

K-12 Science Education, Workforce Readiness and Science Based Industry

A Discussion about
Opportunities

Anders Hedberg, Ph.D.
Bristol-Myers Squibb

SWOT Analysis – STEM Education

For the sake of argument WTSO

Weaknesses:

- Non-unified leadership of K-12 education
- Insufficient resource allocation
- Under-valuation of teaching as a keystone profession
- Low sense of urgency in the public domain

Threats [to]:

- *The Individual* - Future security and well-being of all citizens
- *The Nation* - Global economic leadership and progress
- *International cooperation* – Talent trade as a basis for global sustainable development

SWOT Analysis – STEM Education

Strengths:

- Institutional understanding of STEM
- Strong STEM applications in academia and industry
- Flares of visionary non-profit leadership and advocacy
- Solid models for improvement
- Sense of insight and urgency among leaders

Opportunities:

- Broaden the base by sharing models and success stories
- Catalyze collaboration between “ready” stakeholders
- Do “translational” research – Learning to Use-of-Knowledge
- Explore modes of knowledge transfer (School – STEM-based workplace)

Who are the STEM-Edu Stakeholders?

Users:

- Tier 1: Academia
 Government (Fed – State – City/Municipal)
 Business and Industry
- Tier 2: All Customers to Tier 1 (education, health,
 consumers)
 i.e. Pretty much everybody

Providers:

- Teachers and administrators
Teachers/trainers of teachers
Departments of Education
Policy makers
Advocates and supporters

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STEM-based Business and Industry Operates to:

Provide added value through STEM-based products and services at a reasonable cost

Based on:

- Understanding of customer needs
- Innovation (R&D)
- Productivity/Resource management
- Delivery – On time and with quality

To accomplish that

STEM-based Business and Industry

Needs Employees Who Are:

- Formally Educated and Trained
- Technically Proficient
- Workplace "Sensible"
- Good Communicators
- Good Collaborators
- Self-Confident
- Independent
- Reliable
- Accountable
- Flexible
- Respectful of Diversity

STEM-based Business and Industry

Needs Innovators Who Are:

- Creative
- Curious
- Objective and Open-minded
- Analytical and Evidence-driven
- Fearless of Failure

STEM-based Business and Industry Employees include:

- Scientists
- Engineers
- Data Monitors
- Statisticians
- Medical Professionals
- Tech Ops and Manufacturing Professionals
- Financial Systems Analysts
- Information Technologists
- Distribution Specialists
- Marketing & Sales Professionals
- Human Resources Administrators

Where do we find these employees?

All over the world.

Wherever they are best prepared.

How is talent preparation comparing internationally?

PISA 2003

- American 15-year-olds ranked 22 of 40 developed nations in science, 28 in math, and 29 in problem solving – Below OECD average
- Mexican age-matched students ranked 37 in science and math and problem solving
- Swedish students ranked 15 in science, 18 in math and 17 in problem solving - Above OECD average
- Chinese students ranked 3/7 (HK/M) in science, 2/6 math and 3/5 in problem solving

We have a shared responsibility

As socially responsible corporate members of our community, we are committed to do our best to help prepare US students to compete effectively for jobs everywhere, and to lead healthy and productive lives

“Corporate Social Responsibility”

“CSR – Commitment to Communities Where We Live and Work”

Broad Application:

Dedication of knowledge, cash, products and services to critical issues and charitable purposes in our communities

- Education
- Health and Sick Care
- Environment
- Culture and Recreation
- Infrastructure

“Corporate Social Responsibility”

Strategic commitment with long range objectives and values

- Local investment for global leadership in critical areas of need
- NSRC *US*, Innovec/FUMEC *Mexico*, RSAS *Sweden*, DoEd *Puerto Rico* (Inter-Academies Panel/International Corporate Sector)
- International measurements and benchmarks as well as global collaboration for teaching and learning of STEM

CSR in the Pharmaceutical Sector

A ground breaking new path - An example of continuing CSR investment from the pharmaceutical industry



- Developed for American High Schools, adaptable for international implementation
- Educational model with unlimited possibilities for adaptation to different areas of applied R&D



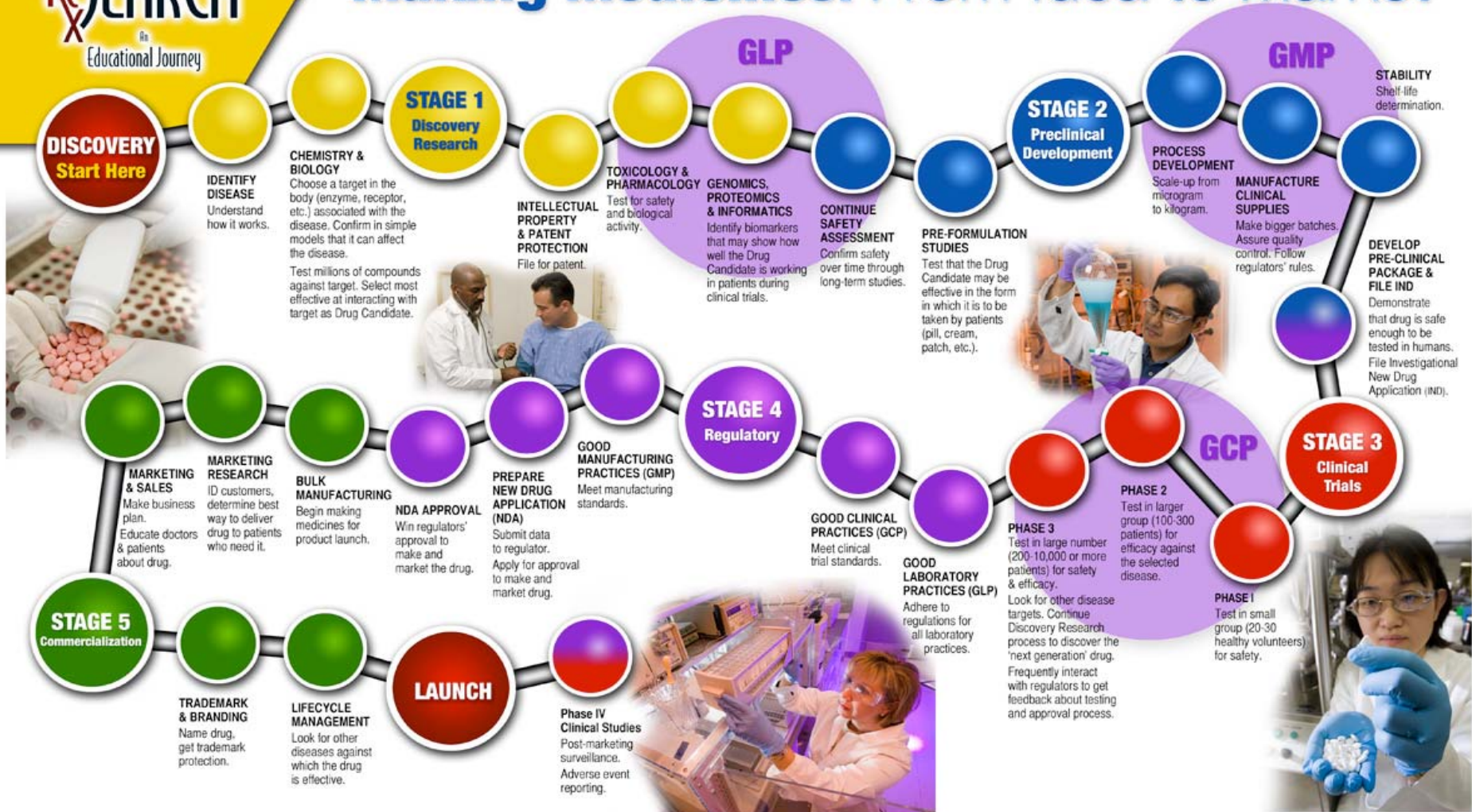
Project Description

Provides students with an understanding of how STEM is applied in the making of new medicines through intense research and development.

Builds understanding of R&D principles and processes and prepares for knowledge transfer from school to work.

- **Integrates biology, chemistry, mathematics, social sciences and language-arts**
- **Breaks down barriers between subject areas**
- **Adaptable to educational regional standards and objectives**
- **Focuses on development of skills in problem identification, analysis, critical thinking, resource planning and decision making, all within a framework of team work**

Making Medicines: From Idea to Market





Concept Transfer: Business to School

Pharmaceutical R&D



High School

IDEA

Research and Development



Medicine & Science
Theory and Practice
PROBLEM SOLVING



10:th-12:th Grade

Chemistry
Biology



Mathematical modeling,
Data handling & statistics
ANALYSIS



Mathematics



Strategic planning
Ethical considerations
CRITICAL THINKING



Social Studies/
Health Care Policy



Resource mgmt; Finance
Market research and planning
DECISION MAKING



Language-Arts/
Communication



HEALTHCARE
MARKETPLACE

COLLABORATION WITHIN &
BETWEEN EXPERT TEAMS

INTEGRATED LEARNING
AND SKILL DEVELOPMENT



Project Description

Phase 1 - Components:

- Condensed program to teach elementary theory and practice of pharmaceutical R&D with “deep dives” in biology, chemistry, ethics and practical reality-based case examples
- Sequence of eleven subject area lessons centered on inquiry
- Laboratory experimentation
- Rich – and growing roster of supplemental subject lessons (Clinical trial design, statistical data analysis, mathematical modeling of [pharmacodynamics and –kinetics, vaccine and biologics development, etc.)
- Teacher professional development (Summer Institute)
- Active participation of pharmaceutical scientists
- Independent evaluation



Course Overview

Lesson 1	Introduction	<i>Diseases and Their Impact</i>
Lesson 2	Discovery	<i>Targets and Magic Bullets</i>
Lesson 3	Discovery	<i>Screening for Solutions</i>
Lesson 4	Discovery	<i>The Power of Molecules</i>
Lesson 5	Preclin. Development	<i>Chromatography Separation</i>
Lesson 6	Preclin. Development	<i>Selecting the Best Molecule</i>
Lesson 7	Clinical R&D	<i>IND and Phase I</i>
Lesson 8	Clinical R&D	<i>Phase II</i>
Lesson 9	Clinical R&D	<i>Phase III and NDA</i>
Lesson 10	Commercialization	<i>Exploring the Business of Science and Medicine</i>
Lesson 11	Marketing	<i>Where Business & Science Overlap</i>

ReSEARCH

Educational Journey

Making Medicines: From Idea to Market

DISCOVERY
Start Here

L1
IDENTIFY DISEASE
Understand how it works.

L2

CHEMISTRY & BIOLOGY
Choose a target in the body (enzyme, receptor, etc.) associated with the disease. Confirm in simple models that it can affect the disease.
Test millions of compound against target. Select most effective at interacting with target as Drug Candidate.

STAGE 1
Discovery Research

L3

INTELLECTUAL PROPERTY & PATENT PROTECTION
File for patent.

L5

TOXICOLOGY & PHARMACOLOGY
Test for safety and biological activity.

GLP
GENOMICS, PROTEOMICS & INFORMATICS
Identify biomarkers that may show how well the Drug Candidate is working in patients during clinical trials.

CONTINUE SAFETY ASSESSMENT
Confirm safety over time through long-term studies.

PRE-FORMULATION STUDIES
Test that the Drug Candidate may be effective in the form in which it is to be taken by patients (pill, cream, patch, etc.).

STAGE 2
Preclinical Development

L6

PROCESS DEVELOPMENT
Scale-up from microgram kilogram.

MANUFACTURE CLINICAL SUPPLIES
Make bigger batches. Assure quality control. Follow regulators' rules.

GMP

STABILITY
Shelf-life determination.

DEVELOP PRE-CLINICAL PACKAGE & FILE IND
Demonstrate that drug is safe enough to be tested in humans.
File Investigational New Drug Application (IND).

L10

MARKETING & SALES
Make business plan. Educate doctors & patients about drug.

MARKETING RESEARCH
ID customers, determine best way to deliver drug to patients who need it.

BULK MANUFACTURING
Begin making medicines for product launch.

NDA APPROVAL
Win regulators' approval to make and market the drug.

PREPARE NEW DRUG APPLICATION (NDA)
Submit data to regulator. Apply for approval to make and market drug.

GOOD MANUFACTURING PRACTICES (GMP)
Meet manufacturing standards.

STAGE 4
Regulatory

GOOD CLINICAL PRACTICES (GCP)
Meet clinical trial standards.

GOOD LABORATORY PRACTICES (GLP)
Adhere to regulations for all laboratory practices.

PHASE 3
Test in large number (200-10,000 or more patients) for safety & efficacy.
Look for other disease targets. Continue Discovery Research process to discover the 'next generation' drug.

L8

PHASE 2
Test in larger group (100-300 patients) for efficacy against the selected disease.

PHASE 1
Test in small group (20-30 healthy volunteers) for safety.

STAGE 3
Clinical Trials

L7

STAGE 5
Commercialization

L11

TRADEMARK & BRANDING
Name drug, get trademark protection.

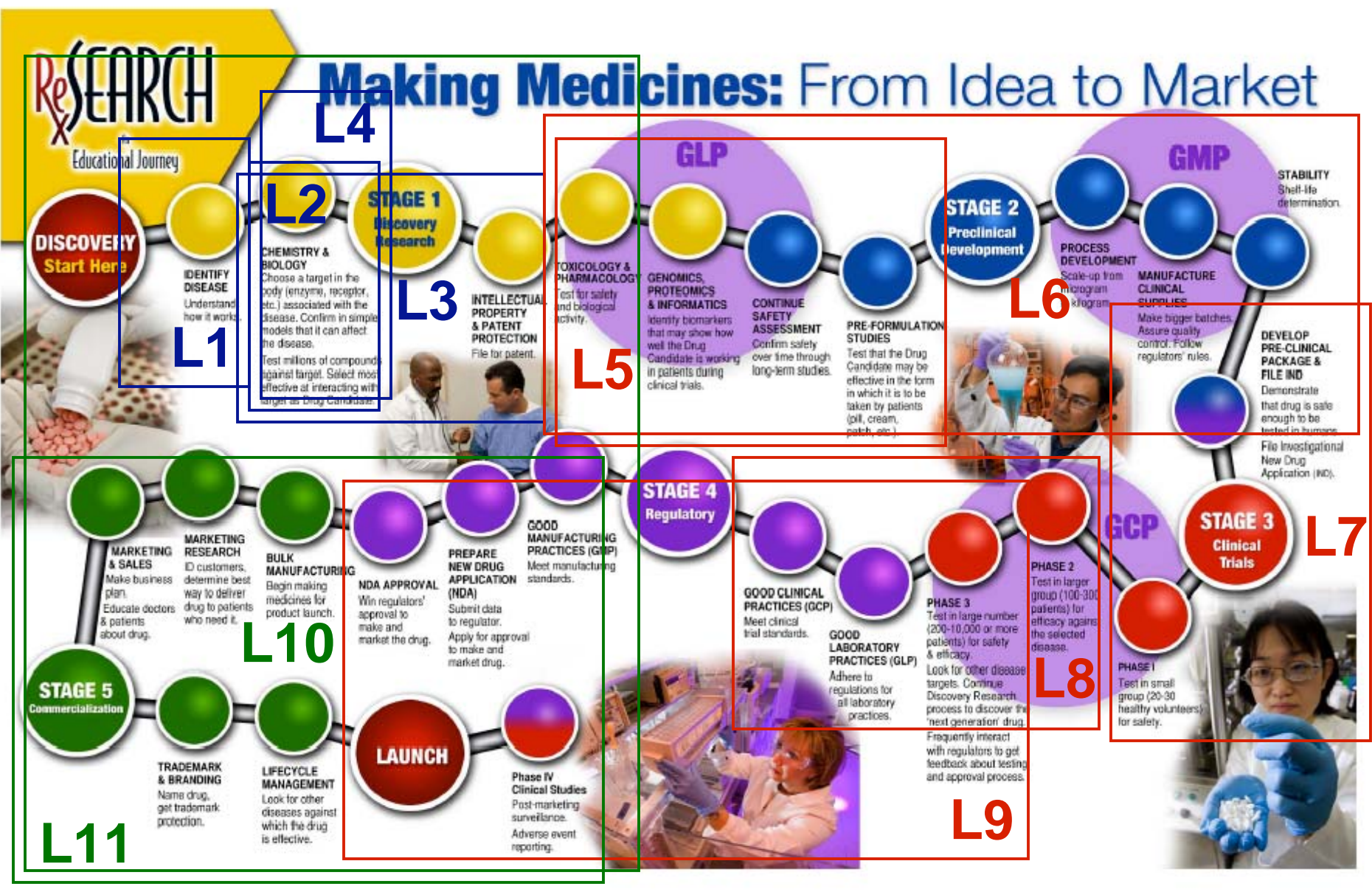
LIFECYCLE MANAGEMENT
Look for other diseases against which the drug is effective.

LAUNCH

Phase IV Clinical Studies
Post-marketing surveillance. Adverse event reporting.

L9

Frequently interact with regulators to get feedback about testing and approval process.





Project Team

Program Lead: PhRMA (Pharmaceutical Research & Manufacturers of America)

Steering Committee:

- PhRMA members:
 - Bristol-Myers Squibb
 - GlaxoSmithKline
 - Johnson & Johnson
 - Novartis
 - Schering-Plough
 - Wyeth
- Nine School Districts in NJ, NY, MA, PA and IA
- NJ Department of Education
- Healthcare Institute of New Jersey
- National Science Resources Center
- Biological Sciences Curriculum Study (evaluation)
- Museum of Contemporary Science



Outcomes Objectives Key Stakeholders

PRIVATE SECTOR

- Broaden understanding of the R&D process. **Provide facts about the quest for new leads to make better medicines**
- Create student **interest & readiness for industry careers**
- Demonstrate **corporate social responsibility**
- Strengthen **relationship with grassroots community**



SOCIETY/GENERAL PUBLIC

- Provide a new model for **demonstrating relevance of STEM*** to students' lives
- Prepare students for **21st century jobs**
- Strengthen the high-school experience to make it **globally competitive** through applied learning

PUBLIC EDUCATION SECTOR

- Broaden **understanding of the scientific enterprise** and its real-world applications
- Heighten **motivation for further study of STEM***
- Provide deep understanding and **mastery of content**
- Develop authentic, in depth **skills in problem-solving, analysis and critical thinking** through integrated learning

*STEM: Science, Technology, Engineering, Mathematics



Thank You!

