Careers in Science and Medicine
Eastern Iowa Home School Conference, 2009

I. OVERVIEW OF THE MAJOR SCIENTIFIC DISCIPLINES

PHYSICS

- Physics: the study of matter and motion to better understanding of the physical world and the regulation of the interactions between energy, matter, and motion.
- Typically divided into classical and modern physics.
  - Classical physics contains categories of:
    - Mechanics
    - Thermodynamics
    - Vibrations and Waves
    - Electricity and Magnetism
    - Light and Optics
  - Categories of modern physical include:
    - Relativity
    - Quantum physics
    - Atomic and nuclear physics
- A typical undergraduate course sequence will involve math through Differential Equations, and a broad understanding of physics from General Physic to Thermal and Quantum Physics, Electromagnetic Theory, and Quantum Mechanics.
- The study of physics heavily involves higher mathematical principles and a lot of analytical thinking. Most work in "pure physics" at the research level is conducted at universities; a lot of "applied physicists" find work in IT, communications, engineering and industrial positions. Also, a physics undergraduate degree can be a great stepping stone to working in many other fields, even medicine or law.

CHEMISTRY

- Chemistry is the study of interactions at the atomic level; it's the study of matter and its changes from one form to another.
- The field of chemistry is vast; however, five main categories of chemistry are:
  - Organic chemistry – the study of carbon containing compounds; although carbon isn't the most common element, it does combine to form the most compounds. Organic chemists can be found in many different fields, but particularly those dealing with fuels, textiles and dyes, and pharmaceutics.
  - Inorganic chemistry – the study of all the other compounds that don't have carbon in them as well as organometallics. These substances can come from non-living matter and the earth's crust and are important in many of our modern appliances.
  - Biochemistry – the study of the chemistry of life; it looks at biological processes at the molecular level. Biochemistry has revealed the chemical pathways for food digestion in living creatures and the functioning of enzymes and other chemical compounds necessary for life. Biochemistry is used in the study of disease and pharmaceutical developments
  - Analytical chemistry –used to determine the composition of compounds; analytical chemists will do a lot of work with titrations, and must be able to do very precise work. A lot of environmental chemistry is analytical in nature.
  - Physical chemistry – is in many ways the basis for all the other branches of chemistry as it deals with understanding the theoretical reasons for the behavior of chemical substances. Physical chemistry often involves a great deal of higher math and computer modeling.
- The typical undergraduate course requires 4 years of course work. Most degrees require classes in humanities, math (at least through Calculus II), physics, and a chemistry sequence. The typical sequence is: General chemistry, analytical chemistry, organic chemistry, inorganic chemistry, physical chemistry, and several chemistry electives as well as research classes.

- Chemical research involves a lot of experimentation and tinkering with lab equipment. There are many areas of research for anyone interested in a pure approach to chemistry; in addition, many industrial positions are open to qualified chemists in fields as diverse as petrochemists to organic chemists developing lubricants for NASA to biochemists analyzing the mechanisms of proteases.

BIOLOGY

- Biology is, quite literally, the “study of life.” It is a process of understanding the relations and classifications of living matter.
- Biology is an incredibly vast and diverse field. If it’s living matter, it’s biological! Some common divisions are:
    - Botany and Ecology – the study of plants and the relationships between organisms and the environment.
    - Zoology – the study of animal life, zoology ranges from the study of invertebrates to vertebrates
    - Developmental Biology – how organisms, such as humans, develop from a zygote to a full structure
    - Molecular and Cellular Biology – the interactions among and in cells at the cellular basis
    - Evolutionary Biology – the study of change in genotypes and phenotypes among populations.
- The typical undergraduate degree consists of 4 years of work; a degree can be obtained in Biology (BA or BS) or a more specific part of it such as a degree in Molecular and Cellular Biology. A typical course sequence for biology includes General Biology, Botany, Zoology, Genetics, Biochemistry, Cell Biology, and many biology electives and research classes. The math requirement generally isn’t as strenuous as in other sciences, requiring at the most Calculus II, and generally only Statistics.
- Biological research occurs anywhere from the lab to the field or stream. Industrial applications of biology are important in areas such as agriculture and pharmaceuticals; in addition, other fields such as engineering (biomechanics) or physics (biophysics) are often combined with biology for further developments, such as hip replacements. An undergraduate biology degree is often used as a stepping stone into other professions, such as zoo keeping or medicine.

ENGINEERING

- Engineering is the application of scientific and mathematical principles to create objects that realize a particular goal.
- Engineering is also a huge field, with many areas and subspecialties of different study and applications. A few of the main categories include:
    - Mechanical engineering
    - Electrical engineering
    - Civil engineering
    - Biomedical engineering
    - Chemical engineering
- Engineers can be found designing everything from computers, to electrical devices, aircraft, surgical instruments, or bridges. Engineering research often takes place in universities to private companies; the industrial opportunities for engineers are immense. The critical thinking that engineering develops often proves helpful for undergraduate engineering students who might be interested in entering another professional field, such as dentistry or law.

II. CAREERS IN SCIENCE AND TECHNOLOGY

A. At the BS level

-A BS degree generally lasts four years and includes some humanities classes as well as a specific course sequence relevant to the particular science.

-In physics, chemistry, and biology, most BS holders that enter the workforce will work as research lab assistants or technicians for companies.

-The entry-level salary is about $20,000-$30,000

-Many science students go on for further schooling.

-Many engineering students enter the workforce directly after obtaining their Bachelor's degree and licensing in their respective field, although some engineering jobs (such as biomedical) require advanced degrees.

-The entry level salary for an engineer is often $30-$40,000

B. At the MS level

-Most MS degrees in science are obtained after 2-3 years (full-time study)

-MS degrees must be paid for by the student or often by the employer

-MS degrees are generally not useful for research careers and are most often seen in industry, particularly engineering and chemistry

- An MS typically is for lab work as an RA or industrial advancement

-Some community colleges accept MS degrees for a good teaching position

C. At the PhD level

-Take about 6 years to complete.

-Entry often requires the GRE and a related undergraduate degree

-Most PhD programs in offer full tuition scholarships and stipends (~$20-30,000/year), and students can apply for outside funding. In the PhD program, a student may spend the first two years taking courses, working as a teacher's assistant (TA) and research assistant (RA), and beginning on their research and dissertation. Often all the research required for a full dissertation takes about four years, by which time many students have a few publications.

-After a PhD, a student can obtain work in labs, continue his own research, obtaining a fellowship or a post-doc.

-If going on to do research in a university, one will continue with his research while doing more teaching. There is a hierarchy from working as a non-tenured lecturer as a PhD student or post-doc to working on tenure as a professor; professors move through the ranks from assistant professors (the first tenure-track position), associate professors, professors, distinguished professors, and emeritus professors (retired).

-PhD holders can also obtain work as a professor at a community college, where there would not be as much emphasis on research.

-The typical salary for a PhD for a research career can range from $50-80,000

-PhD holders can also enter into industrial careers, often working on R&D

III. CAREERS IN MEDICINE

A. Nursing

1. Typical job duties
    - -Assessing and implementing care for patients, often has direct patient contact
    - -Work ranges from the operating room to post-op care to floor nursing to the ER
    - -Some nurses also work outside the strictly medical field in such areas as law
2. Education pathways
    - a. Registered Nurse (RN)
        - i. A community college diploma program
            - -Leads to the ADN
            - -2 years
        - ii. Bachelor of Science in nursing
            - -4 years
            - -First two years are introductory science courses and lab skills classes while the second two are clinical years.
            - -Preparatory for further education

iii. The NCLEX-RN

b. Licensed Practical Nurse

3. Further education

1. Master of science of nursing

-3 years of full-time study

-Offers opportunities for specialization

-CRNA, NP, CNS

2. Doctoral level

-PhD, DNP, DNS, EdD

-3-5 years

-for research, administration, teaching

4. Salaries

-on average, $50,000

5. Considerations

-Often directly caring for patients, requires responsibility.

-Often a lot of paperwork

-Coursework requires an understanding of the basic sciences with the ability to perform manual skills.

-Have many opportunities such as administration, public health, research and other professions

B. Prehospital emergency medicine

1. EMT-B

-a one semester class often from a local community college (~$800)

-certified by NREMT

2. EMT-I (1985 or 1999 level)

3. EMT-Paramedic

-A 2 year degree often from a community college

-Can provide more advance level of care before reaching the hospital

-Often part of becoming a firefighter

4. Salaries

-Can be volunteer

-Median is around $25,000, with the median 50% between $20 - $35,000

5. Considerations

-Fast-paced environment with many critical decisions. Also consider the hours and level of responsibility

C. Physician's assistant

1. Training

-Most programs are graduate programs leading to a Master's

-These programs often require an undergraduate degree and the GRE or MCAT

-Training lasts 2-4 years

-Must pass PANCE to become a PA-C

-Continuing education requirements

2. Practice

-Must be under a physician's supervision, although not necessarily on site

-Can diagnose and treat patients, including medicine prescription

-Many work in underserved areas

3. Salaries

-Median salary was $70,000; the median 50% was between $60 - $90,000

4. Considerations

-Direct patient contact is involved; the profession is somewhat of a new-comer.

D. Physicians

1. Pre-medical educational pathway
  - -Most require an undergraduate degree (~4 years) in any field
  - -Application begins in the junior year
    - -Primary application: AMCAS
    - -Secondary applications
    - -Interviews
  - -Medical schools require extracurriculars
    - -Volunteering
    - -Shadowing
    - -Other

2. Medical School
  - -2 types of degrees in the US: MD or DO
  - -First two years have intense training in basic sciences
  - -Final two years are rotations
  - -Must pass the USMLE Step 1 and (most of the time) Step 2

3. Residency
  - -National Resident Match Program
  - -Lasts 3-6 years depending on the specialty, while working under physicians
  - -Must pass USMLE Step 3
  - -Subspecialties often go for fellowships and additional training

4. Practice
  - -Primary care
    - -Family medicine and general practice, internal medicine, OB-GYN, peds
  - -Specialties
    - -Anesthesiology, psychiatry, surgical
  - -Subspecialties

5. Salaries
  - -Vary widely among specialties from ~$150 for family practice to over $300,000 for an anesthesiologist
  - -Must also take into consideration location, incentives, and insurance

6. Considerations
  - -Difficulty and the length of training; there are a lot of hours and responsibility involved. Of further consideration is the amount of remuneration as well as the insurance.

IV. PLANNING FOR HIGH SCHOOL STUDENTS

A. Aptitude considerations
  - -Favorite classes, interests and abilities, personality, shadowing personal research

B. Classes/Exams to take
  - AP, CLEP, IB, PSEO

C. Extracurricular activities
  1. Volunteering, shadowing, clubs, interests

D. Internships
  1. During the school year
    - -Offer to work as a volunteer for a researcher/lab
    - -Take pre-requisite classes and build a resume
  2. During the summer (see “Resources”)
    - -Formal application to a summer program
      - -search for: Summer Internship Program (SIP), Summer Undergraduate Research Program (SURF), Research Experience for Undergraduates
    - -Apply early!
    - -Look for local opportunities

Resources

Physics

http://www.aps.org American Physical Society; great information for anything ranging from careers to policy making to journals to advice.

http://www.physics.purdue.edu/career/ A website from Purdue that has a lot of links to career information, internships, and organizations

http://www.physicsforums.com Discussions about anything and everything about physics for students and professionals

Chemistry

http://www.acs.org The American Chemical Society website; a great resource for any information chemistry related; careers, publications, advice, and more!

http://www.chemicalforums.com Discussions about anything and everything about chemistry for students and professionals

Biology

http://www.aibs.org/core/index.html American Institute of Biology; lots of links and info!

http://www.biology-online.org/biology-forum/ Biology related forums

http://ocw.mit.edu/OcwWeb/hs/biology/biology/ MIT's open-ware course for general bio.

Engineering

http://www.engineering.com/ Geared more towards professionals; good job information

http://www.discoverengineering.org/ Good introductory site!

Nursing

http://www.allnurses.com Nursing discussion

http://www.discovernursing.com Good introductory site!

http://www.nursingworld.org American Nurses Association

Emergency Medicine

http://www.paramedic.com

Physicians

http://www.studentdoctor.net/ An amazing resource for anyone interested in healthcare – information, articles, links, and forums

http://www.aamc.org All about the MCAT and medical school by the American Association of Medical Colleges

http://www.aspiringdocs.org Good information for "aspiring doctors"

http://www.nrmp.org National Residency Match Program

http://www.osteopathic.org/index.cfm American Osteopathic Association

http://www.aacom.org American Association of Colleges of Osteopathic Medicine

High School: Classes

http://www.collegeboard.com/student/testing/ap/about.html For the AP

http://www.ibo.org/ The IB

http://www.collegeboard.com/student/testing/clep/about.html CLEP

Summer Internships/Summer Classes

http://www.training.nih.gov/student/ The NIH summer programs for high schoolers

http://www.columbia.edu/cu/biology/ug/intern.html List of programs; not just for high school

http://www.baylor.edu/summerscience/ Baylor's summer program

http://www.education.uiowa.edu/belinblank/summer/ UI's summer programs

http://www.smdep.org/ Summer medical and dental experience program

Other

http://www.bls.gov The National Bureau of Labor Statistics. A great website for an overview of any given career, as well as job outlooks and salary information.

http://www.usfirst.org/ Robotics competitions for high schoolers.