Engineering impossible materials

Products at Zymergen

July 2018

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Megatrends create significant opportunities for our industry

Where should we focus?

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Molecular innovation is urgently needed across verticals

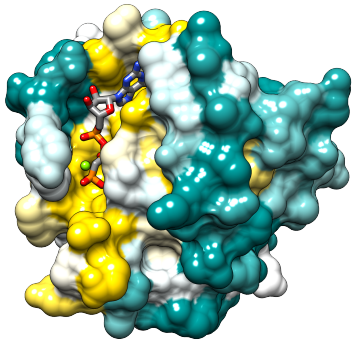
Chemicals and Materials

Product innovation (e.g. digital, wearables, electric vehicles) is creating demand for new materials

Agriculture

Constantly **evolving pest pressure** and challenging growing conditions (e.g., marginal land, climate) putting pressure on agriculture

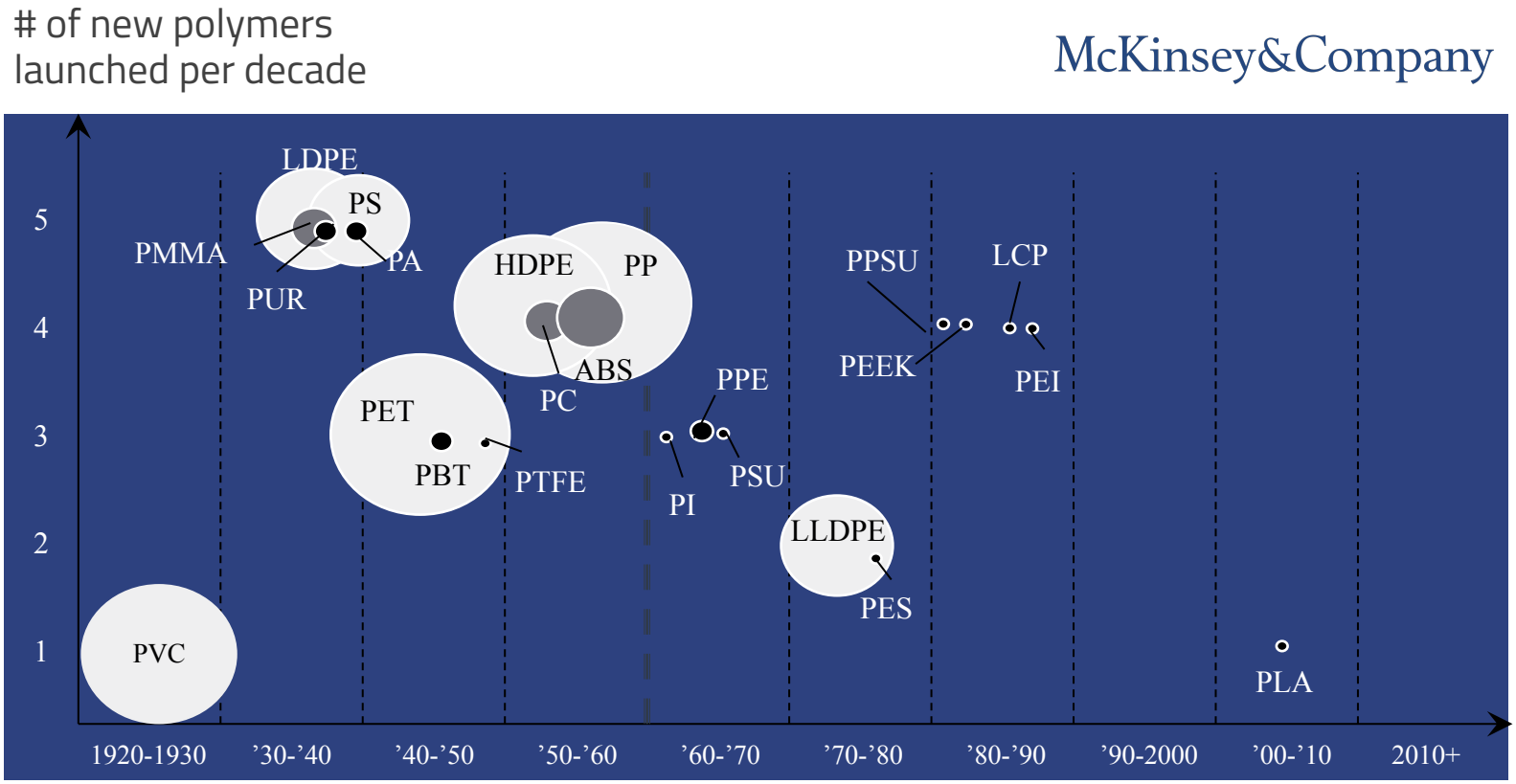
Healthcare



70-80% of potential **drug targets** not addressable by traditional drug classes (i.e., synthetic chemistry, antibodies)

However innovation from the traditional suppliers of molecular technology has stalled

High-risk launches no longer generate favorable IRR (<8-12%)



Source: Chemsystems, Price Waterhouse Cooper

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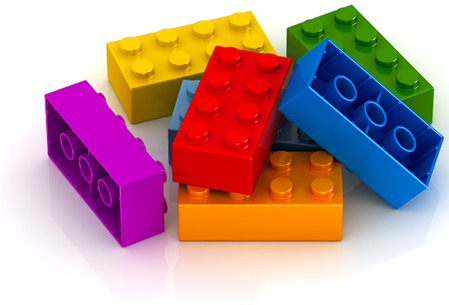
More “Building Block” molecules will enable the next generation of innovative products

Few blocks/molecules



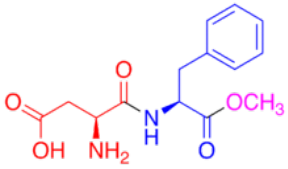
Simple products

Complex blocks and shapes

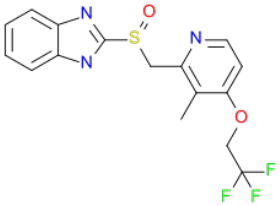
Complex products

Biologically derived molecules have unique chemical potential to create new materials and products

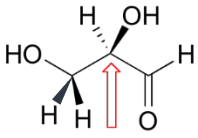
Multi-functional groups

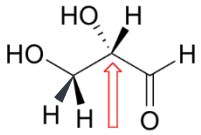


Heteroatoms

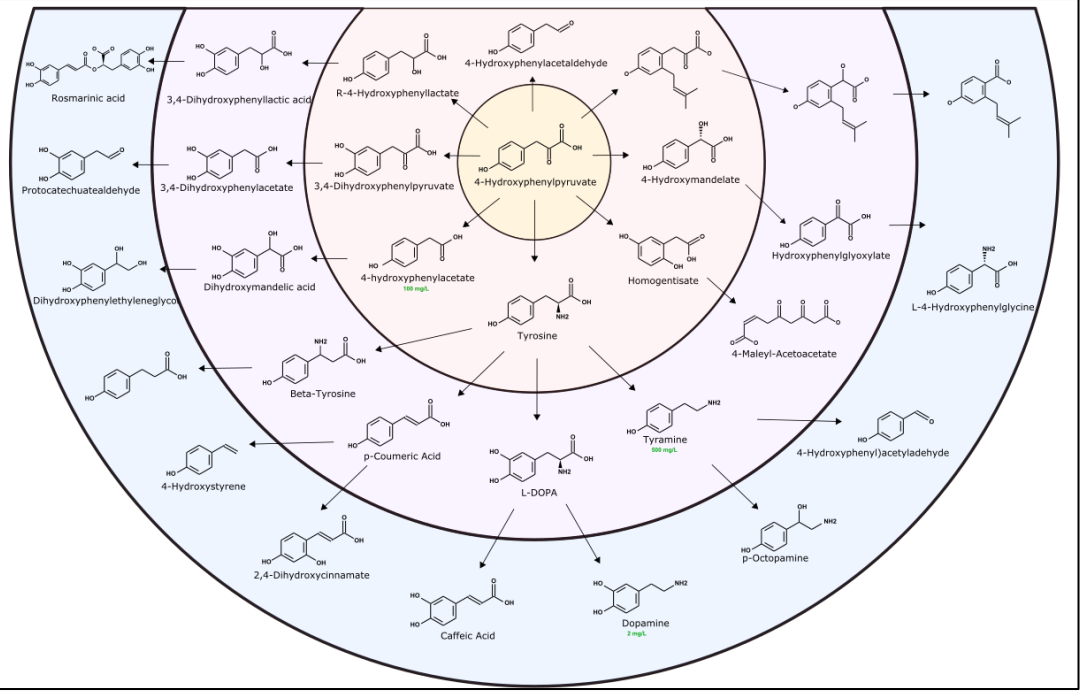


Chirality





Many variations possible based on pathway design



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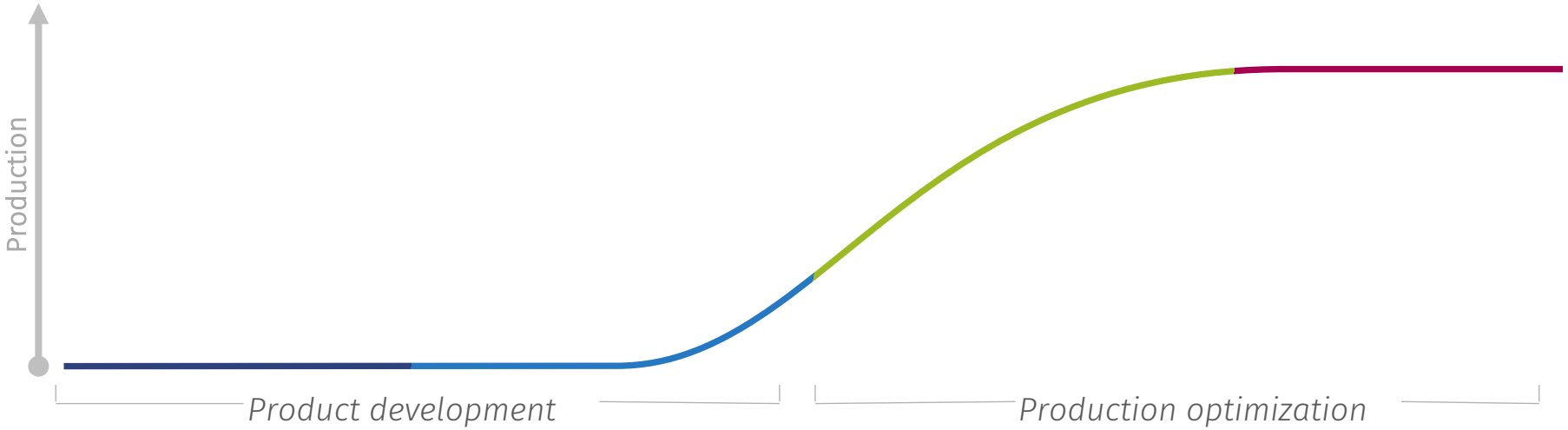
The Zymergen platform enables molecular discovery, optimization and improved production economics



1/ Discovery

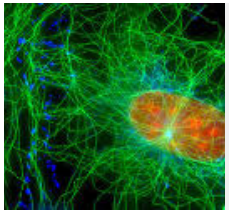
2/ Molecule optimization

3/ Strain development

4/ Competitively advantaged economics

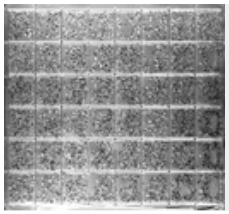
Our approach accelerates the pace of discovery by treating biology as a data science.

We search beyond the bounds of human intuition.



Proprietary Databases of Molecular Diversity

World's largest databases of bioreachable small molecules and metagenomics libraries to discover and rapidly prototype new products



Cutting-Edge Molecular Biology

Techniques to test large perturbations across the genome and industrialize even the most intractable hosts

Fully-Automated Integrated Platform

Increases the capacity of a researcher to perform experiments by >1000X with significantly less error

Proprietary Machine Learning Algorithms

Flexible data infrastructure captures information, fast search capabilities mine data across the process, and proprietary algorithms increase effectiveness of future experiments

For delivery, we would work with a large existing industrial base for fermentation

Large existing fermentation install-base ...

.. which we can leverage to serve markets at any scale

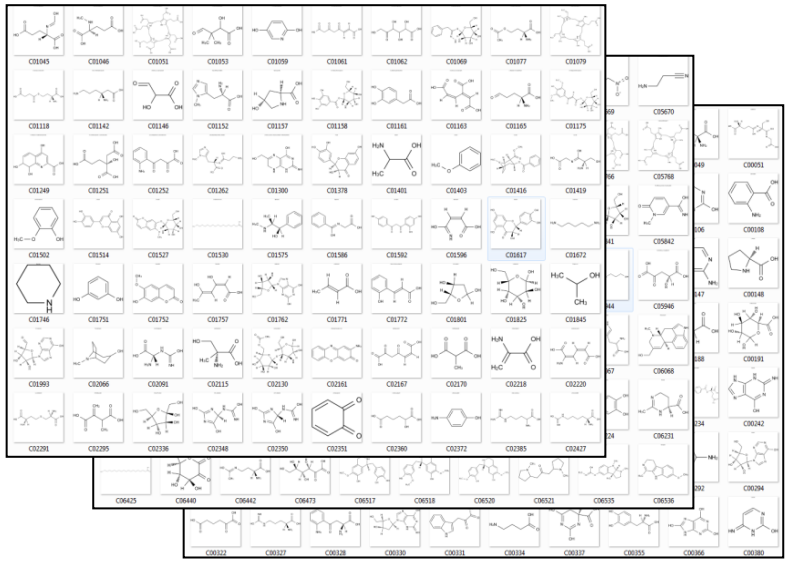
1. Relationships with fermenters from our Strain Optimization business provides us **access to excess production capacity** to deploy production strains into

2. Process development and technology transfer capabilities **proven to enable production at-scale**

As our technology discovery and optimization platform improves, we are confident in we can scale production via tolling

Zymergen has identified > 4,000 molecules, all candidates for innovative new products and materials

We have generated a list of bioreachable using a proprietary algorithm



4,000+ bioreachable molecules are curated in the bioreachable database

… that are truly differentiated from what is available today

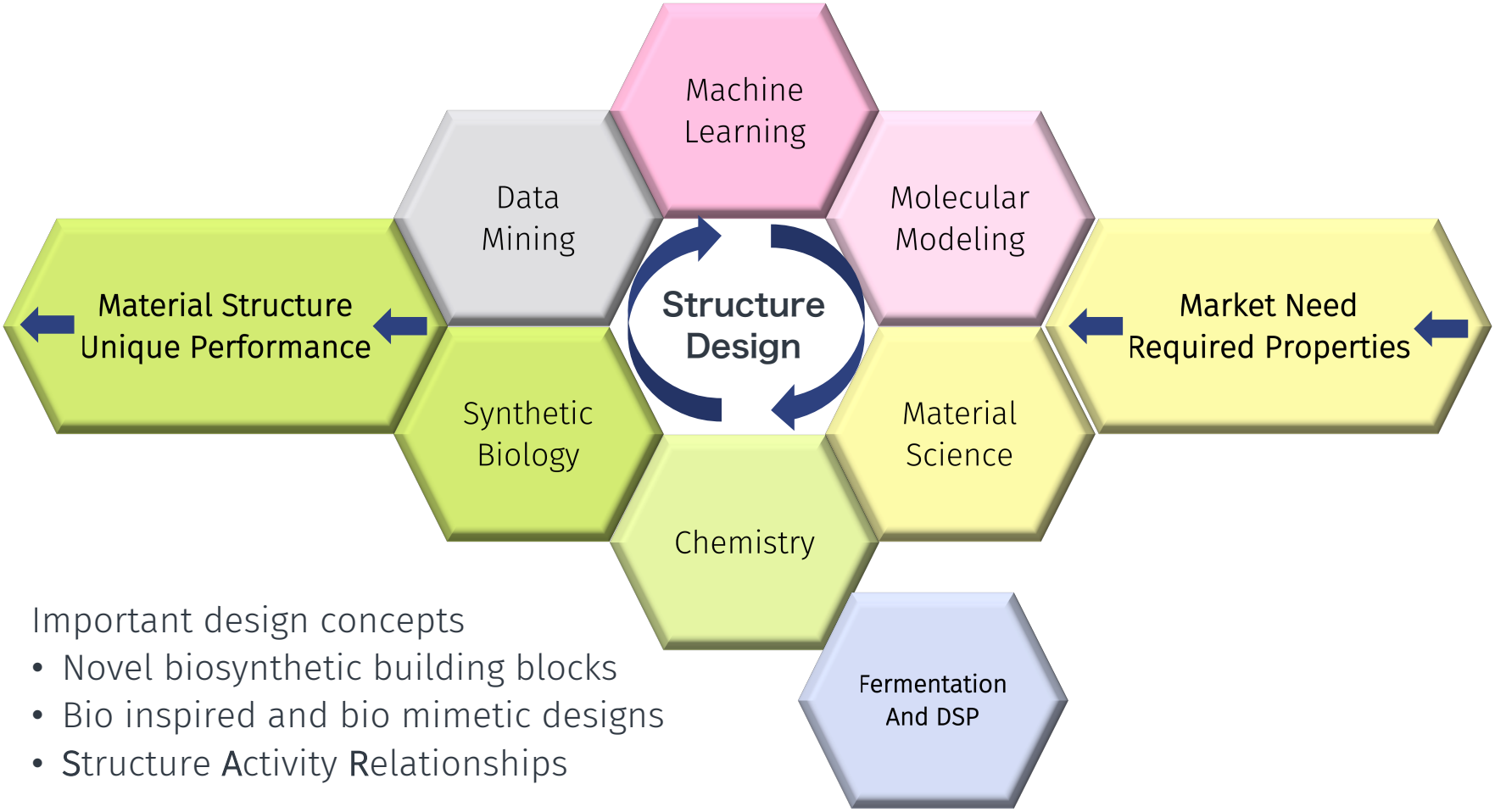
Out of 4,000 molecules in our database (Mercator):

- 2,700 are **completely novel**
- 1,300 are available at research scale **only** from vendors
- These new structures may be **produced cost effectively** via synthetic biology
- Many offer **new structural diversity** for materials
- We can expand the structural space with additional chemical conversion

- How do we develop new materials?

Our multidisciplinary design process creates new materials and products based on these bioreachables

Molecular architecture elements

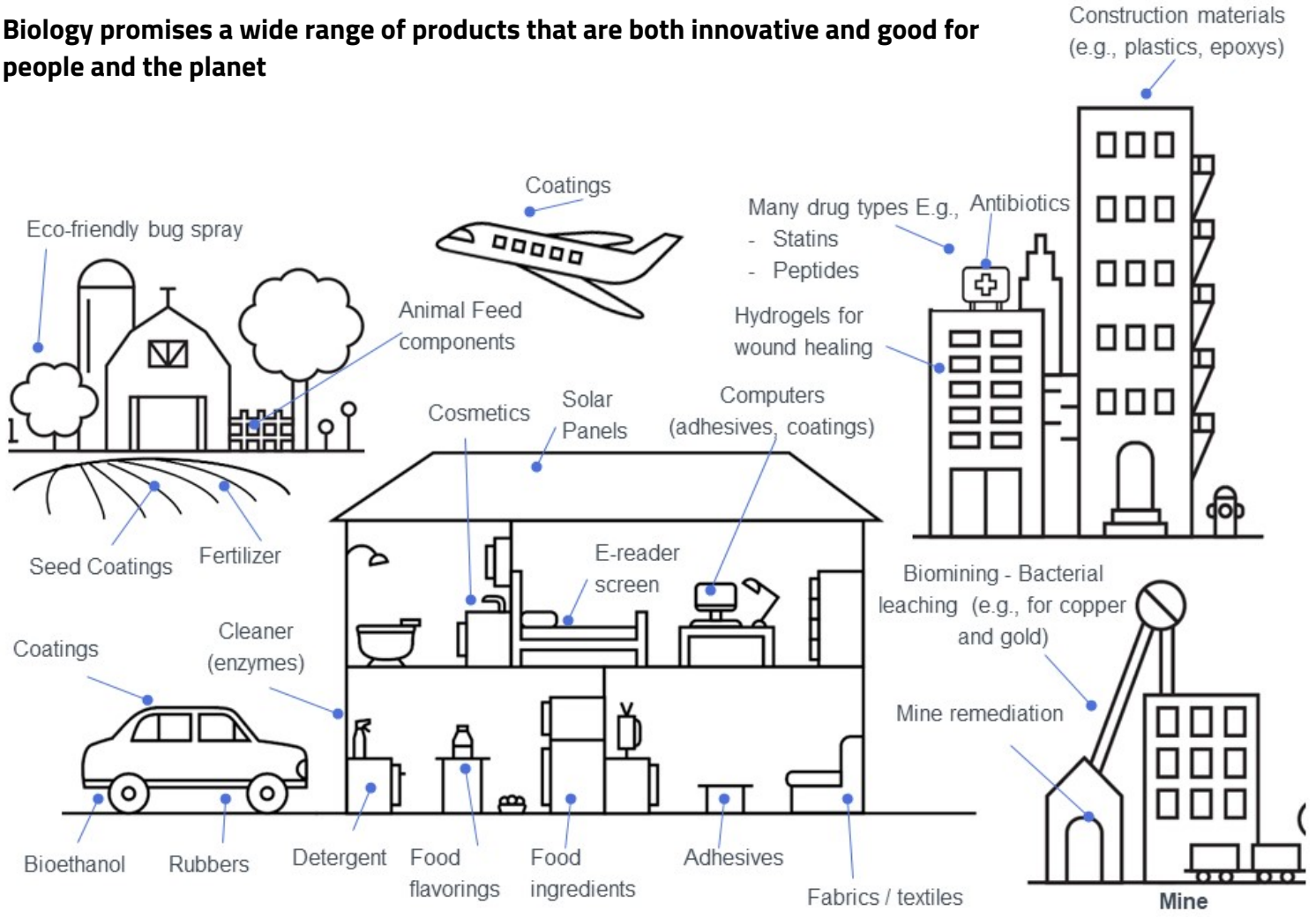


Important design concepts

- Novel biosynthetic building blocks
- Bio inspired and bio mimetic designs
- Structure Activity Relationships

The opportunity for novel molecules/materials from biology has been promising but not yet delivered

Biology promises a wide range of products that are both innovative and good for people and the planet



We have developed innovative bio-based materials that support the electronics industry

Examples of some material prototypes for adhesives, coatings and films

Adhesives

A family of adhesives and adhesion promoters that bond multiple substrates

Coatings

Sealants with higher cross linking, very high solids, no halogens, and bio-sourced

Hard coatings that are flexible

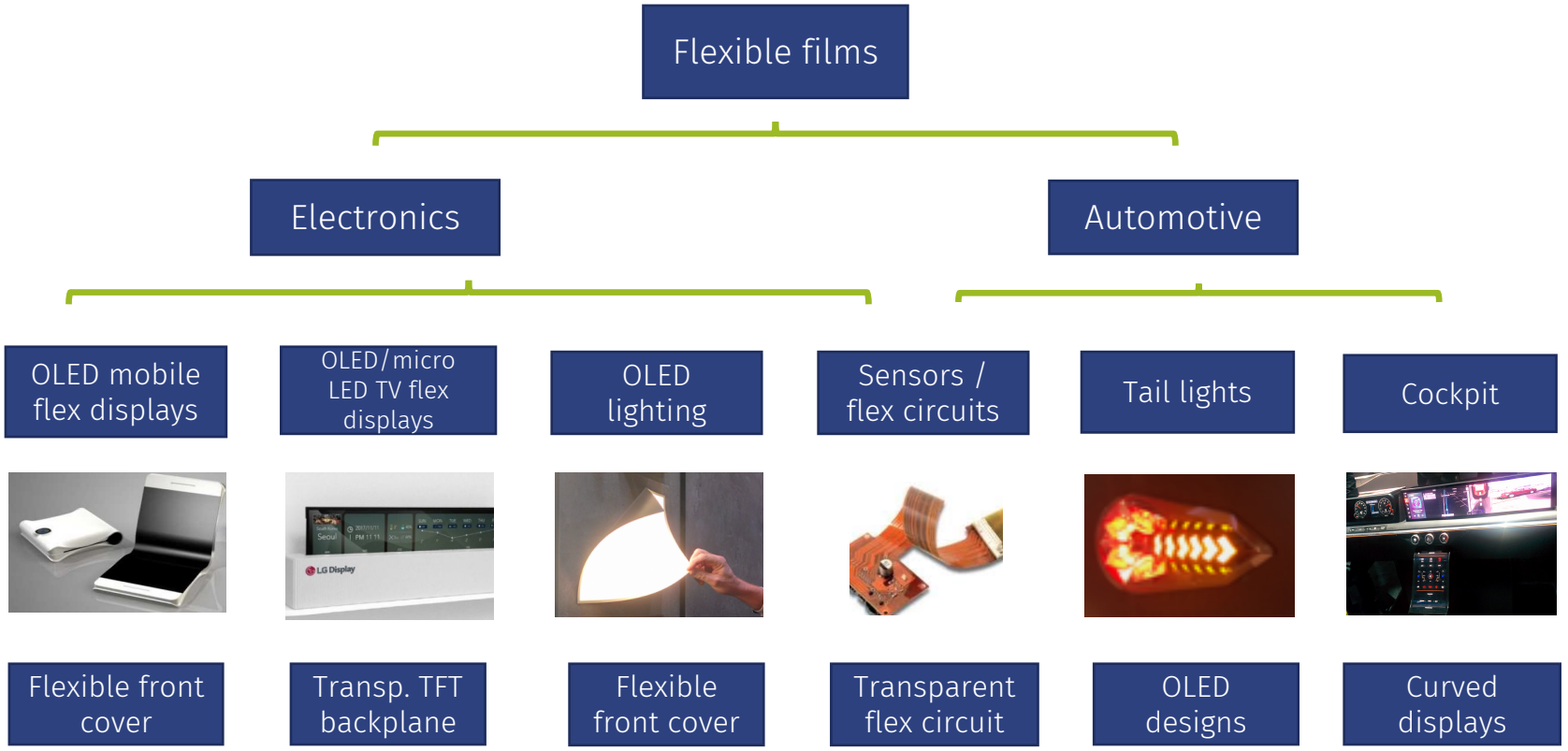
Soft coatings with wear resistance

Films

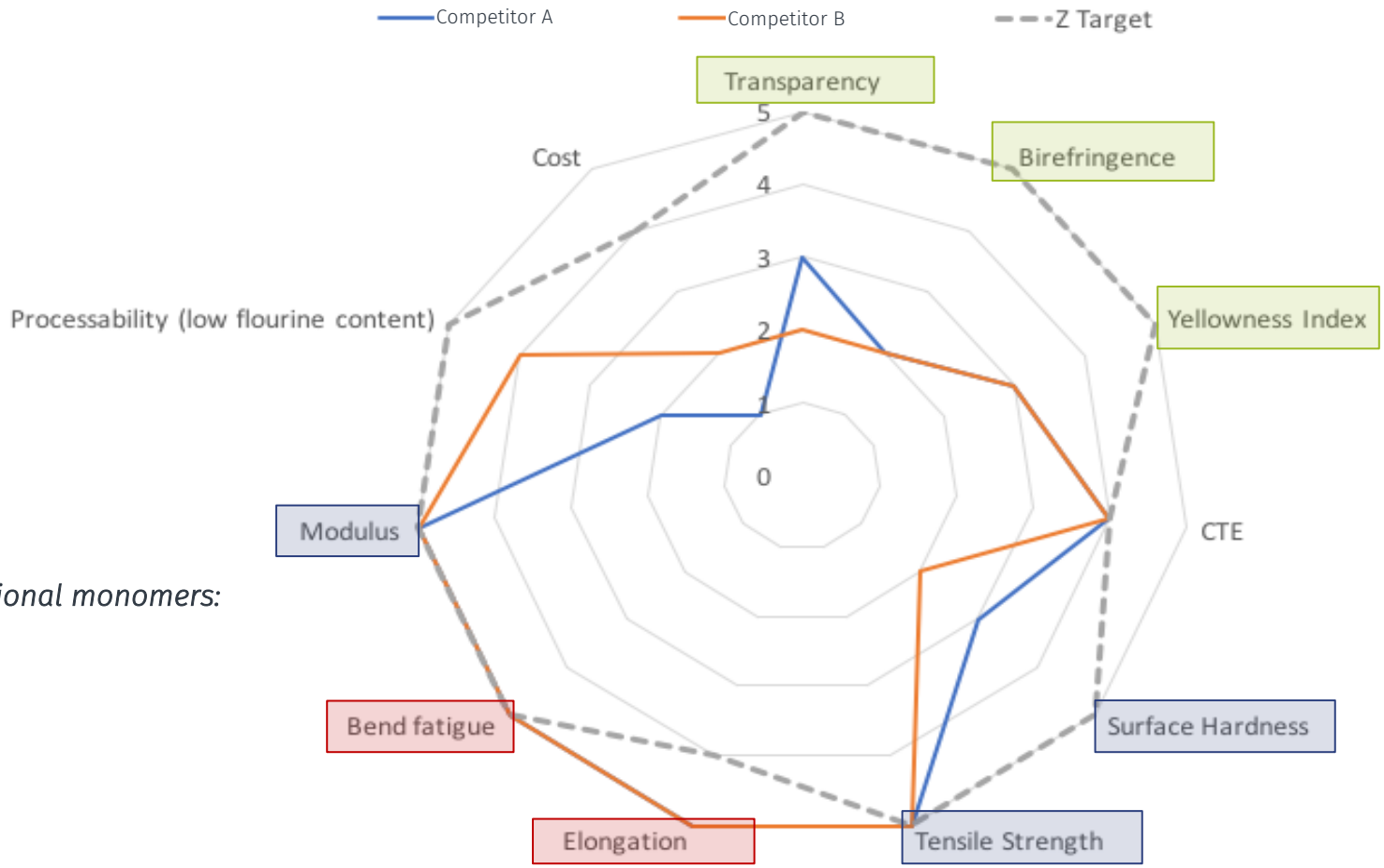
Optically transparent, flexible, non-yellowing, no birefringence, for displays

High temperature, opaque for flexible printed circuits

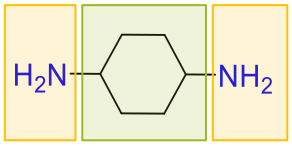
We explore new opportunities for display film enabled by our broad palette of new monomers available

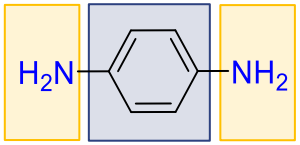


Film example: Our 20+ new monomers enable novel materials to achieve specs and deliver performance not possible with synthetic chemistry



Examples of conventional monomers:





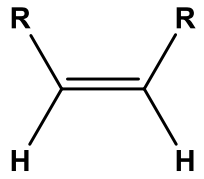
Coatings with bio-derived molecules enable tuning to balance mechanical and chemical properties

Zymergen has access to a novel palette of bio-derived chemistries with unique properties including chiral centers, multiple functional groups and heteroatoms.

Coating properties – *same monomers, but different conformation*

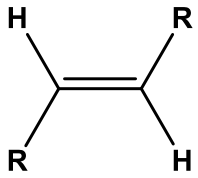
	Cis	Trans
König hardness (s)	**130**	83
Impact resistance (lbs x in)	**68**	2
Elongation at break (conical mandrel, %)	**22**	6
MEK double rubs (chemical resistance)	>400	>400

cis (same side)



Cis

trans (opposite side)



Trans

Isomers have a profound effect on **mechanical** coating properties – can tune properties based on conformation.

Isomers have a low effect on **chemical** coating properties.

Summary

1. Megatrends drive **urgent demand for new material and product solutions**
2. **Biology** offers an incredibly attractive toolbox for innovation
3. Zymergen has **>> 4,000 molecules** as building blocks
4. Zymergen is building **an integrated approach to launching new products** leveraging its molecular technology platform
5. Our first products are in **pre-launch phase** for electronics and other markets
6. **The specialty opportunity for bio-based solutions has never been better** for the biotech industry……..

Thank you

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