Tool Development for Transformational Biotechnology Advances

Breakout Session: Engineering Tools

Transformation/Analytical Tools

Gene-delivery methods

- Agrobacteria
- Viral
- Biolistics
- Electrotransfection
- Polyfection
- Lipofection
- Injection-based methods
- Wave/beam mediated
- Dessication

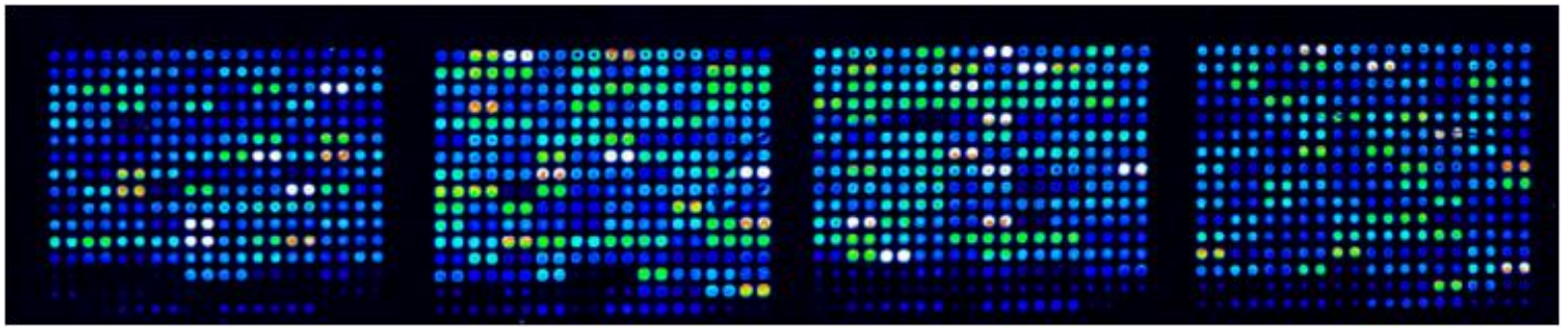
Analytical methods

- Mass spectrometry
- Radiolabeling
- Fluorescence-labeling
- PCR
- ‘omics
- Visual analysis

Transformation/Analytical Tools

- The combination of photolithography and molecular biology led to the development of high throughput DNA analysis (DNA microarrays) and established the field of genomics.

- One of the first examples of a high throughput analytical tool for a biological system.



Goals

The focus of this session is to:

1) Discuss briefly the state of the art in engineering approaches used to dramatically increase the throughput and efficiency of formerly time-consuming, delicate, and manpower-intensive tasks.

2) Clarify to ARPA-E what are the most promising approaches that can be applied for the characterization of plants and what challenges are involved in developing these technologies.

3) Identify how we can leverage the engineering approaches (identified above) to dramatically increase the throughput and efficiency of plant transformations and phenotype analysis.

Please try to consider…

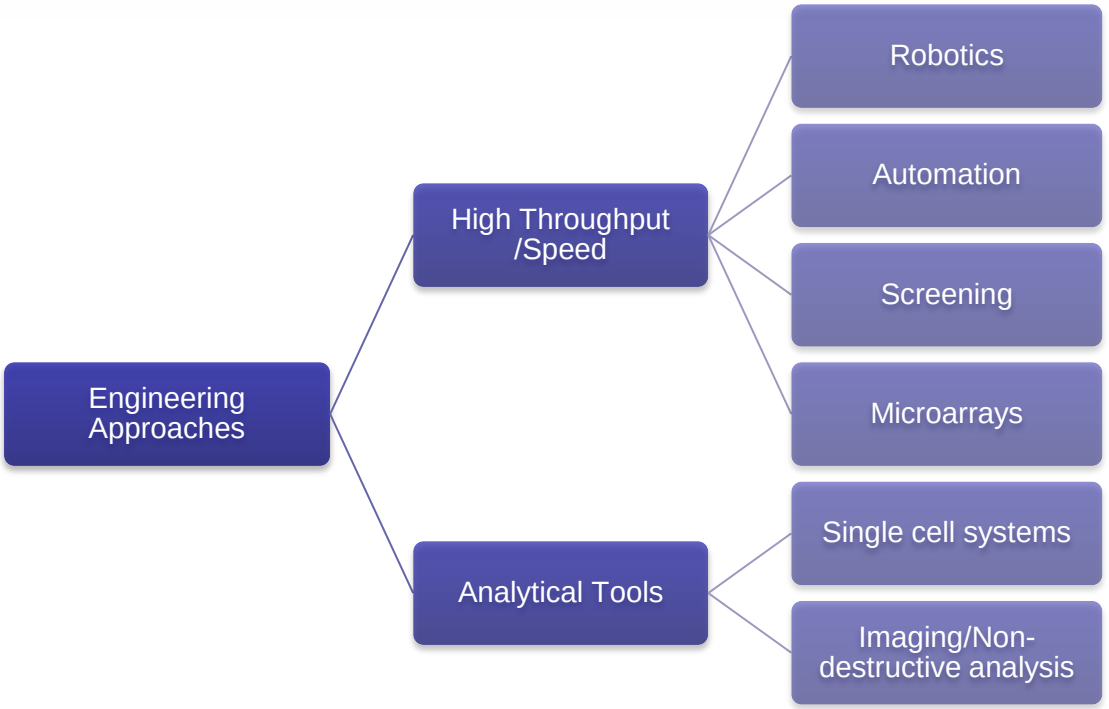
- **What are the quantitative (theoretical) limits of technologies?**
- **If a technology improvement works at 100%, what would the impact on plant transformation or analysis throughput be?**
  - What factors might reduce this impact, and how might they be quantified?
- **How can we reduce these ideas to practice?**
  - What is the current and target TRL (technology readiness level)?
  - Is the idea science, engineering, or both?
  - What tools/techniques are needed to move the technology up the TRL scale?
- **Is a technology breakthrough in a 3-5 year timeframe realistic?**
  - What are the aspects of the technology that constrain development?
  - Are there advances in related fields that could shorten the timeline?

Please try to consider…

ARPA-E is not looking to fund basic research into better understanding the processes behind these analytical techniques or instrumentation.

Engineering & Analytical Tools

- Transformation
- Phenotyping



Questions on Transformation:

1) What aspects of plant transformation (including transient expression in tobacco or tissue culture) can be automated that reduces manpower and increases reliability? What capabilities would be needed?

- Hard to teach a robot what makes a good versus bad callus
  - Need highly trained “artists” , need a better way to define a good callus
- There may be opportunities to use smaller callus samples in an array that can be analyzed
- Would be great to speed up some of the labor-intensive processes by using robotics to keep a plant maturing after callus development
- Needs
  - biomarkers – metabolic, genetic and morphology
  - modeling - prediction
- Questions
  - Can you shrink down the culture needed to develop a plant

Other topics

- Can we leverage our experience from semiconductor development for the analysis of plants?
  - Can we develop a substrate/planar technology that can be handled as an array, working on many samples in parallel (potentially a leaf?)
  - Scan the samples with an instrument

Questions on Analysis:

2) Are there roadblocks that stand in the way of automating the sequencing and analysis of plant genomes?

Questions on Analysis:

3) Are there reliable methods of massive parallel metabolite analysis that might be useful to increase throughput? What would it take to develop these methods?

-there are methods, but they might not be reliable

Questions on Analysis:

4) What non-invasive/non-destructive methods are available for manipulation and analysis (e.g. assay metabolite/protein levels) of single cells in an automated fashion? In contrast, what are the capabilities of systems that can analyze larger tissue samples or complete organisms?

- Can do single-cell analysis, just a question of how useful it will be