## What is the project?

**Main question**: How do *cis*-regulatory elements evolve in plants?

- *Cis* meaning same
  - in this case elements on the same DNA strand

- i.e. how do non-coding elements on the same DNA strand affect gene expression?

## What are *cis*-regulatory elements?

### *Cis*-regulatory elements

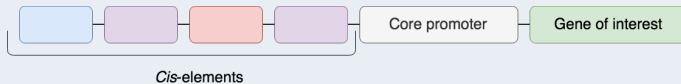- They are usually enhancers and promoters that control development and physiology by regulating gene expression. [1]



Figure 1: Example promoter containing cis-regulatory elements. Cis-elements can be repeated more than once (purple) and can recruit different transcription factors (blue/red), all driving the same gene (green)

[1]Wittkopp and Kalay (2012)

## Why are they important?

### Gene expression / phenotypic variation

- For most of the twentieth century, evolution of protein-coding sequences was commonly thought to be primarily (if not solely) responsible for phenotypic evolution

- Whereas more recent studies show that mutations which affect the function of these sequences contribute to phenotypic diversity within and between species
  - Many studies imply divergent *cis*-regulatory activity in phenotypic evolution [2]

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[2]Carroll (2008)

# How can you study the evolution of *cis*-regulatory elements, in plants?

## Materials

- Start with a little known plant: *Arabidopsis thaliana*
  - Has an extremely well covered genome, as well as transcription factor database

- Will later move towards *Nicotiana benthamiana*, to evaluate how transferable work on model systems are to others'
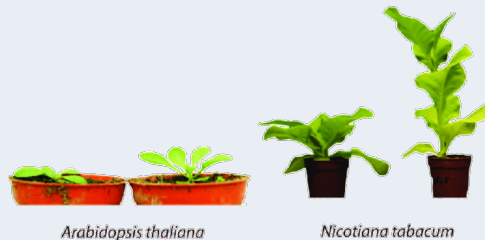
## Plants



*Arabidopsis thaliana*          *Nicotiana tabacum*

Figure 2: Example of *Arabidopsis* and *Nicotiana*

# Promoter study

## Procedure to evaluate ?

First choose two types of promoters to study:
The most constitutively expressed and Nitrogen-responsive
For each promoter type:

1. Identify motifs where TFs bind, check if any TFs are commonly used
2. Determine whether any patterns or similarities are present in groups/types of TFs
3. Incorporate nucleosome occupancy data (whether DNA is wrapped around a nucleosome or is open)
4. Verify hypothesis in lab