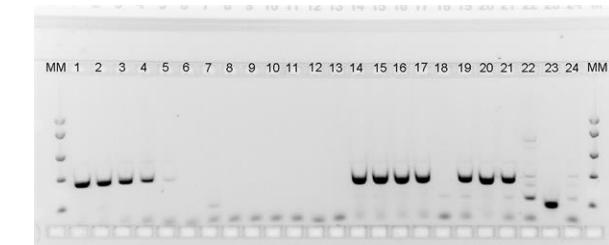
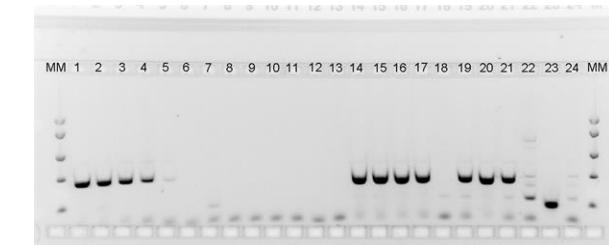
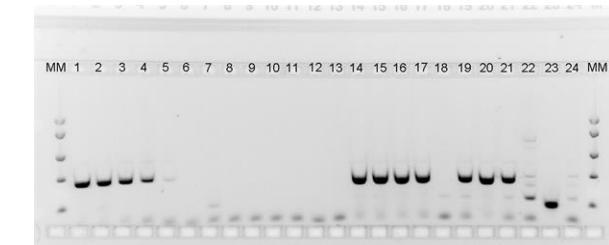
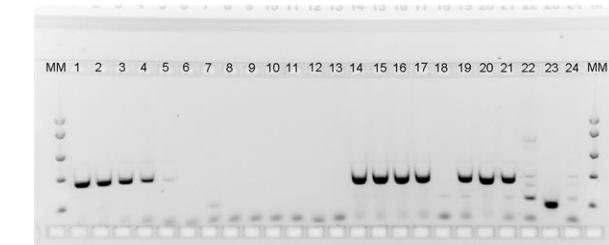
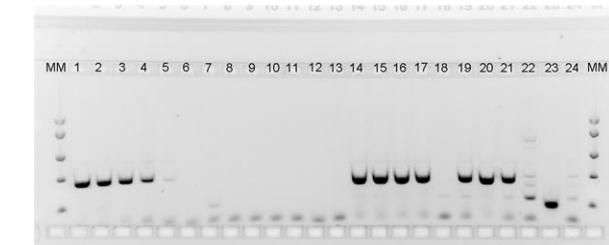
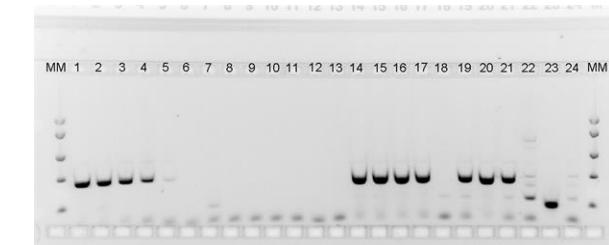
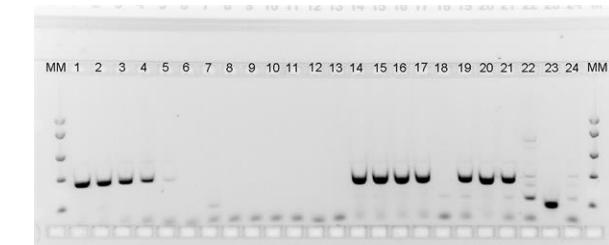
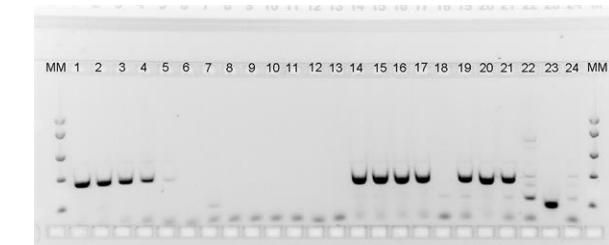
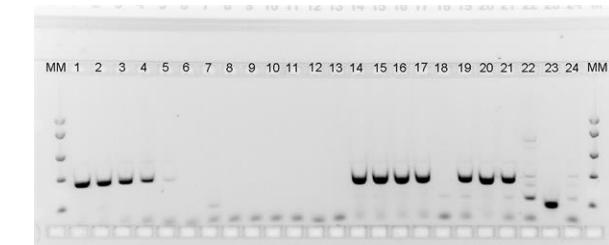
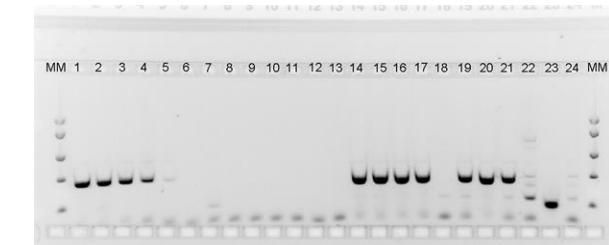
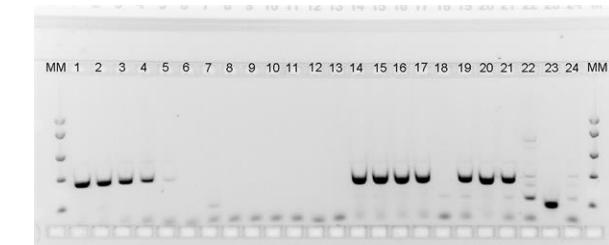
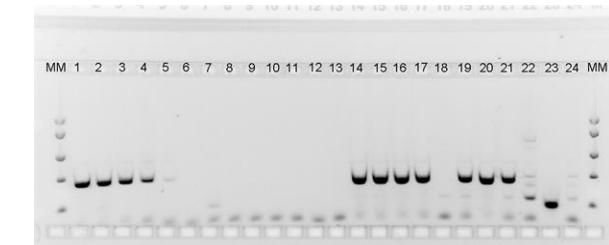
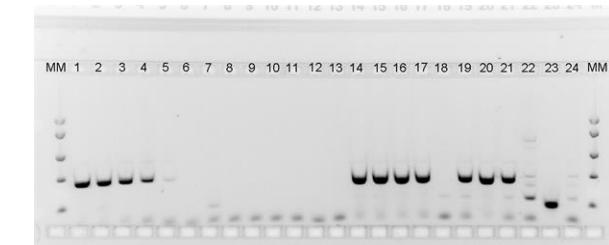
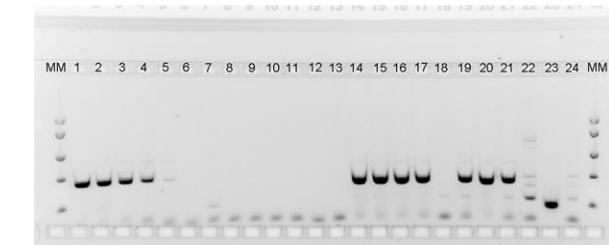
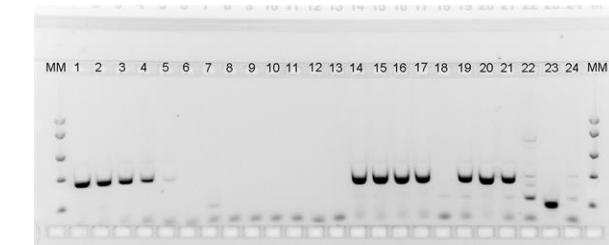
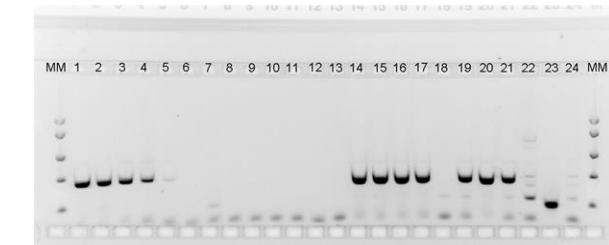
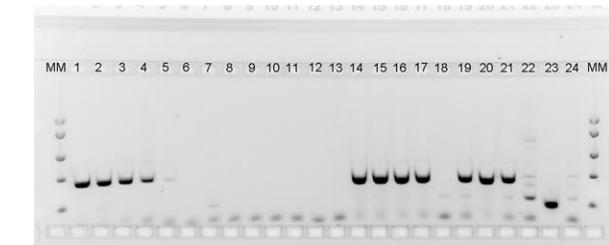
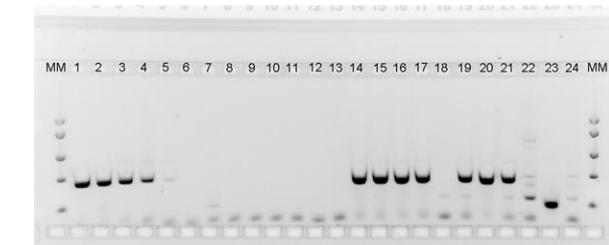
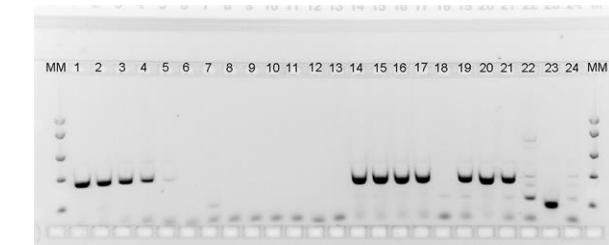
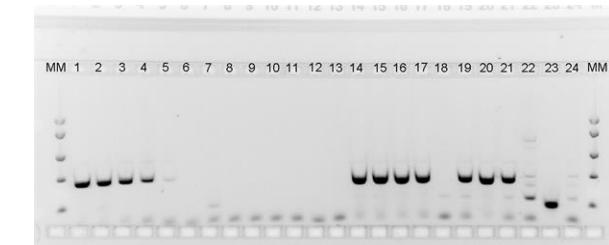
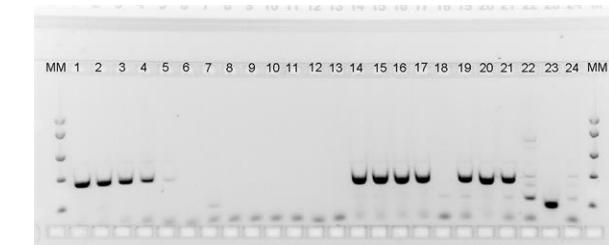
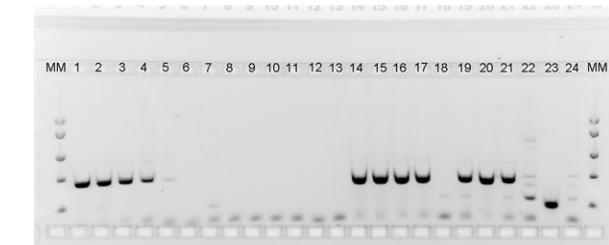
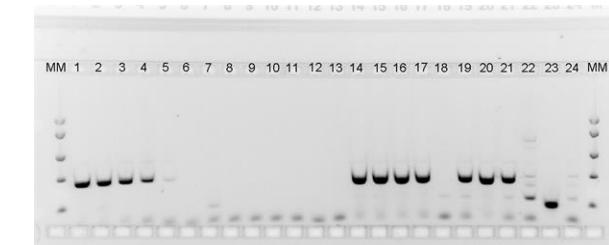
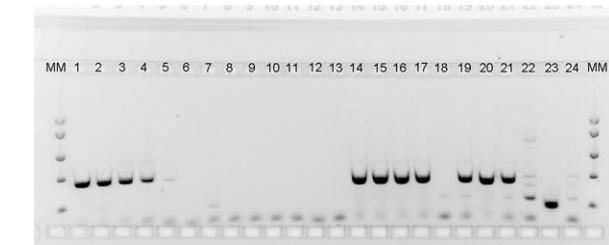
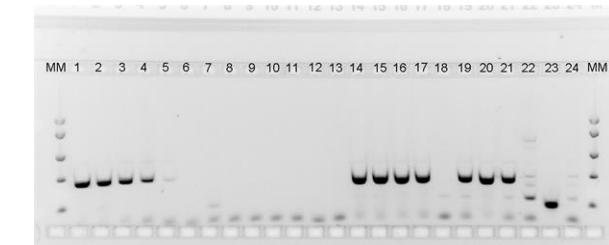
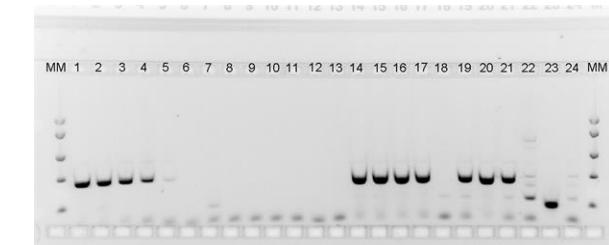
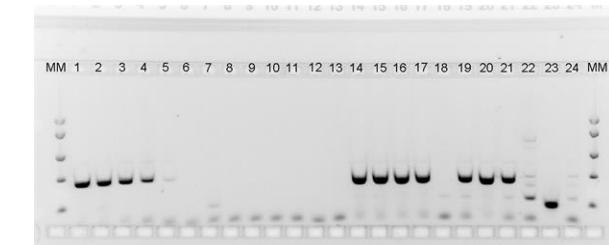
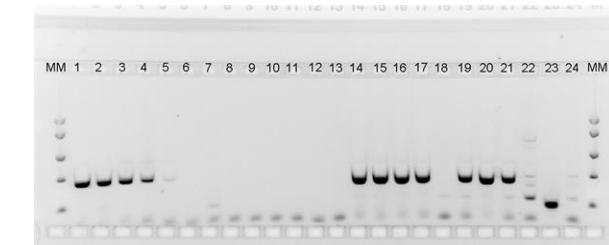
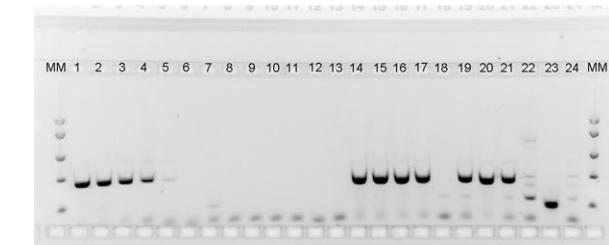
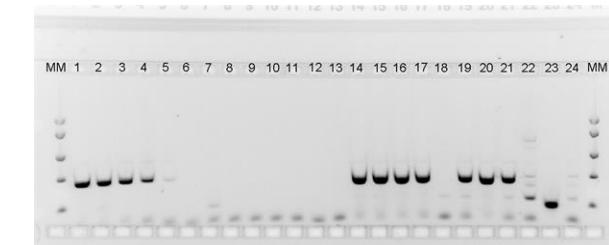
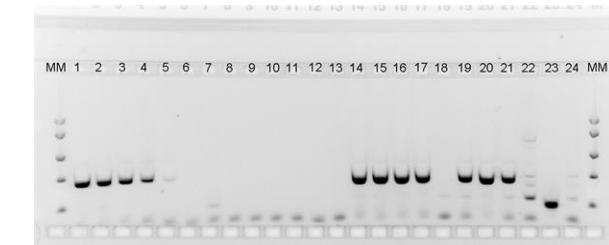
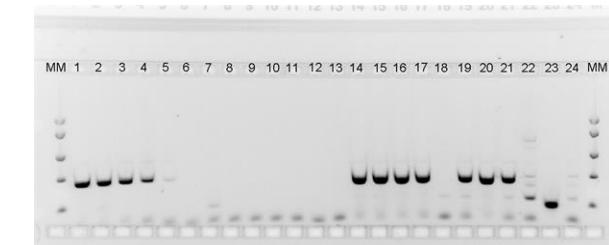
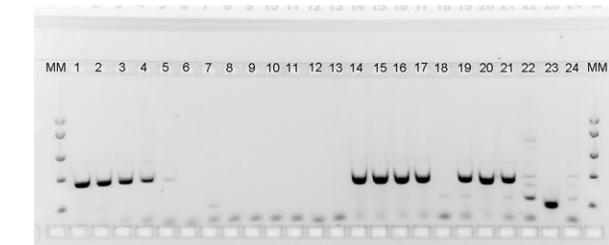
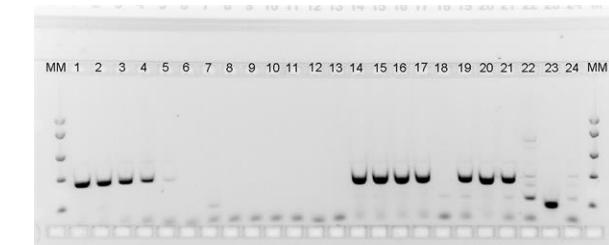
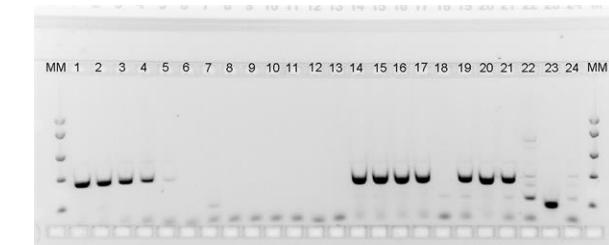
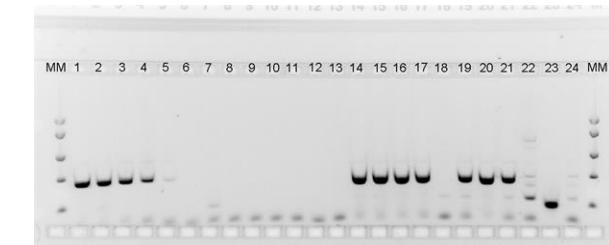
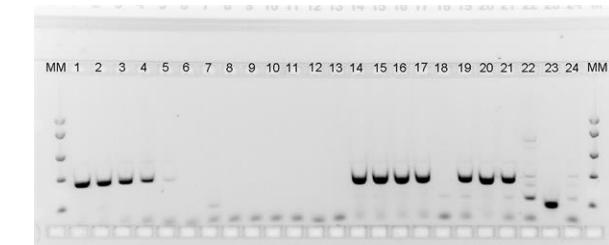
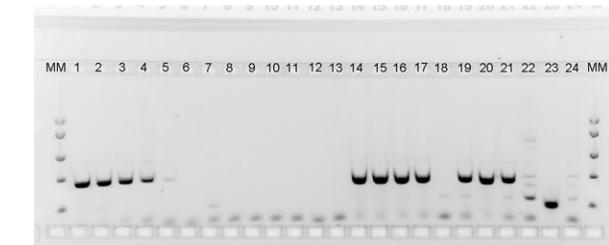
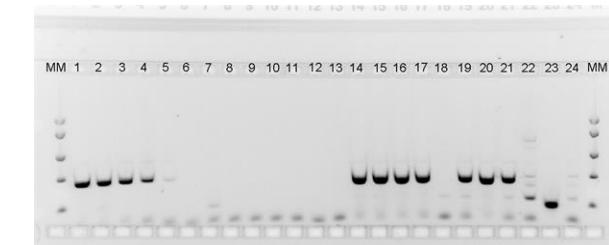
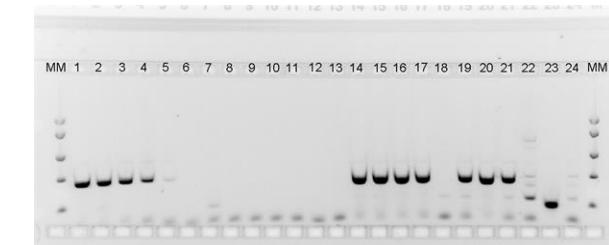
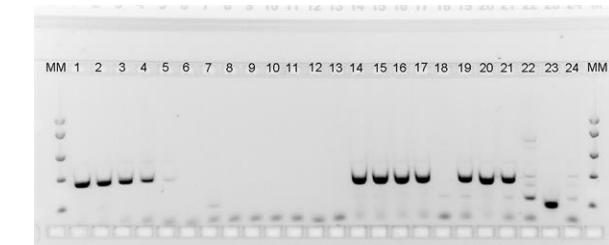
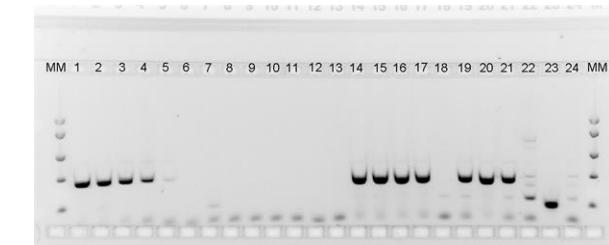
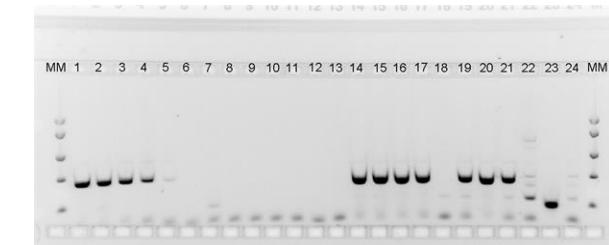
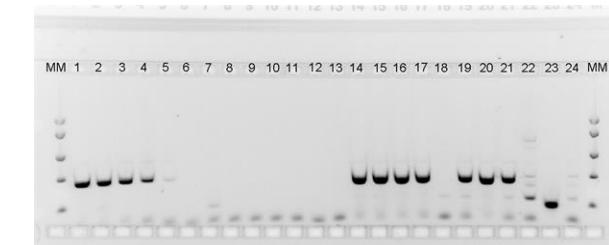
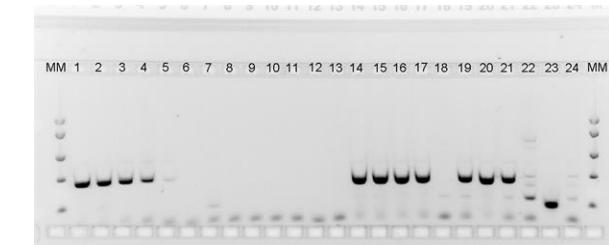
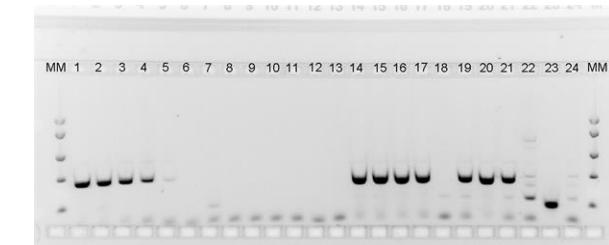
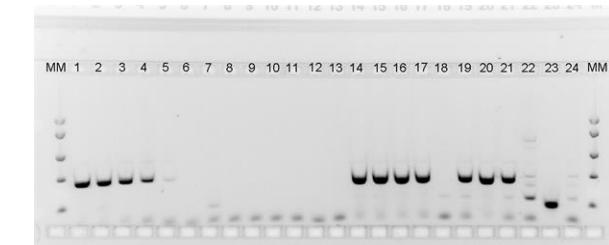
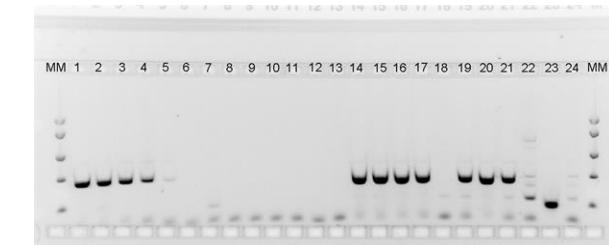
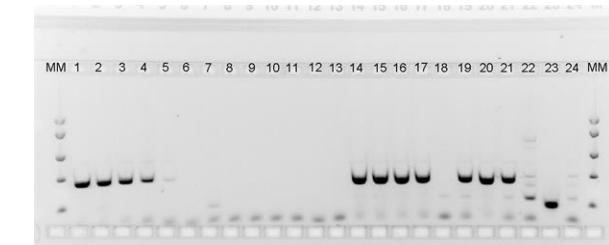
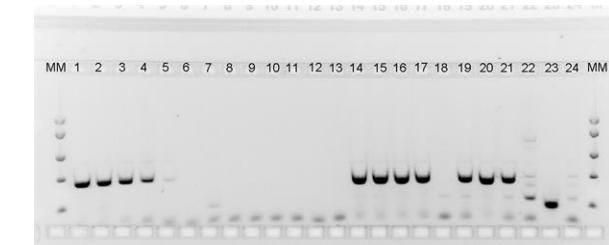
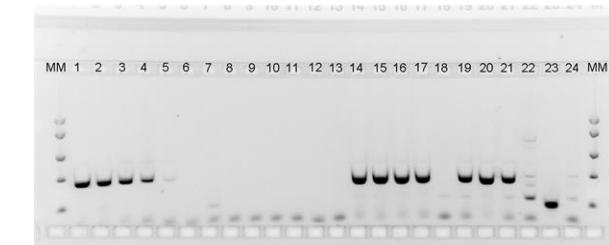
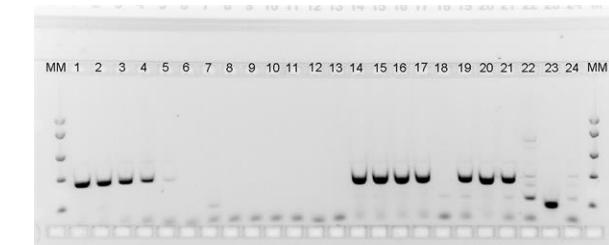
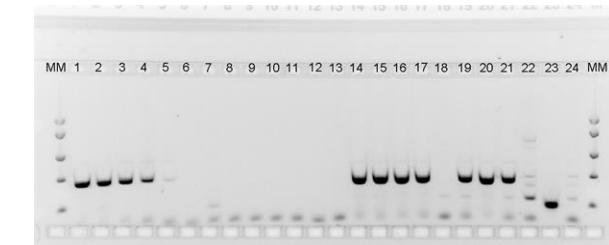
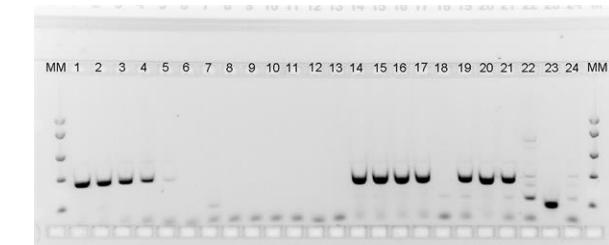
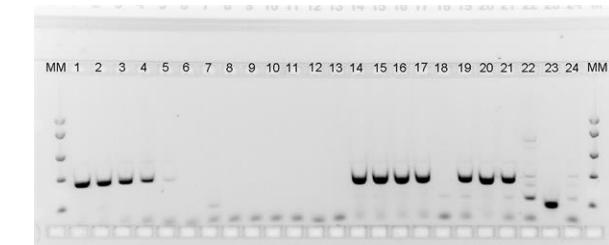
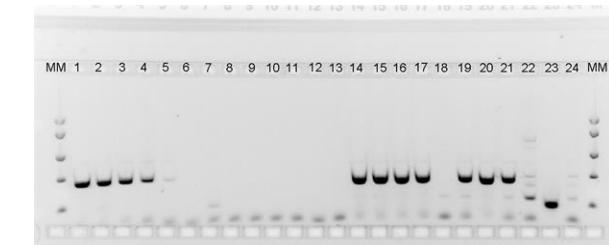
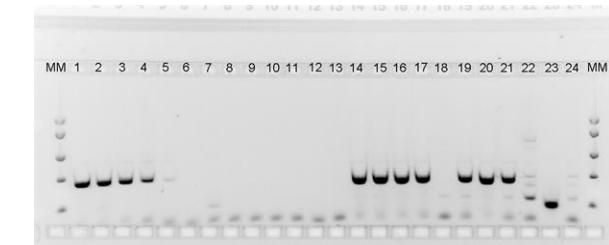
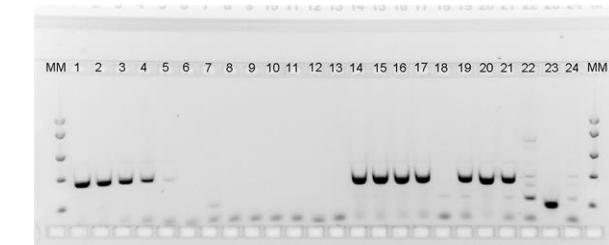
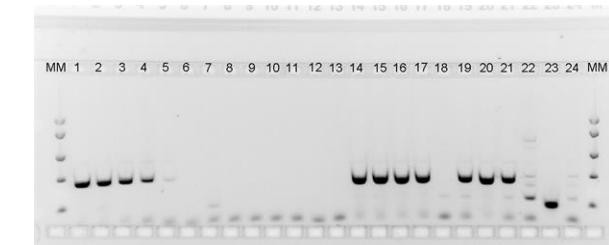
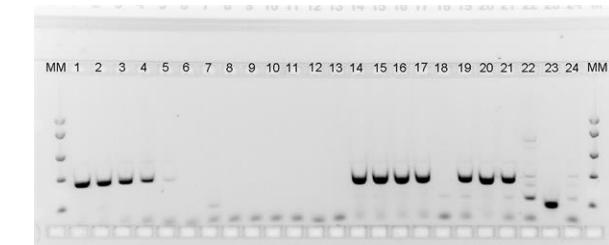
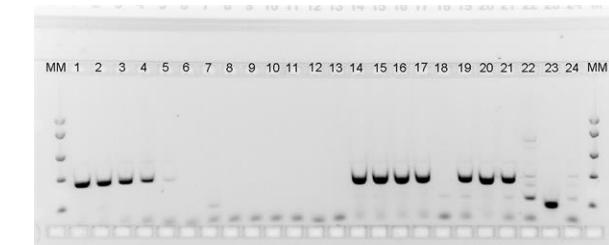
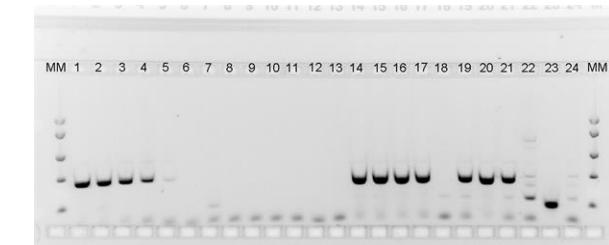
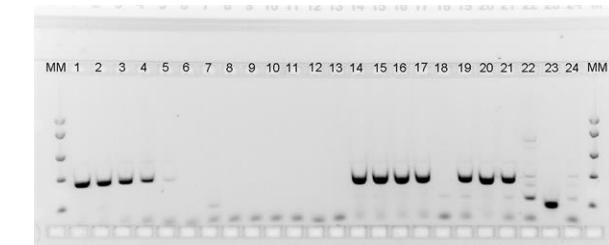
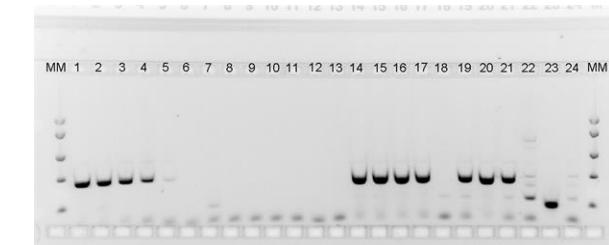
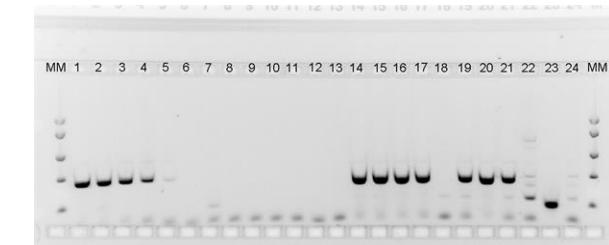
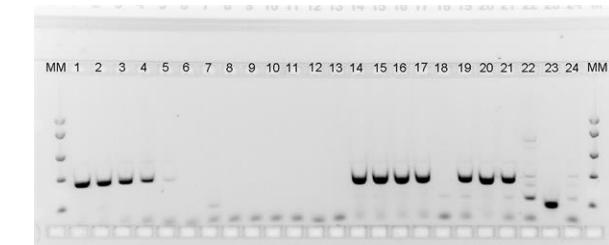
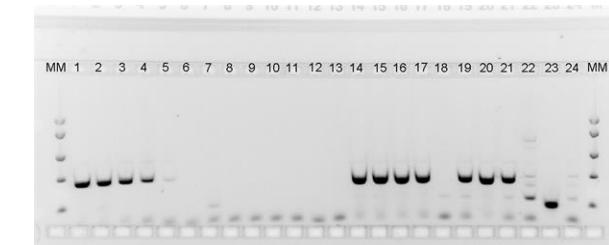
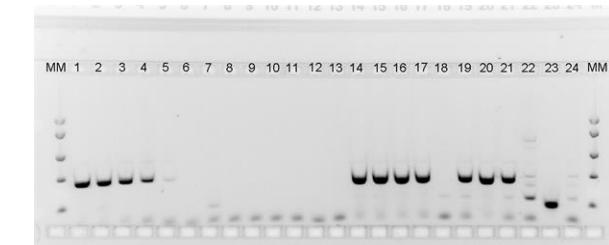
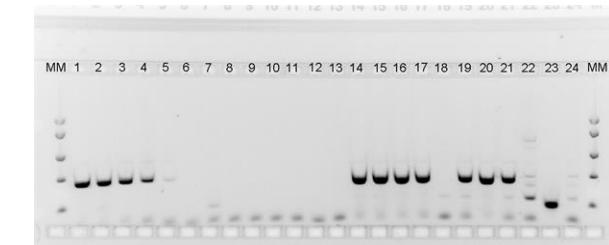
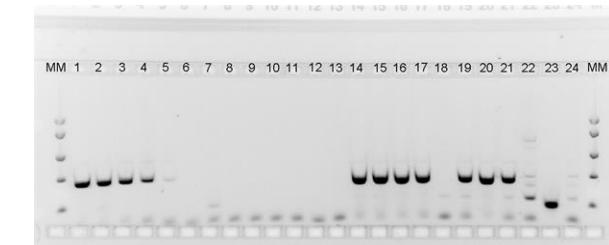
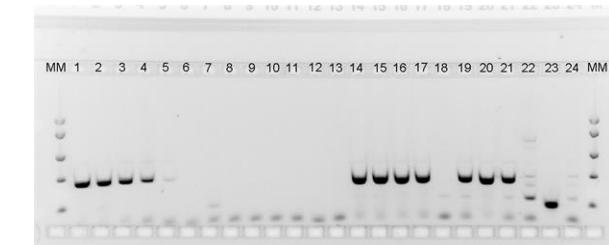
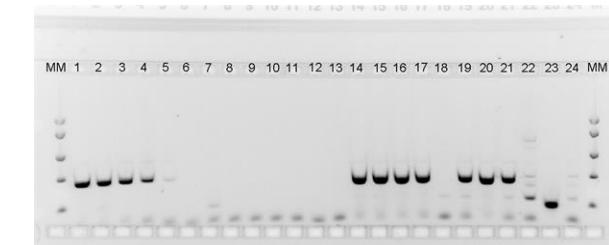
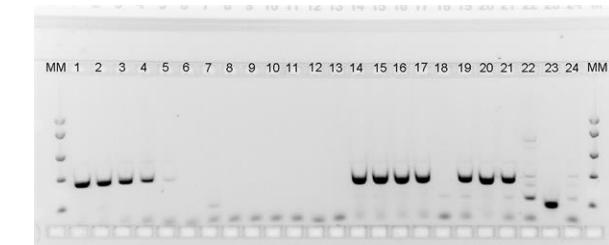
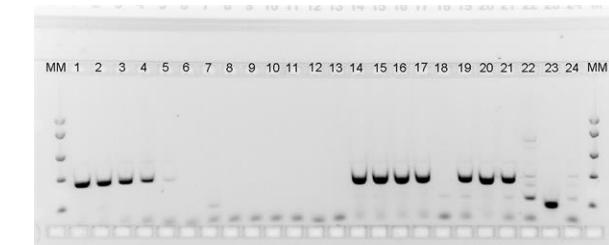
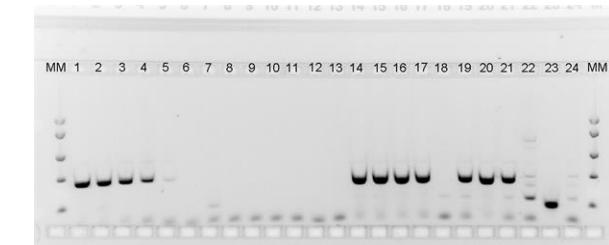
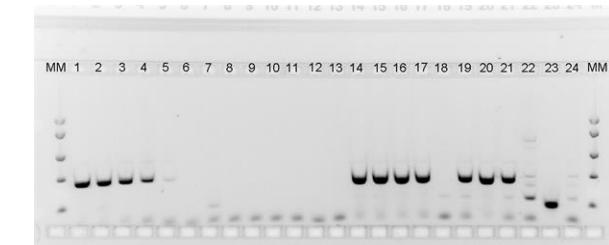
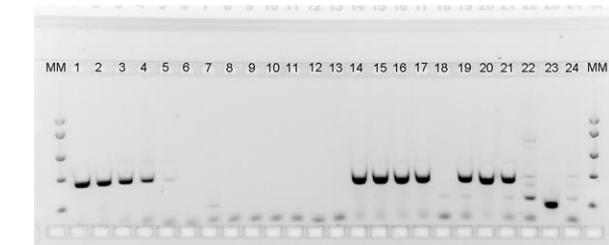
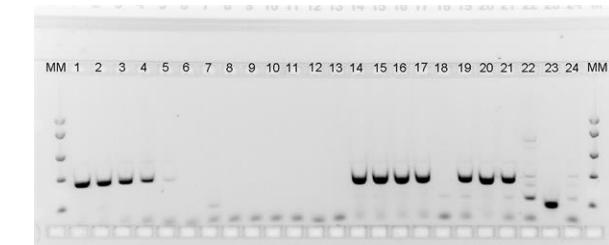
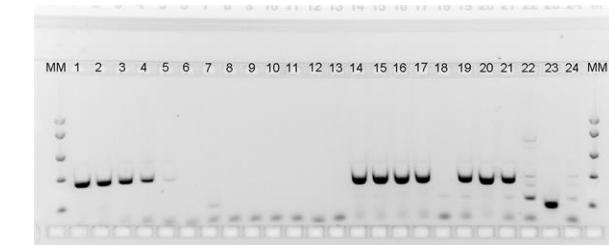
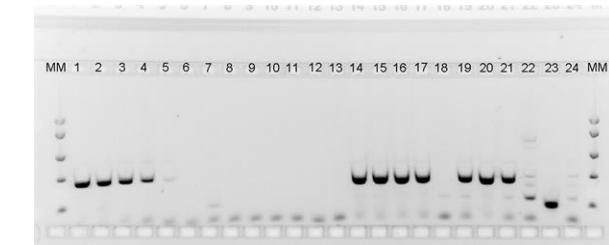
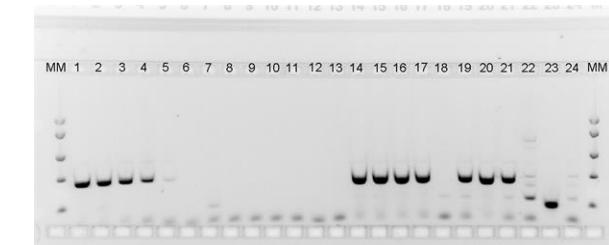
Sequencing



Apply Deep Learning (CNN)



Laboratory Testing



> Great success!

- It works!

> Great success...?

- Later, same results obtained with simpler methods
 - But they required more thinking and expert knowledge
 - ML/DL can be good for first approach
 - It also works for SARS-CoV-2 variants!

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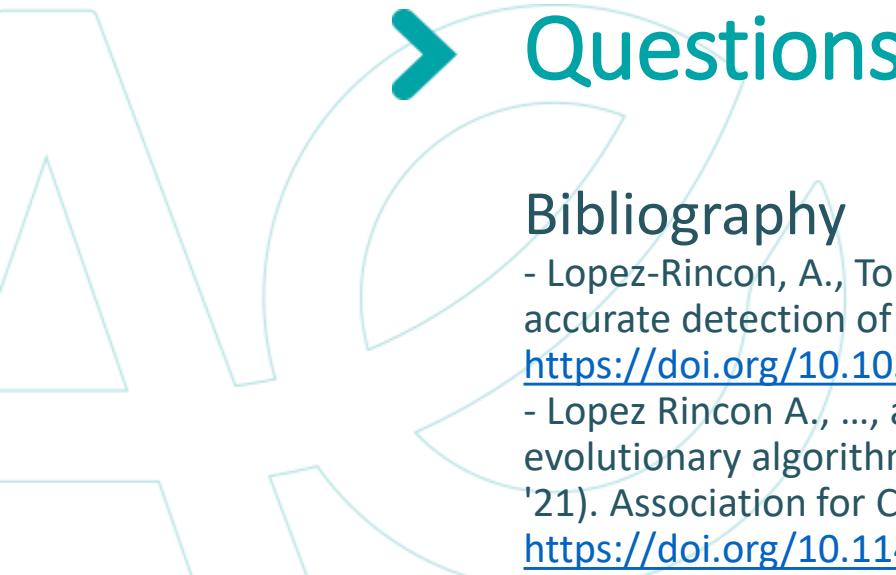
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An Innovative AI-based primer design tool for precise and accurate detection of SARS-CoV-2 variants of concern

[Carmina Angelica Perez-Romero](#), [Lucero Mendoza-Maldonado](#), [Alberto Tonda](#), [Etienne Coz](#), [Patrick Tabeling](#), [Jessica Vanhomwegen](#), [John MacSharry](#), [Joanna Szafran](#), [Lucina Bobadilla-Morales](#), [Alfredo Corona-Rivera](#), [Eric Claassen](#), [Johan Garssen](#), [Aletta D. Kraneveld](#) & [Alejandro Lopez-Rincon](#)✉

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Questions?

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