

better medical devices and systems designed by biomedical engineers. For example, computer-assisted surgery and cellular and tissue engineering are being more heavily researched and are developing rapidly. In addition, the rehabilitation and orthopedic engineering specialties are growing quickly, increasing the need for more biomedical engineers. Along with the demand for more sophisticated medical equipment and procedures is an increased concern for cost efficiency and effectiveness that also will increase the need for biomedical engineers.

Earnings

Median annual earnings of biomedical engineers were \$57,480 in 2000. The middle 50 percent earned between \$45,760 and \$74,120. The lowest 10 percent earned less than \$36,860 and the highest 10 percent earned more than \$90,530.

According to a 2001 salary survey by the National Association of Colleges and Employers, bachelor's degree candidates in biomedical engineering received starting offers averaging \$47,850 a year and master's degree candidates, on average, were offered \$62,600.

Sources of Additional Information

For further information about biomedical engineers, contact:

► Biomedical Engineering Society, 8401 Corporate Dr., Suite 110, Landover, MD 20785-2224. Internet:

<http://mecca.org/BME/BMES/society/index.htm>

(See introduction to the section on engineers for information on working conditions, training requirements, and other sources of additional information.)

Chemical Engineers

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Nature of the Work

Chemical engineers apply the principles of chemistry and engineering to solve problems involving the production or use of chemicals, building a bridge between science and manufacturing. They design equipment and develop processes for large-scale chemical manufacturing, plan and test methods of manufacturing the products and treating the by-products, and supervise production. Chemical engineers also work in a variety of manufacturing industries other than chemical manufacturing, such as those producing electronics, photographic equipment, clothing, and pulp and paper. They also work in the healthcare, biotechnology, and business services industries.

The knowledge and duties of chemical engineers overlap many fields. Chemical engineers apply principles of chemistry, physics, mathematics, and mechanical and electrical engineering. They frequently specialize in a particular operation such as oxidation or polymerization. Others specialize in a particular area, such as pollution control or the production of specific products such as fertilizers and pesticides, automotive plastics, or chlorine bleach. They must be aware of all aspects of chemicals manufacturing and how it affects the environment, the safety of workers, and customers. Because chemical engineers use computer technology to optimize all phases of research and production, they need to understand how to apply computer skills to process analysis, automated control systems, and statistical quality control.

Employment

Chemical engineers held about 33,000 jobs in 2000. Manufacturing industries employed 73 percent of all chemical engineers, primarily in the chemicals, electronics, petroleum refining, paper, and



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related industries. Most others worked for engineering services, research and testing services, or consulting firms that design chemical plants. Some also worked on a contract basis for government agencies or as independent consultants.

Job Outlook

Chemical engineering graduates may face competition for jobs as the number of openings in traditional fields is projected to be lower than the number of graduates. Employment of chemical engineers is projected to grow more slowly than the average for all occupations through 2010. Although overall employment in the chemical manufacturing industry is expected to decline, chemical companies will continue to research and develop new chemicals and more efficient processes to increase output of existing chemicals, resulting in some new jobs for chemical engineers. Among manufacturing industries, specialty chemicals, plastics materials, pharmaceuticals, biotechnology, and electronics may provide the best opportunities. Much of the projected growth in employment of chemical engineers, however, will be in nonmanufacturing industries, especially services industries such as research and testing services.

Earnings

Median annual earnings of chemical engineers were \$65,960 in 2000. The middle 50 percent earned between \$53,440 and \$80,840. The lowest 10 percent earned less than \$45,200, and the highest 10 percent earned more than \$93,430.

According to a 2001 salary survey by the National Association of Colleges and Employers, bachelor's degree candidates in chemical engineering received starting offers averaging \$51,073 a year, master's degree candidates averaged \$57,221, and Ph.D. candidates averaged \$75,521.

Sources of Additional Information

Further information about chemical engineers is available from:

► American Institute of Chemical Engineers, Three Park Ave., New York, NY 10016-5901. Internet: <http://www.aiche.org>

► American Chemical Society, Department of Career Services, 1155 16th St. NW., Washington, DC 20036. Internet: <http://www.acs.org>

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