CBiRC
NSF Engineering Research Center for Biorenewable Chemicals

Entrepreneurship & Innovation

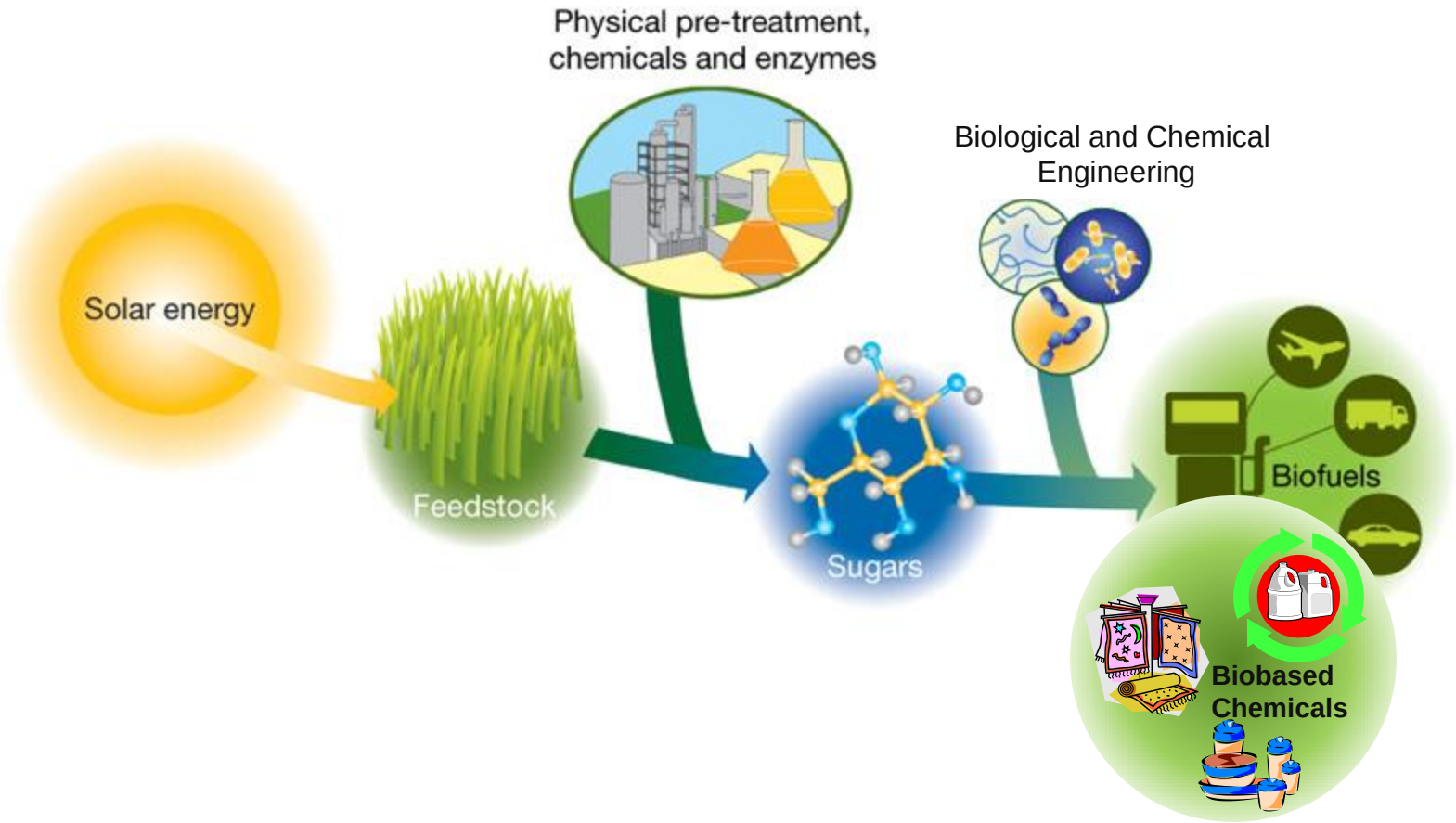
Peter L Keeling

NSF

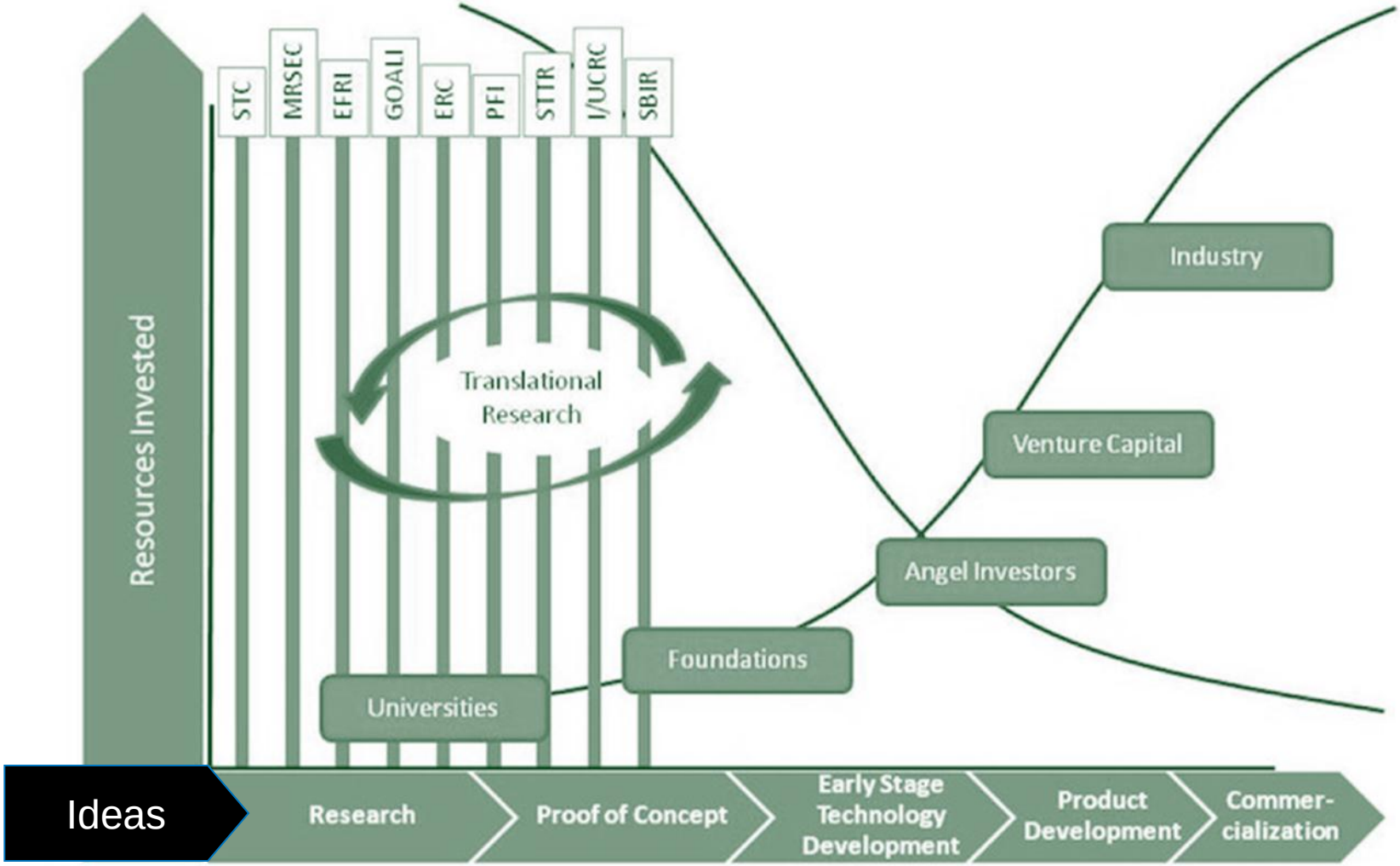
CBiRC

CBiRC
NSF Engineering Research Center for Biorenewable Chemicals

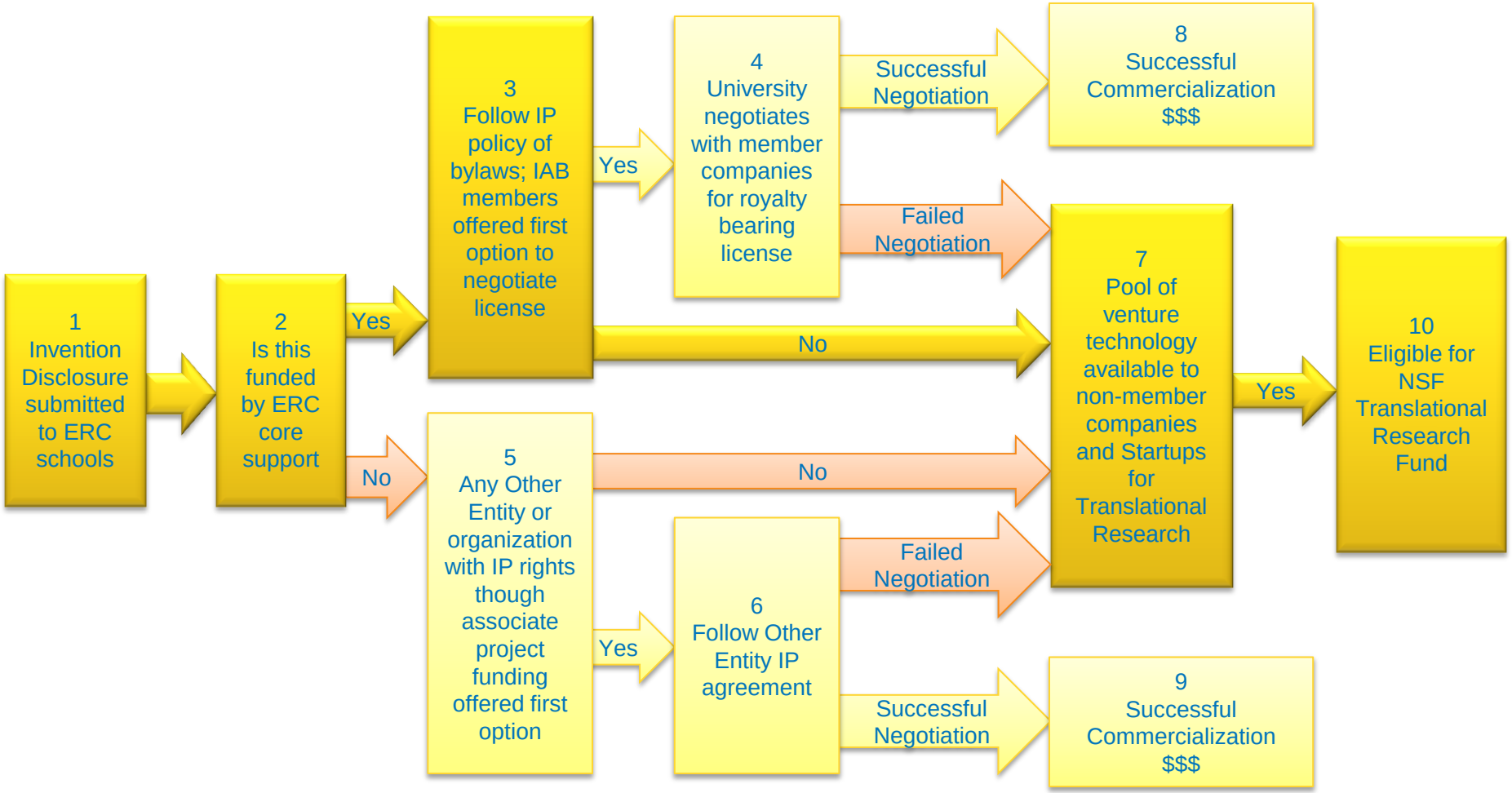
Biomass + Biological & Chemical Engineering = Biobased Chemicals



Funding Translational Research



Invention Disclosure Process



Invention Disclosures

CBiRC
NSF Engineering Research Center for Biorenewable Chemicals

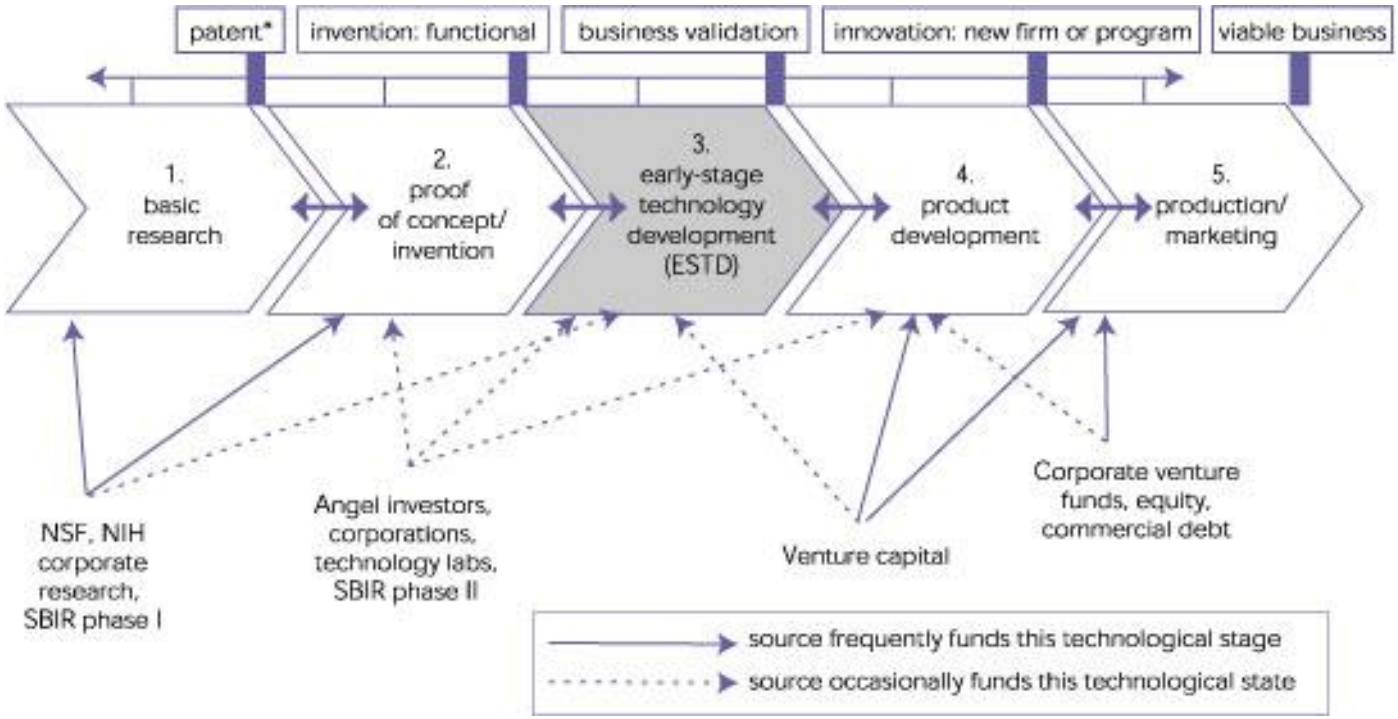
Very little taken by industry members

Patent #	Patent Title	Brief Description of Technology (non-enabling)	CBiRC	Year Filed
UM File #4421 Application	Methyl Ketone Synthases	Methyl Ketone Synthases are Central in the Biosynthesis of Methylketones from Intermediates of the Fatty Acid Biosynthetic Pathway.	CBiRC U.Michigan	2009
ISU File #03768 1 Abandoned	Selective Dehydration of Hexoses.	Selective Dehydration of Hexoses to 5-hydroxymethylfurfural. Abandoned due to earlier patent application by Wisconsin (WARF).	CBiRC Iowa State	2009
ISU File #03796 Application	Alpha Olefins from Organic Acids	Alpha Olefins from Organic Acids	CBiRC Iowa State	2010
ISURF #3864 1 Disclosure	4-Alkyl Benzoic Acids	Synthesis of 4-Alkyl Benzoic Acids	CBiRC Iowa State	2010
P100264US01 WARF Application	Pyrone Ring Opening	Production of 2,4-Hexadienoic Acid and 1,3- Pentadiene From 6-Methyl-5,6-dihydro-2-pyrone	CBiRC U.Wisconsin	2010
ISURF #03827 1 Disclosure	Acyl-CoA Synthetase and Redox	Control of Acyl-CoA Synthetase by Modifying Redox Regulation	CBiRC Iowa State	2010
2010-048 RICE 6 Disclosures	Bacteria and Methods for Synthesizing Fatty Acids	A Recombinant Bacterium and a Method for Producing Fatty Acids (Multiple disclosures being combined into a single filing)	CBiRC Rice Univ	2010
ISURF #03919 Application	Novel Thioesterases	The Functional Characterization of Novel Thioesterases for the Production of Functionalized Carboxylic Acids.	CBiRC Iowa State	2011
WARF #P110282 Application	Diones from Pyrone	Production of Pentane-2,4-dione from 4-hydroxy-6-methyl-2-Pyrone.	CBiRC U.Wisconsin	2011
RICE #2012-031 Application	Free Fatty Acids	Methods to Produce Free Fatty Acids from Renewable Carbon Sources.	CBiRC Rice Univ	2011
WARF #P120054 Application	HMF from Glucose	Combined Lewis and Bronsted Acid Catalyzed Production of 5-hydroxmethylfufural (HMF) from Glucose ().	CBiRC U.Wisconsin	2011

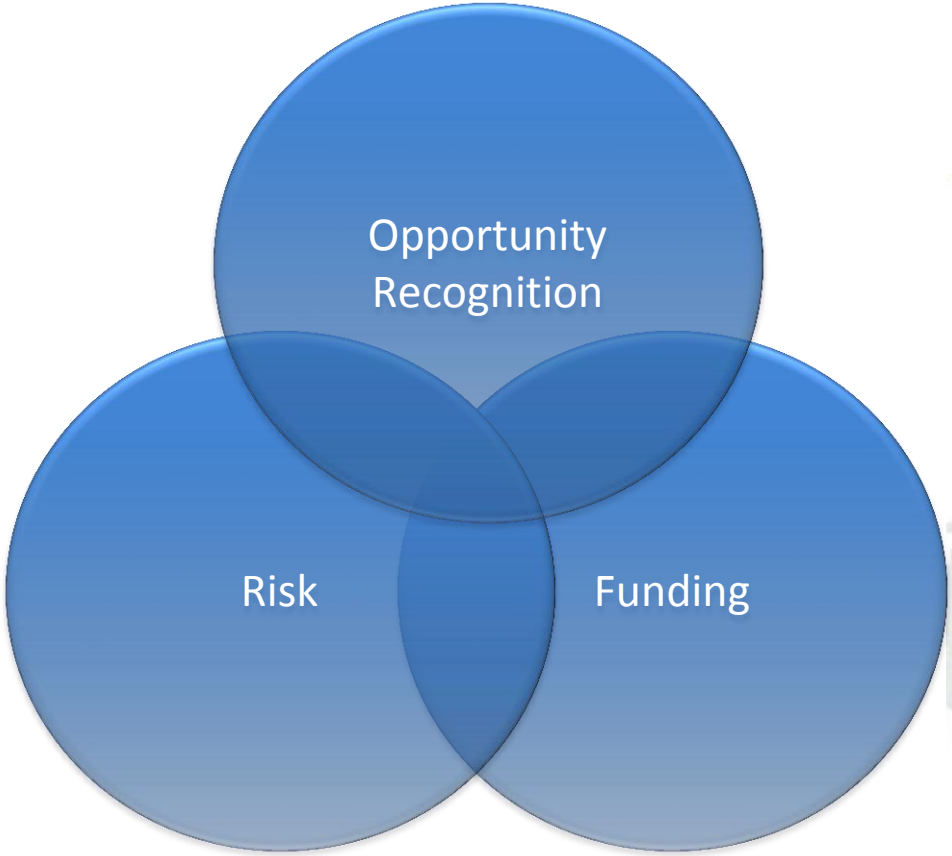
Patent #	Patent Title	Brief Description of Technology (non-enabling)	Associated	Year Filed
PCT/US2009/062440 Application	Microaerobic Cultures for Converting Glycerol to Chemicals	Microaerobic Cultures for Converting Glycerol to Chemicals	Associated Rice Univ	2009
PCT/US2010/0104872 Application	High Protein Low Starch QQS Soybeans	High Protein Low Starch QQS Soybeans for Enhanced Value	Associated Iowa State	2009
ISU File #03790 Application	Biological Isobutene Production	Biological Isobutene Production	Associated Iowa State	2010
P100099US01 WARF Application	Hydrocarbons from aqueous solutions of lactones, acids, and/or alcohols	Integrated Process and Apparatus to Produce Hydrocarbons from Aqueous Solutions of Lactones, Hydroxy-Carboxylic Acids, Alkene-Carboxylic Acids, and/or Alcohols	Associated U.Wisconsin	2010
P100112US01 WARF Application	Methyl-vinyl ketone from levulinic acid	Production of Methyl-Vinyl Ketone from Levulinic Acid	Associated U.Wisconsin	2010
2010-000 RICE Disclosure	NADP-Dependent GAPDH	Native NAD-Dependent GAPDH Replaced with NADP-Dependent GAPDH	Associated Rice Univ	2010
2011-001 RICE Disclosure	Reverse Beta oxidation for synthesis of chemicals	Reverse Beta Oxidation for Synthesis of Chemicals	Associated Rice Univ	2011
2012 NewMexico Disclosure	Synthesis of Palladium Nanoparticles	Nanostructured Catalysts for Hydrogen Generation from Renewable Feedstocks	Associated Univ New Mexico	2012
US7,927,859 JP4,771,437 Patent	High Molar Succinate Yield	High Molar Succinate Yield by Increasing Intracellular NADH	Associated Rice Univ	2012
US7,901,924 Patent	Bacterial CoA	Increased Bacterial CoA and Acetyl-CoA Pools	Associated Rice Univ	2012

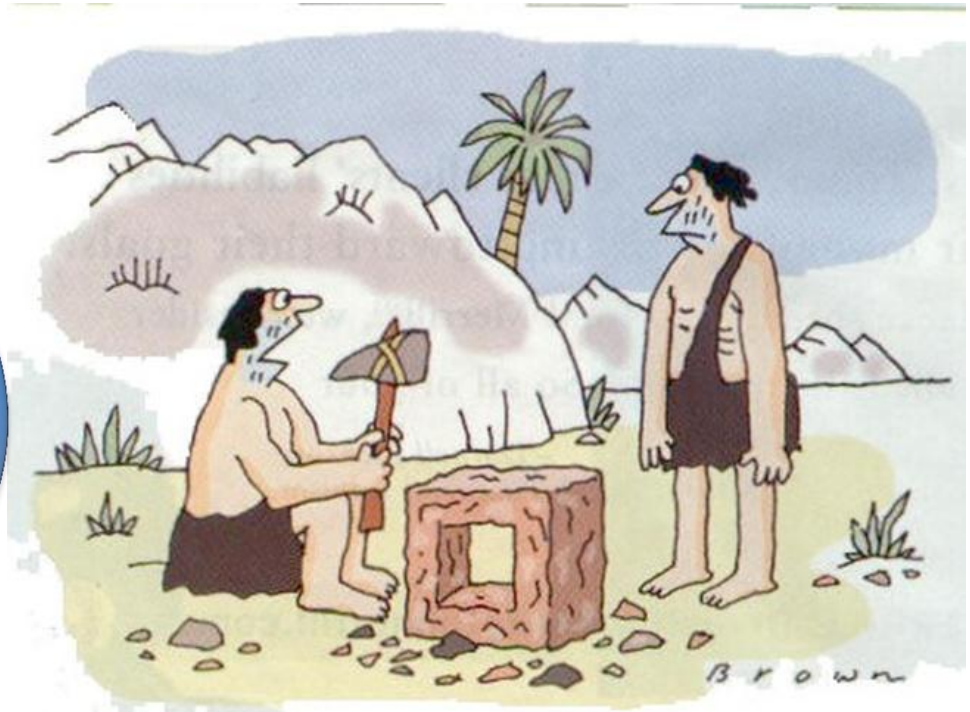
Residual Technical Risk

- **VC's "will not fund if there is residual technical risk"**



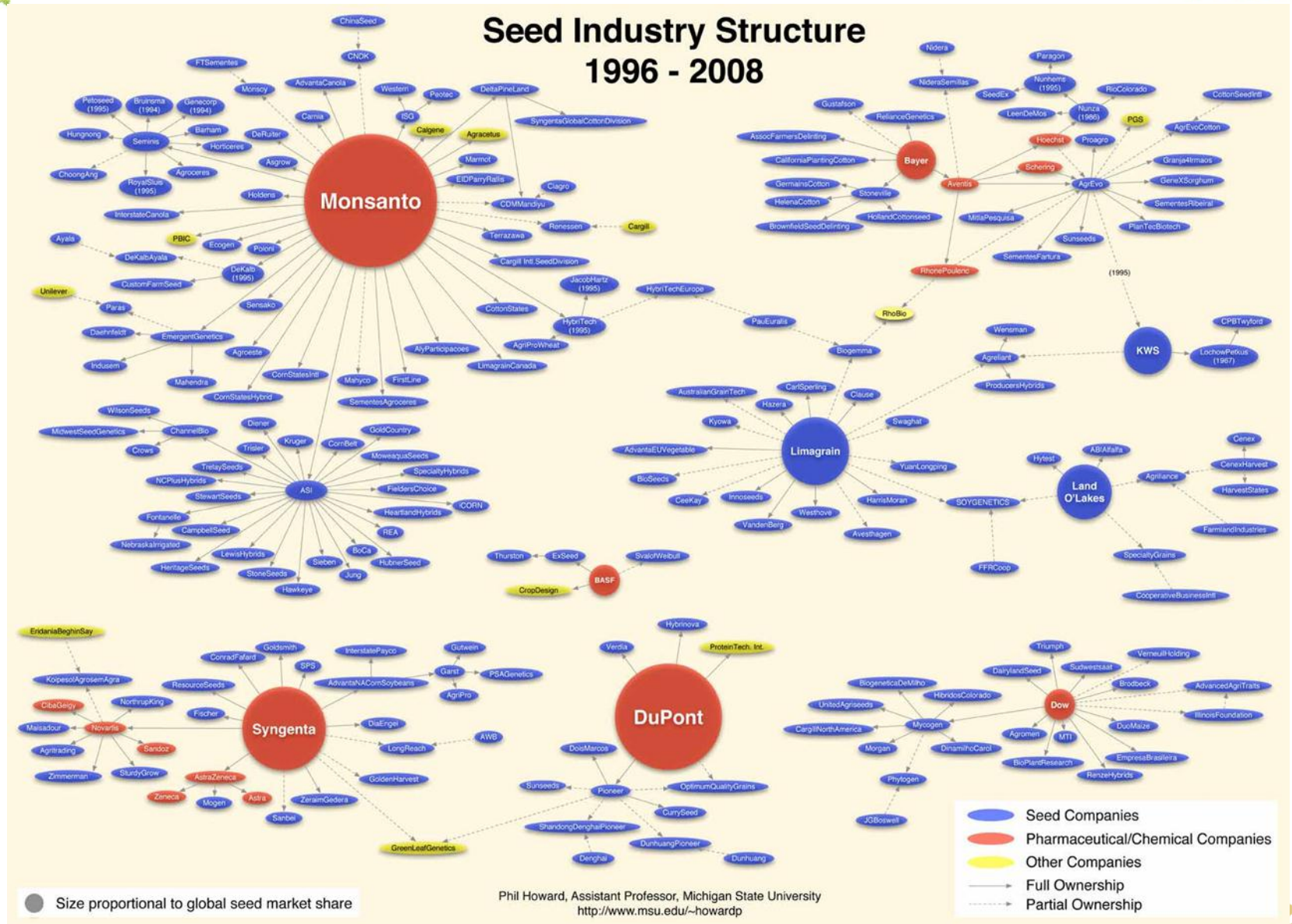
Multiple Problems





Plant Biotech Consolidation

CBiRC
NSF Engineering Research Center for Biorenewable Chemicals



Embracing Risk

- **Startups are the key**

Innovation Staging

CBiRC
NSF Engineering Research Center for Biorenewable Chemicals

Lacking formative-stage support | *Plenty of early-stage support*

CBiRC

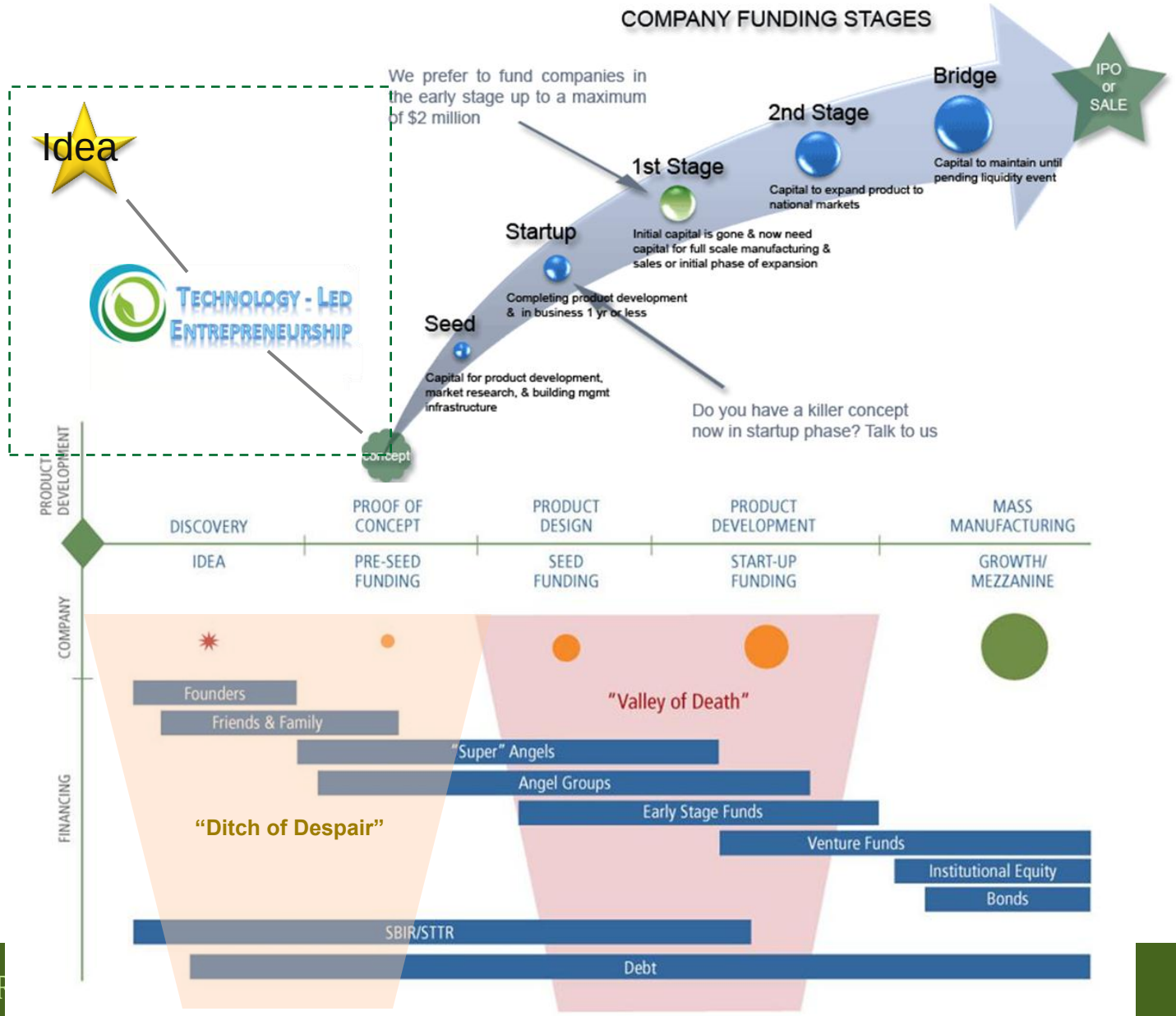
- Discovery Research
- Technology Development
- Patents and Licensing

Innovation Partners

- Local Innovation Resources
- Economic Development
- Proof of Concept / Partnering
- VC / Industry Funding

NSF

Stages of Company Funding

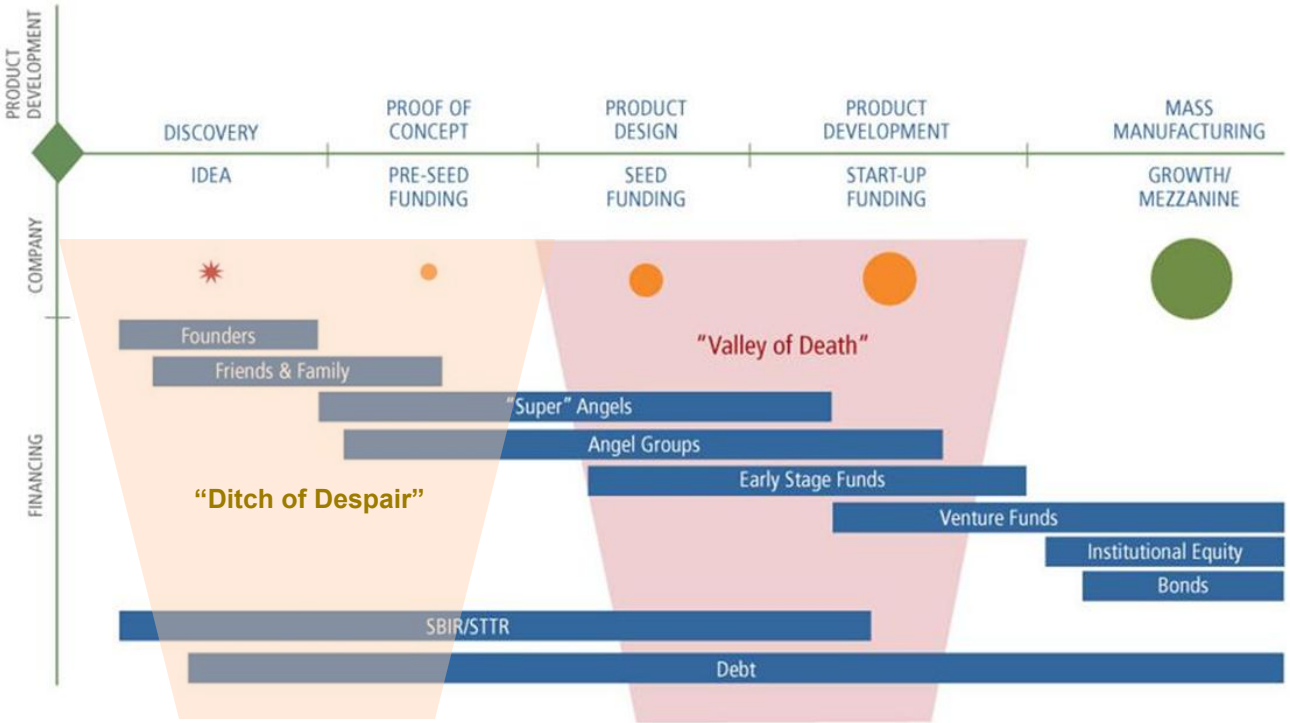


Support for Formative Stages

CBiRC
NSF Engineering Research Center for Biorenewable Chemicals

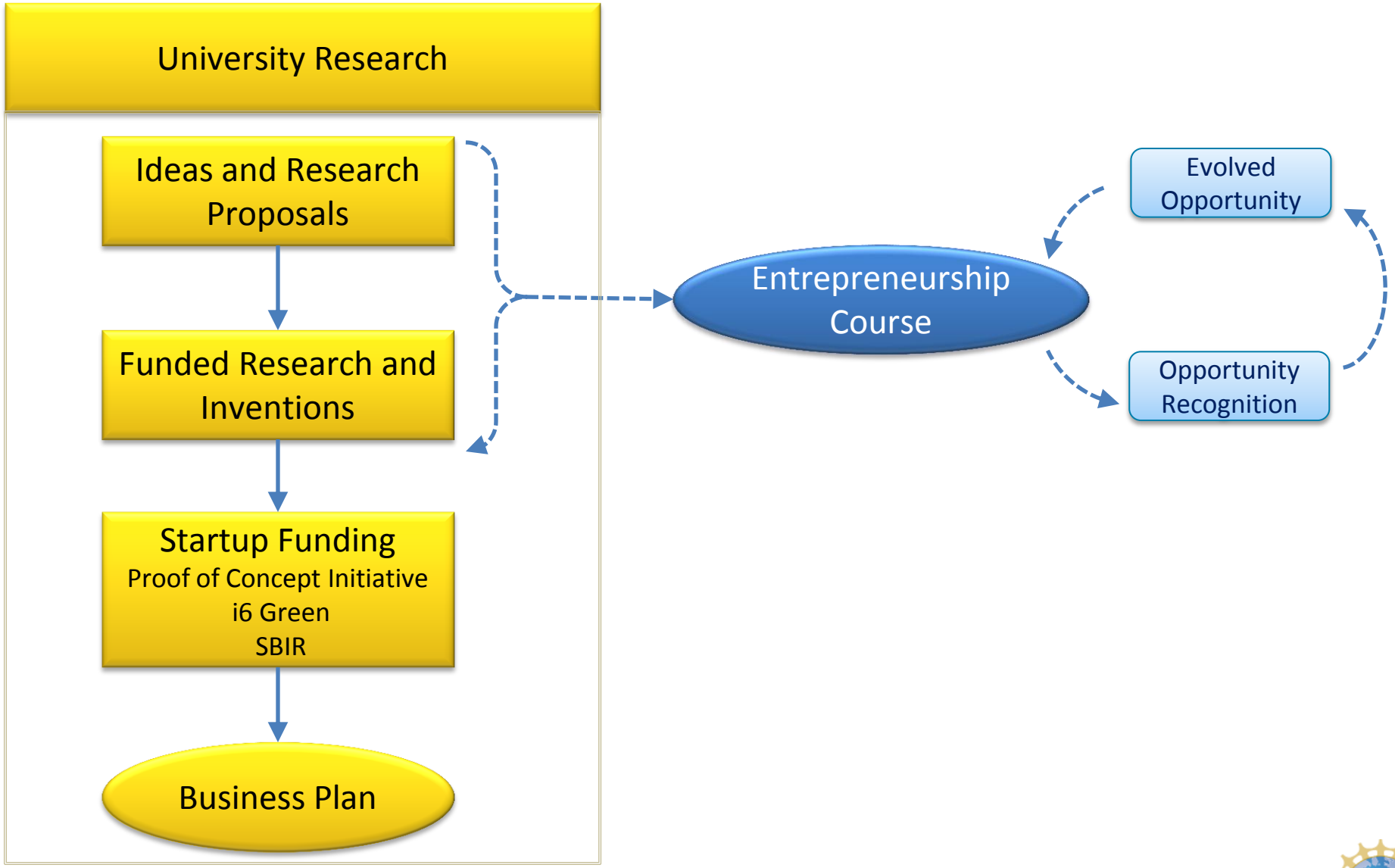
Entrepreneurship

FACULTY & STUDENTS



NSF

Entrepreneurship Course



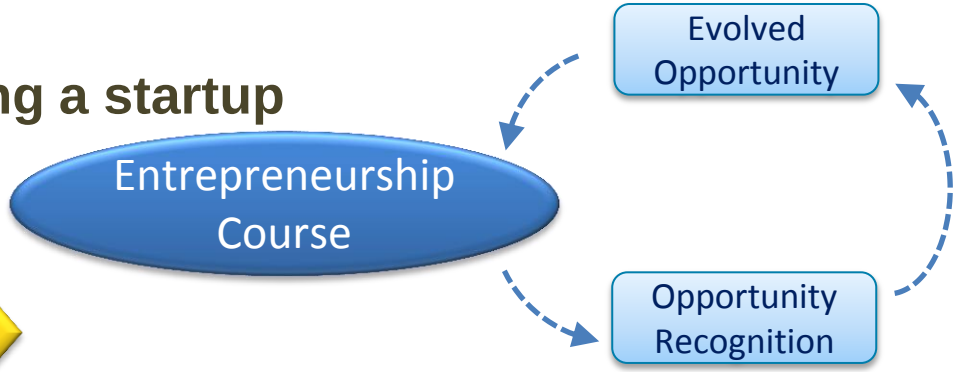
Entrepreneurship Course

CBiRC
NSF Engineering Research Center for Biorenewable Chemicals

15 Week Course in Graduate Program

Technology Led Entrepreneurship

Walk through a process of creating a startup



- Innovation, Entrepreneurship & Discovery Research
- Inventions, Intellectual Property & Risk
- Resources, Funding and Grants
- Techno-Commercial Analysis & Key Assets
- Project Management, NPV and Value Proposition
- Culminates in “The Dragons Den”

Course Output

COMPANY NAME
Project/Product Title
Author and Date

CBiRC
NSF Engineering Research Center for Biorenewable Chemicals

SARET

A renewable future

Abios pharmaceuticals

ACEGEN BIORENEWABLES, LLC

AlgeBios

PYRONEZYME

USMKetones

Permuzyme

flourogenes

perfectEn

NYLOS RENEWABLE
Catalysts for a Sustainable Future

PHYTOSCAPE

Reciclar

BioCan

CO-vorans | Bioenergy

- Executive Summary (1 page)

The executive summary introduces your business strategy in simple and unambiguous terms ("Company makes this product for that market"). This is the most important section for lending institutions.

- Management Team

Describe who you are and what skills you bring to the company. Who will be key hires in the future? Use an organizational chart to show a future concept.

- A Brief Description of the Problem

Describe the pain you are alleviating. Show that the problem is current and the solution is in demand in the near term. An evolving market can be unkind to the pioneers.

- Your Company Solution

Explain the method to alleviate the pain. Provide listing of two or three most important benefits from the perspective of the customer. Quantify the net benefit for the average customer and compute ROI.

- Business Model

Explain how you make money and primary distribution method(s) If not obvious, make it clear who the customer is (e.g., medical clinic or insurance company). Provide info on customers who are using products, or who have shown some significant interest or intent.

- Key Technology

Describe (in non-enabling ways) the fundamental discovery, intellectual property, development or trade secret that provides an unfair advantage over the competition. The goal here is to gain credibility and show sustainability via intellectual property or significant head start that will keep competitors in chase

- Market Opportunity

Show market size, prioritize segments, and show drivers of adoption, key marketing tactics and distribution method. .

- Competition

Show the competitive landscape including indirect competitors. How will you compete? Indirect competitors can be considered as a group, whereas the top direct competitors need to be discussed.

- Status Report and Future Goals

Status report, key milestones, funding, time requirement needed to accomplish milestones, and key uses of funds (e.g., research, regulatory approval, prototype dev., marketing and sales).

- NPV Analysis

Provide a 15 year forecast.

- Resources and Budget

List your company resource requirements with a 3-5 year financial projection. Include in this section a summary of your financial forecasts, with the spreadsheets you used to reach your projections

NSF

NSF I-Corps Program

CBiRC
NSF Engineering Research Center for Biorenewable Chemicals

University Research

Ideas and Research Proposals

Funded Research and Inventions

Startup Funding
Proof of Concept Initiative
i6 Green
SBIR

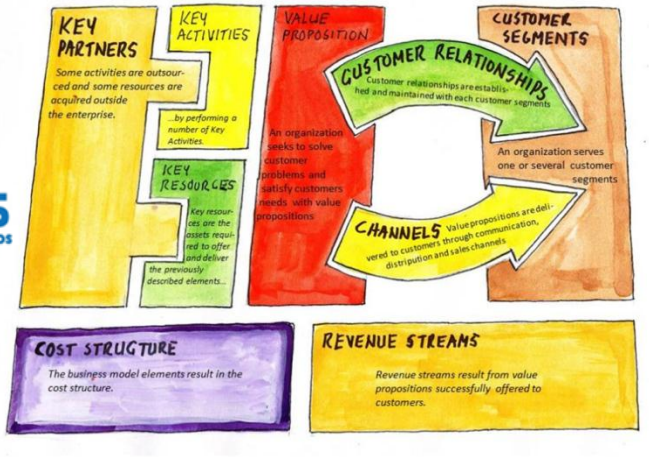
Business Plan

Entrepreneurship Course

Evolved Opportunity

Opportunity Recognition

NSF CORPS NSF Innovation Corps



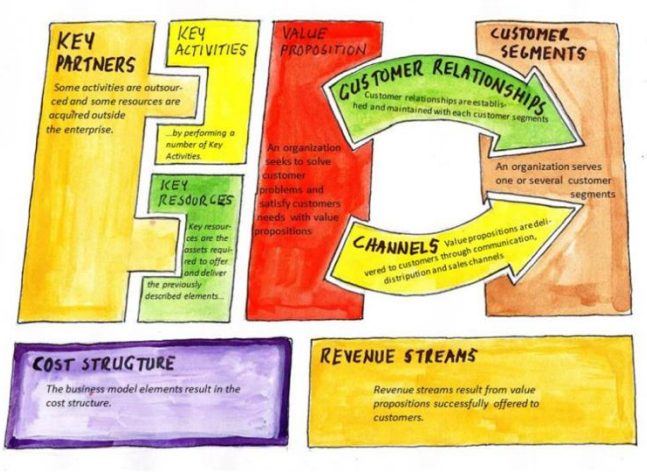
Refining the Early Stage

CBiRC
NSF Engineering Research Center for Biorenewable Chemicals

NSF I-CORPS NSF Innovation Corps

I-Corps Program takes early stage further…..

- Supports promising early ideas by connecting to customers:
  - Startup is a New Entity Seeking a Scalable Business.
  - Get out of the building to test product concept with customers.



Business Model Canvass

CBiRC
NSF Engineering Research Center for Biorenewable Chemicals

The Business Model Canvas

Designed for:

Designed by:

Date:

Iteration:

Key Partners

Who are our Key Partners?
Who are our key suppliers?
Which Key Resources are we acquiring from partners?
Which Key Activities do partners perform?

Key Activities

What Key Activities do our Value Propositions require?
Our Distribution Channels?
Customer Relationships?
Revenue streams?

Key Resources

What Key Resources do our Value Propositions require?
Our Distribution Channels? Customer Relationships?
Revenue Streams?

Value Propositions

What value do we deliver to the customer?
Which one of our customer's problems are we helping to solve?
What bundles of products and services are we offering to each Customer Segment?
Which customer needs are we satisfying?

Customer Relationships

What type of relationship does each of our Customer Segments expect us to establish and maintain with them?
Which ones have we established?
How are they integrated with the rest of our business model?
How costly are they?

Channels

Through which Channels do our Customer Segments want to be reached?
How are we reaching them now?
How are our Channels integrated?
Which ones work best?
Which ones are most cost-efficient?
How are we integrating them with customer routines?

Customer Segments

For whom are we creating value?
Who are our most important customers?

Cost Structure

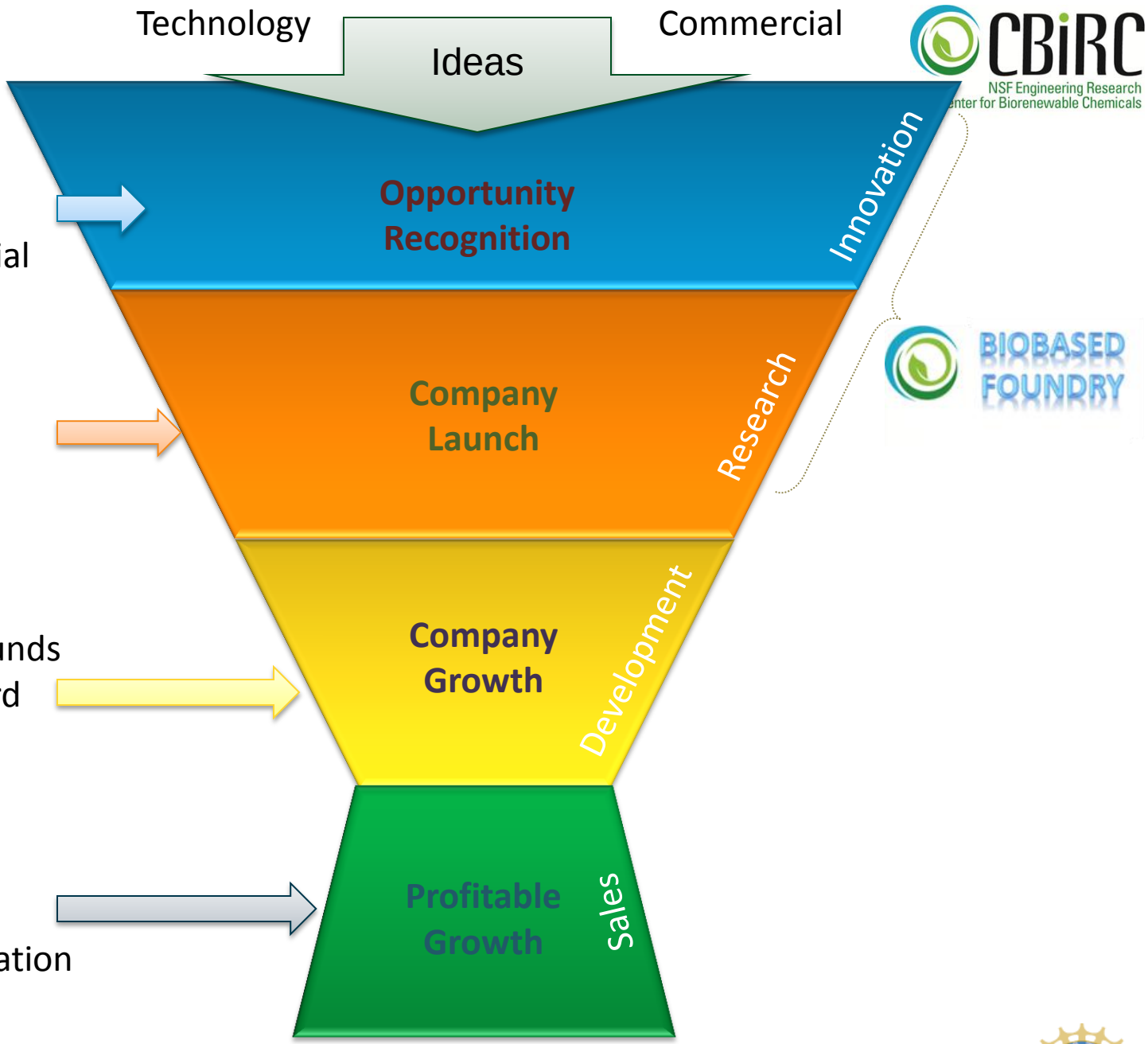
What are the most important costs inherent in our business model?
Which Key Resources are most expensive?
Which Key Activities are most expensive?

Revenue Streams

For what value are our customers really willing to pay?
For what do they currently pay?
How are they currently paying?
How would they prefer to pay?
How much does each Revenue Stream contribute to overall revenues?

www.businessmodelgeneration.com

NSF



1. Early Grants
2. Course/Foundry
3. Techno-Commercial

1. POCI Application
2. SBIR Application
3. COI Completed
4. Employees Hired

1. Grants/Awards/Funds
2. Advisors and Board
3. Venture Capital

1. Product Launch
2. Product Support
3. Product Diversification

CBiRC
NSF Engineering Research Center for Biorenewable Chemicals

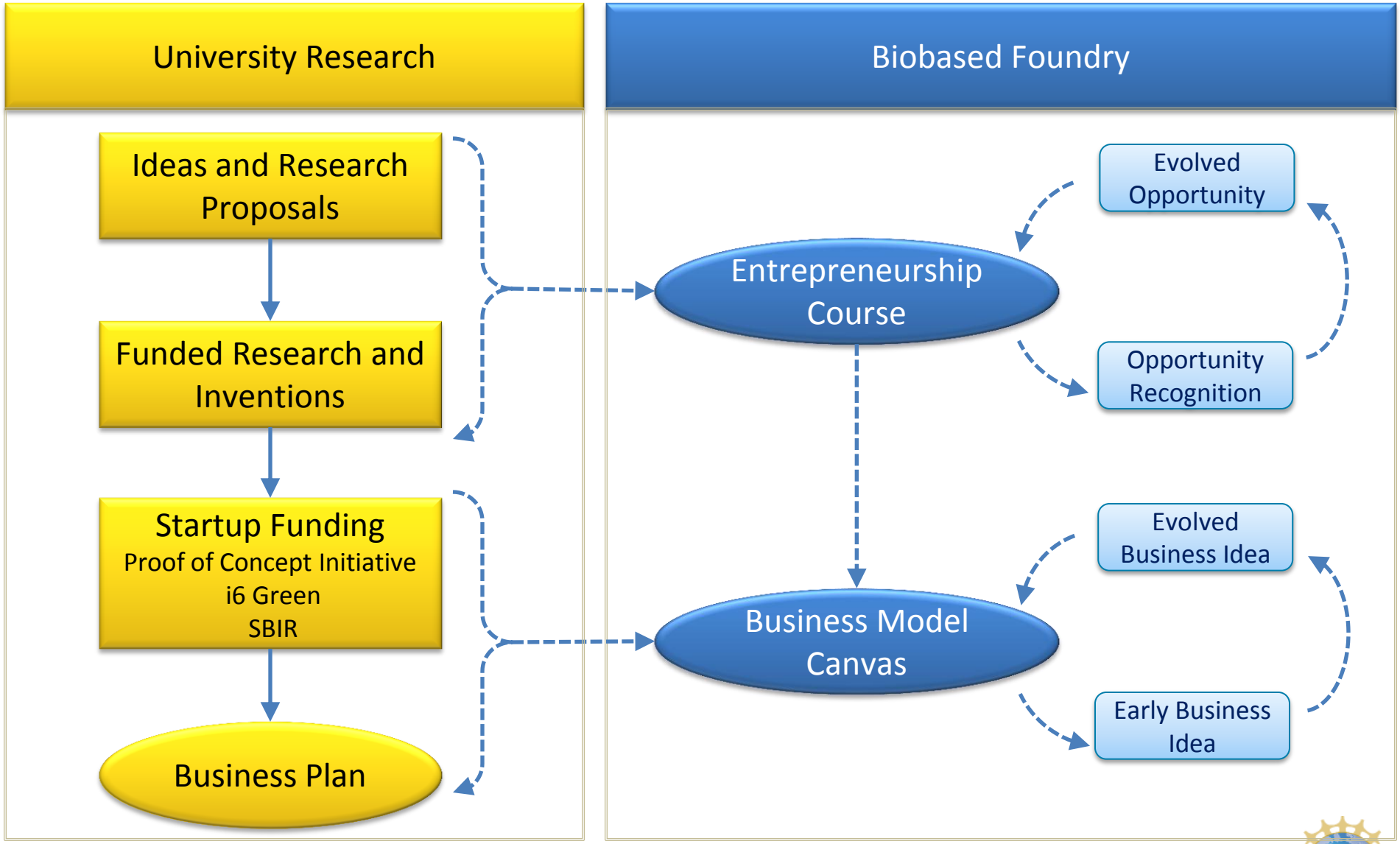
BIOBASED FOUNDRY

NSF

Foundry Concept

Current Process Flow
Proposed Additional Flow

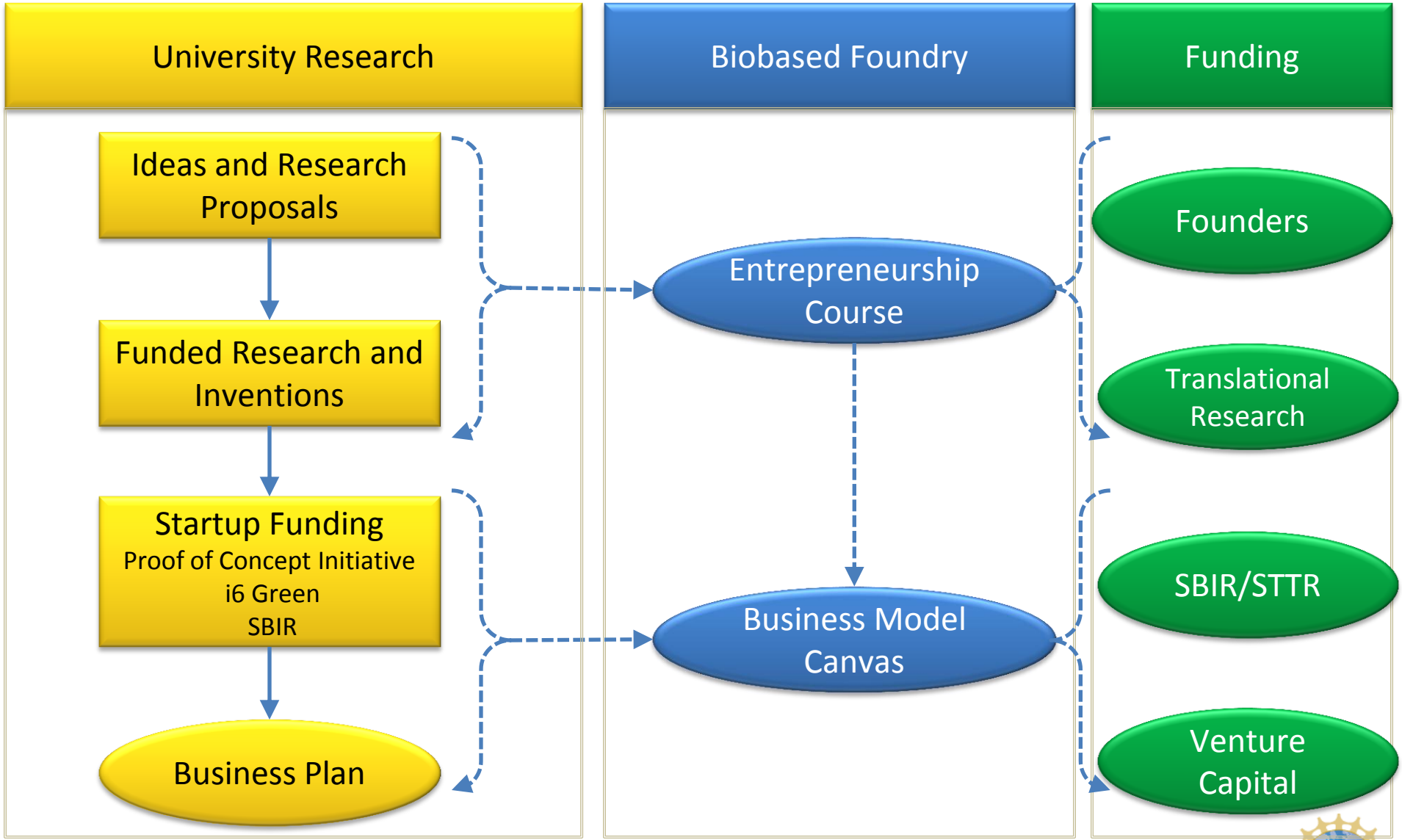
CBiRC
NSF Engineering Research Center for Biorenewable Chemicals



Foundry Concept

Current Process Flow
Proposed Additional Flow

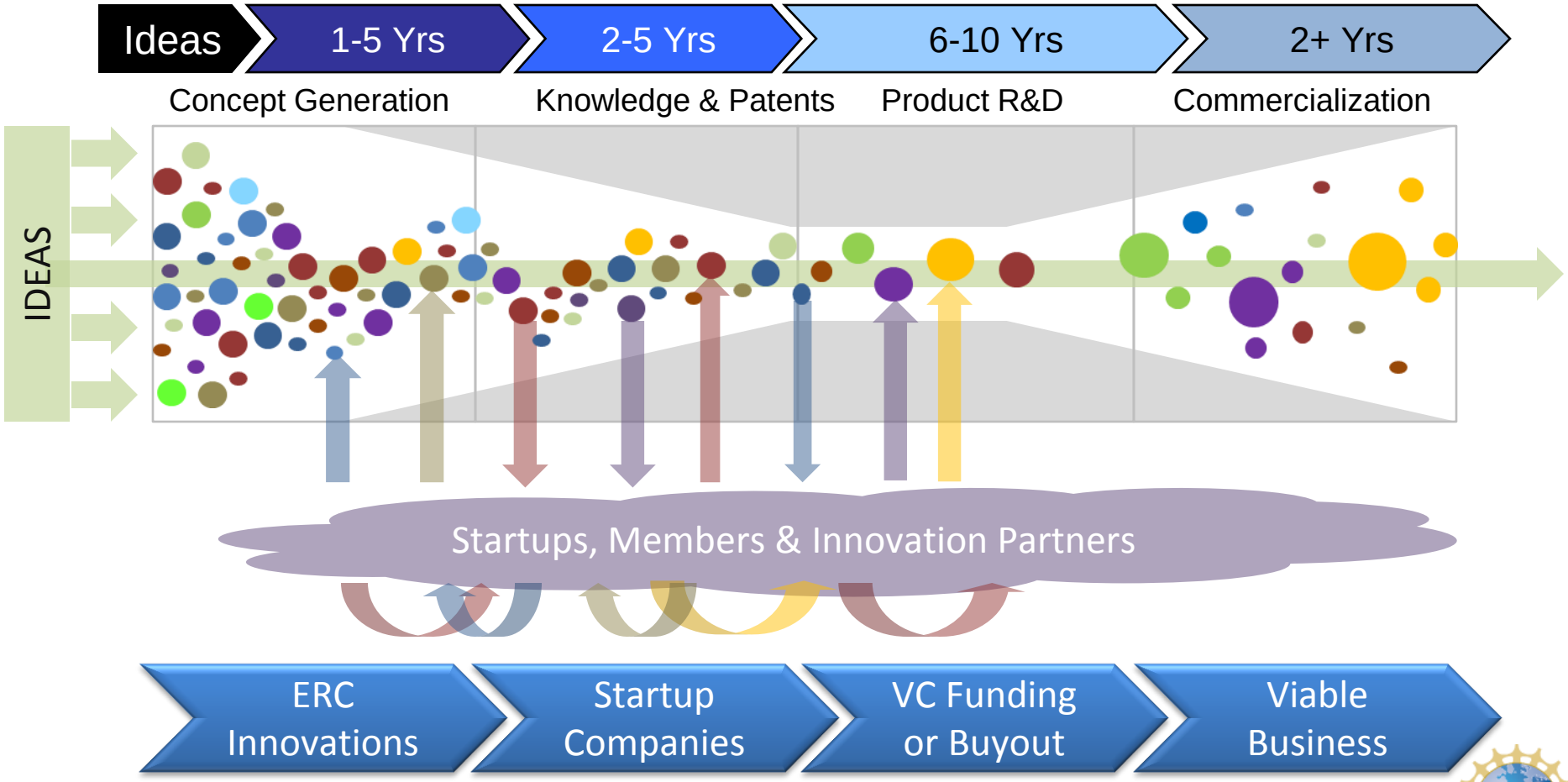
CBiRC
NSF Engineering Research Center for Biorenewable Chemicals



Innovation Ecosystem

CBiRC
NSF Engineering Research Center for Biorenewable Chemicals

Creating a framework of support for **Translational Research**.



Thank you!!

CBiRC
NSF Engineering Research Center for Biorenewable Chemicals

Innovation is the i in CBiRC.

Stages of Project Development

CBiRC
NSF Engineering Research Center for Biorenewable Chemicals

	Stage 1. Discovery	Stage 2. Research	Stage 3. Knowledge	Stage 4. Proof of Concept	Stage 5. Development	Stage 6. Commercialization
Ideation	Develop technical concept with evaluation of enzymes and catalysts required	Develop technical concept with initial evaluation of technical feasibility. Conduct initial R&D to develop full project proposal	Implement initial research project plan leading to the identification and validation of new product concepts.	Develop and optimize product concept specifications and appropriate analytic tools to evaluate product performance.	Selection of lead product candidates and backup possibilities if they exist.	N/A
Strategy	Conduct preliminary technical research and develop path forwards	Conduct preliminary market research and develop value-capture model	Refine business model and define product specifications.	Define ideal and acceptable products with detailed R&D cost estimates and specific target market segments.	Develop marketing strategy through contacts with potential customers.	Develop and implement marketing and sales programs.
Patents	Preliminary Intellectual Property evaluation in relation to perceived way forwards	More detailed Intellectual Property evaluation and development of patent and licensing strategy.	File patent applications and seek-out patent portfolio opportunities.	Continue implementation of patent strategy and broaden patent portfolio through licensing.	Evaluate patent portfolio in relation to product R&D direction.	Apply for trademark(s) whilst conducting full FTO evaluation in order to provide full product clearance.
Logistics	Evaluate research logistics such as what, where, how, timelines	Evaluate logistics such as what, where, how, timelines	Develop a logistics plan that enables implementation of production in relation to product specs.	Initial examination of product specs in relation to functionality.	Devise a development strategy including continuation and expansion of product production concept	Implement development strategy alongside optimal production methods for producing marketable samples.
Functionality	Determine user acceptance via brainstorming possible model compounds	Determine user acceptance via application testing based on model compounds	Evaluate function and supporting use information.	Develop functionality in relation to end product specifications.	End product functionality testing with end users	Confirm end product functionality in commercial products
Quality	Check identity and ownership of incoming research materials	Confirm identity and ownership of incoming materials	Examine quality control aspects of product	Evaluate quality issues during product production.	Examine all aspects of quality control for product.	Ensure product quality, purity and functionality
Safety	Evaluate known safety issues requiring caution in research activities	Evaluate known safety issues requiring R&D or compliance	Examine options for regulatory and compliance issues.	Seek out regulatory assistance and product compliance requirements.	Prepare registration strategy and consult with regulatory agencies.	Seek local and global approval by submitting regulatory dossiers to key marketing and export countries.

NSF