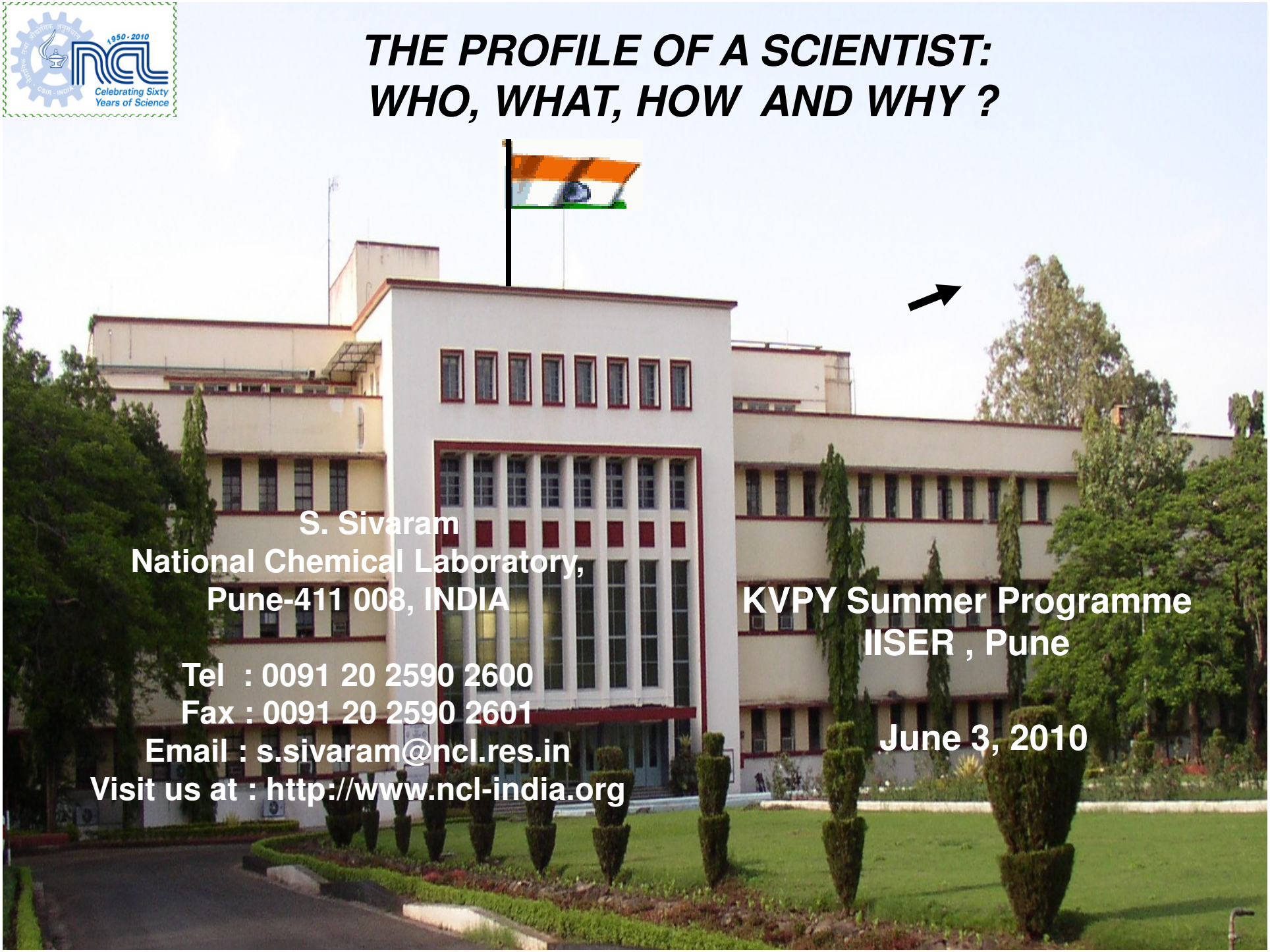
THE PROFILE OF A SCIENTIST: WHO, WHAT, HOW AND WHY ?



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THE PROFILE OF A SCIENTIST

- **WHO**
- **WHAT**
- **HOW**
- **WHY**

WHO IS A SCIENTIST ?

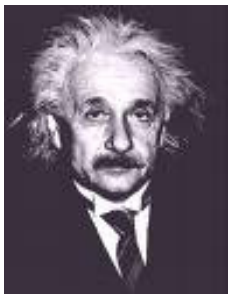
- One who practices science as a profession
- Science can be practiced in universities, research laboratories, government departments, schools and colleges or industries
- One who invents or discovers irrespective of whether one works in an organized enterprise or not
- Science managers , administrators or bureaucrats
- Teachers, communicators, journalists, legal professionals

WHAT DO SCIENTISTS DO?

Discovery : Penicillin

Invention : Light Bulb

Relativity



Innovation :Retail Store

All the world is a stage
And all the men and women merely players
They have their exits and their entrances
And one man in his time plays many parts
His acts being seven ages

W. Shakespeare
As you like it

THE STAGES OF A SCIENTIST

Stage 1	:	As a Ph.D. student in an University (4-5 years)
Stage 2	:	Post doctoral research (1-3 years)
Stage 3	:	Independent research positions or career positions
Stage 4	:	Growth and craving for peer recognition
Stage 5	:	Leadership and management of science and scientists
Stage 6	:	Post retirement stage – Disengagement
Stage 7	:	Exit from stage

UNDERSTANDING A SCIENTIST

- **Social and educational background**
- **Abilities and traits**
- **Attitude and Aptitude**
- **Working habits**
- **Philosophy**

APTITUDE AND ATTITUDE

- ***APTITUDE*** **: n, Natural or acquired ability or bent of mind**

  - No educational institution can make you a good scientist unless one has an aptitude

  - Aptitude alone will not suffice; Good education and training can make a worthy professional out of a person of average abilities

- ***ATTITUDE*** **: n, State of mind, behavior or conduct regarding some matter, as indicating purpose**

WHAT DIFFERENTIATES THOSE WHO DO AND THOSE WHO MIGHT HAVE DONE

- **Prepared mind**
- **Independent thinking**
- **Courage**
- **Perseverance**
- **Drive and intelligent application**
- **Tolerate ambiguity ; connecting the seemingly unconnected dots**
- **Intense passion**
- **Ability to look at “outliers’**

QUALITIES TO CULTIVATE

- **Curiosity**
- **A keen eye – power of observation**
- **Courage to ask simple or even stupid questions**
- **Seek unity in nature; Nature does not play dice**
- **Differentiate puzzles from problems**
- **Imagination and whole brain thinking**

Creativity is applied imagination

Every great advance in science has been issued from a new audacity of imagination

John Dewey

SCIENCE IN THE 21st CENTURY

- **Blue skies vs Directed Science**
- **Small vs Big Science**
- **Individual vs Team Science**
- **Curiosity driven vs Grand Challenges or Utilitarian Science**
- **Open access vs Intellectual Property**

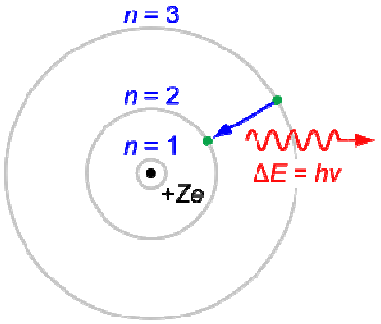
LINKING SCIENCE TO SOCIETY

- **Learning to connect principles of science to the concerns of society ; emphasis on application and functions**
- **Balance breadth with depth, creation of knowledge with delivery of solutions to the stakeholders**
- **Integrate disciplines : Chemistry-biology, material science – physics and engineering**
- **Communication : ability to "sell" the solution, not merely "solve" the problem**
- **Globally competitive and yet be locally relevant**

Focus on problems that need to be solved , not merely those that can be solved

Pasteur's Quadrant

Bohr



Pasteur

Average Academic and Industrial R & D

Edison

Fundamental Research

Use Inspired Research

PUZZLE AND PROBLEM

Puzzle :

"Though the outcome can be anticipated, often in detail so great that what remains to be know itself uninteresting, that the way to achieve that outcome remains very much in doubt

Problem :

"The really pressing problems, e.g. a cure for cancer or creation of an inexhaustible source of clean energy, are often not puzzles at all, largely because they may not have any solution"

Thomas Kuhn
The Structure of Scientific Revolutions

More often than not, failure in science is rooted in not having asked an important question, rather than in having arrived at an incorrect answer

INTEGRATION OF LEARNING WITH PRACTICE

- **Students at a very early stage of their learning must experience the thrill of doing science**
- **The beauty of science lies not in the pages of drab textbooks, but in the perception of its colors, smell and even sound !**
- **Students must practice science in all its dimensions**
- **Experiments must be open ended and must inculcate the discipline of inquiry based learning**
- **It is never too early to get students involved in research. Small research modules can completely replace traditional laboratory experiments**
- **Students must be given opportunity to do science so that they can discover whether "research is for me"**

If we have to infect young minds with the thrill of doing research, we should let students experience what goes on in the life of a scientist In a research laboratory

TEN REASONS WHY AN ACADEMIC CAREER IS REWARDING

- **Freedom to choose your directions**
- **Reinventing oneself throughout one's career**
- **Participating in discovery and inventions**
- **Being a part of a global community**
- **Opportunity to travel and enjoy periods of indolence**
- **Staying young forever**
- **Many measures of success**
- **Be your own boss**
- **Doing some good**
- **Scholarship**

R. D. Vale, 2010

Do you wish to work for a living of live for working?

COMMUNICATION AND LANGUAGE

- **COMMUNICATION : Ability to put across your thoughts clearly to a target group, orally or in writing**

- **LANGUAGE : Medium of communication and a cultural window**

LUCK AND SERENDIPITY

- In science, unlike in sports there are no absolute winners and losers
- Success in science means many things to different people; also success has many levels
- Chance and circumstances, often lead to great discoveries
- However, chance always favours the prepared mind. If there is no fuel, there can be no fire.

CHANCE OF SUCCESS

- **Long years of preparation**
- **A timely read book or paper**
- **Repeated failures**
- **Conversation with a colleague**
- **Periods of indolence**
- **Ambition and courage**
- **Longevity**

Concept of "divine" revelations in science is a myth. Archimedes (Buoyancy), Newton (Gravity) and Kekule (structure of benzene) discoveries were products of deep thoughts, not casual occurrences

LESSONS FOR SUCCESS: WHAT DISTINGUISHES A NOBEL LAUREATE FROM OTHERS

- **Choose a problem ahead of its time, not because it is fashionable; Big challenges are truly ahead of their time**
- **You have to say either the first word or the last word in science to be noticed**
- **Never be the brightest person in a room; In science, it is better to be criticized than adored ! Getting out of intellectual rut requires jolts. If there are more smart people around you, smarter you will become**
- **Stay in close contact with your intellectual competitors competition is inevitable, if you are pursuing important objectives. To know who else is tackling similar problems as you are is an indication of how important the problem is**

LESSONS FOR SUCCESS: WHAT DISTINGUISHES A NOBEL LAUREATE FROM OTHERS

Contd….

- **Work with teams where intellectual partnership is equal**
- **Always have some one to save you. Build a network of well wishers, mentors, men of consequence and angels. In spite of all your accomplishments, you will always need a helping hand as you climb the ladder.**

JD Watson, 1970

The most important thing in science is not so much to obtain new facts as to discover new ways of thinking about them

William Bragg

THINGS YOU MUST KNOW BEYOND SCIENCE

- History of science
- Geography of science
- Sociology of science
- Philosophy of science
- Politics of science

LESSONS FROM SCIENCE

1. We rarely get what we want ; make the best of the second choice
2. Provide early opportunities to learn leadership and organizational skills
3. Learning outside the classroom is more important than inside the classroom
4. Be generous with praise ; It does wonders
5. However big you are , show that you care for everyone in your institution
6. Teach to appreciate the beauty of the written word. Create the love for reading. Language is the window to the soul
7. If you want to find out a person's real aptitude, give him a gift and ask him to select a book from a bookstore
8. Teachers who are committed and show genuine interest in their pupil make good institutions great

LESSONS FROM SCIENCE

9. A liberal education is far more important than learning a few subjects; You can rebuild a façade but can lay the foundation only once

10. A true mentor is one who shows you the way when you do not know where you want to go

11. Knowledge is akin to insurance; You never know when you will need it.

12. Teach less; encourage self learning; make learning a pleasure

13. Pay attention to details; small things are important in science

14. A true mentor is one who is more concerned about his student, not himself

15. There is no greater reward for a student than to know that he has lived up to his teacher' s expectations

16. A true mentor is one who rejoices in the success of his student

LESSONS FROM SCIENCE

- **The power of the mentors -encounters with great minds who see farther than you do**
- **Being at the right place at the right time; an opportunity to be associated with great institutions**
- **Building a robust foundation**
- **Liberal education that teaches you to keep your mind open and observe your environment critically**
- **Repeated learning and relearning experiences**
- **An opportunity to build both character and competence**

In a life's journey, every encounter is a matter of chance
What great minds and institutions teach you is to stand tall, look at the skies, dream passionately and relentlessly work to convert dream into reality

WHY DO YOU WANT TO BE A SCIENTIST?

- **To be famous and be known**
- **To become rich**
- **To be useful to society and help humanity**
- **To invent and create new products for consumers**
- **To teach, excite, inspire and communicate science**

I shall be telling this with a sigh somewhere ages and ages hence;

two roads diverged in a wood

and , I took the one less traveled by,

and that has made all the difference

Robert Frost

The moving finger writes; and having writ,
moves on ; nor all your piety nor writ
shall lure it back to cancel half a line.
Nor all your tears wash out a word of it.

Fitzgerald's Translation
Rubaiyat of Omar Khayyam

FURTHER READING

- Advice to a Young Scientist, Peter Medawar, Harper & Row, New York, 1979
- About science, Myself and Others, V.L. Ginzburg, Institute of Physics, Bristol, 2004
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- A. Lightman, New Scientist, 21-28 December 2002
- R.D. Vale, It's a Wonderful Life: A career as an Academic Scientist, Molecular Biology of the Cell, 21, 11-14, January 1, 2010
- J.C. Polanyi, On being a Scientist; A Personal View, The Globe and Mail (Canada), April 29, 2000

THANK YOU