Pakistan Institutional Excellence Project

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- University Grants Commission, Islamic Republic of Pakistan
- U. S. Agency for International Development
- Midwest Universities Consortium for International Activities, Inc. (MUCIA)

SIX YEAR DEVELOPMENT PLAN

DEPARTMENT OF CHEMISTRY

GOMAL UNIVERSITY

Dera Ismail Khan, Pakistan

May 1991

Lead University:
Purdue University
West Lafayette, IN

PROJECT PURPOSE

The purpose of the Institutional Excellence Project (IEP) is to improve Pakistan's capabilities to develop, adapt, and utilize advanced scientific and technology innovations in support of economic and social development. This purpose will be achieved by strengthening research, teaching and outreach in selected science and technology departments in cooperating universities. The primary mechanisms to be employed in this effort will be the establishment of formal and informal linkages among Pakistani and U.S. scientists and their institutions, education and training and a small grants research program.

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INSTITUTIONAL EXCELLENCE PROJECT (IEP)

SIX-YEAR DEVELOPMENT PLAN
for the
DEPARTMENT OF CHEMISTRY
GOMAL UNIVERSITY
DERA ISMAIL KHAN, PAKISTAN

May 1991

Prepared by:

Midwest Universities Consortium for International Activities, Inc. (MUCIA)

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EXECUTIVE SUMMARY

The overall purpose of the Institutional Excellence Project (IEP) is to improve Pakistan's capabilities to develop, adapt, utilize and advance scientific and technological innovations in support of economic development. This purpose can be achieved by supporting and strengthening research and teaching in a selected number of science and technology departments in phased activities over ten years. This report proposes a Six-Year Development Plan describing how specific programs could be developed in the Department of Chemistry at Gomal University to achieve the general purpose of the IEP.

Gomal University was established in 1974 and is located on a new, visually attractive campus 14 km north of the city of Dera Ismail Khan. The University has fifteen departments, of which the Departments of Chemistry, Physics and Pharmacy constitute a core with primary responsibility for teaching and research in science. There are 24 members in the Chemistry Department faculty and 72 students distributed between the M.Sc. previous and final classes. Graduate programs leading to M.Phil. and Ph.D. degrees are relatively new, and are in an early stage of development. The existence of a well-trained senior faculty and a pool of enthusiastic students, coupled with the pervasiveness of chemistry throughout modern industry, indicate that **the Department of Chemistry of Gomal University has the potential of playing a significant role in the economic development of Pakistan**, both as a resource and a driving force.

The immediate goal of the IEP for the Department of Chemistry at Gomal University is to organize the talents and wide range of research interests of the senior faculty into 2-3 research programs that are highly focused towards Pakistan's technological development. The long-term longevity of these programs can be insured by giving the junior faculty an opportunity for graduate training in related areas, and by linking these programs to Pakistan's evolving industry.

It is proposed to expand three existing primary research programs -- applied biochemistry, polymer technology, and natural products chemistry -- by providing equipment, supplies and training. In addition to assisting these programs directly, a new, state-of-the-art **analytical spectroscopy laboratory is proposed** as a core facility which can serve all areas of Chemistry. Not only can this spectroscopy

laboratory provide essential services to the three primary research programs, it can stimulate other research programs. By providing an atmosphere in which faculty and students can effectively pursue meaningful research, and by providing funds for modest improvements to the Department for teaching chemistry, the IEP can stimulate the production of trained manpower in chemical sciences and technology, as required for further development of Pakistan's chemistry-based industry.

Section 2.2 of this report presents several key issues, along with recommendations, that affect the development of research in the Department of Chemistry. Section 3.3 outlines a detailed plan for action that states the goals, outcomes, and inputs required to achieve desired developments.

1. INTRODUCTION

1.1 PURPOSE

In this document the Chemistry assessment team describes the present status of the Department of Chemistry at Gomal University, important issues that hamper its achieving excellence in education and research, and a six-year plan through which the Institutional Excellence Project (IEP) will address some of these issues.

The overall purpose of the IEP is to improve Pakistan's capabilities to develop, adapt, utilize and advance scientific and technological innovations in support of economic development. This goal will be achieved by supporting and strengthening research and teaching in a number of selected science and technology departments in phased activities over ten years. The primary mechanism for supporting this effort will consist of formal and informal linkages between selected Pakistani and U.S. university departments, and a small grants program to support research. The proposed six-year plan describes how specific programs could be developed in the Department of Chemistry at Gomal University to achieve the general goals of the IEP.

Information for this report was obtained primarily through interviews with the faculty during the time between October 1 and 8 (1990) when the Chemistry Assessment Team visited Gomal University. The nature of the interview process is indicated by the **Interview Schedule**, which is included in this report as Appendix A. Additional information for this report was taken from documents provided by the faculty during the visit.

1.2 GOAL OF GOMAL UNIVERSITY

Gomal University was established in 1974 and is located on a new, visually attractive campus 14 km north of the city of Dera Ismail Khan. The University has fifteen departments, of which the Departments of Chemistry, Physics and Pharmacy constitute a core with primary responsibility for teaching and research in science. There are 24 members in the Chemistry Department faculty and 72 students distributed between the M.Sc. previous and final classes. Graduate programs leading to M.Phil. and Ph.D. degrees are currently available. Because these programs are relatively new, and because of the general lack of facilities, the graduate programs are in an early stage of development. The existence of a well-trained senior faculty and a pool of

enthusiastic students, coupled with the pervasiveness of chemistry throughout modern industry, indicate that the Department of Chemistry has the potential of playing a significant role in the economic development of Pakistan, both as a resource and a driving force.

The senior faculty have a wide range of research interests, most stemming directly from their Ph.D. thesis research. The immediate goal of the Chemistry Assessment Team and IEP is to organize the talents of the senior faculty into 2 or 3 research programs that are highly focused towards Pakistan's technological development. The long-term longevity of these programs will be insured by giving the junior faculty an opportunity for graduate training in related areas, and by linking these programs to Pakistan's evolving industry. Specific areas to be developed include applied biochemistry, polymer technology, and natural products chemistry. In addition, a spectroscopy laboratory, which will include mass spectrometry and nuclear magnetic resonance spectroscopy, will be developed as a core facility to provide services and training in analytical chemistry to the program staff.

2. STATUS

The purpose of this section is to describe the current status of the Department of Chemistry, and to identify its various strengths and weaknesses, as perceived by the assessment team.

2.1 EXISTING PROGRAM

2.1.1 Faculty Expertise and Background

The faculty expertise and background is summarized in Table I, while detailed biographical data are given in Appendix B for the senior faculty. The faculty currently consists of two professors (Dr. Rauf has moved to another university), three associate professors, nine assistant professors, and ten lecturers. In general, the educational background of the senior faculty is strong. All of the professors and associate professors, as well as four of the assistant professors, have their Ph.D. or D. Sc.

TABLE I Faculty Background and Research Interests

Name/Sex	Rank	Age	Highest Degree	Institution	Area	Research Interests
G.A. Miana (M)	Prof.	51	Ph.D.	Calgary (CAN)	Organic	Natural Prod.
Abdur Rauf* (M)	Prof.	50	Ph.D.	Birmingham (U.K.)	Inorganic	Biotechnology
Zulfaqar Alam Khan**(M)	Prof.	42	D.Sc.	Ghent (Belgium)	Biochem.	Nucleic acids
Ahmad Saeed (M)	Assoc. Prof.	42	D.Sc.	Ghent (Belgium)	Biochem.	Proteins
Nazur-ul-Islam (M)	Assoc.	37	Ph.D.	Queen Mary College (UK)	Organic	Organic Synthesis
Musa Kaleem Baloch(M)	Assoc. Prof.	37	Ph.D.	Peshawar (PAK)	Physical	Polymers
Saeed Anwar (M)	Asst. Prof.	36	Ph.D.	Univ. of Dublin (IRE)	Organic	Organic Synthesis
Sher Khan (M)	Asst. Prof.	39	Ph.D.	Antwerpen (Belgium)	Analytical	Biorganic
Irshad Ali (M)	Asst. Prof.	35	Ph.D.	Karachi (PAK)	Physical	Natural Prod.
Muhammad Subham(M)	Asst. Prof.	35	Ph.D.	Peshawar (PAK)	Physical	Mass Spectrometry
Khalid Mahmood (M)	Asst. Prof.	35	M.Phil	Peshawar (PAK)	Physical	Polymers
Bakhtiar Muhammad(M)	Asst. Prof.	35	M.Sc.	Gomal (PAK)	Inorganic	Organo-metallics
Abdur Rahim (M)	Asst. Prof.	33	M.Sc.	Gomal (PAK)	Biochem.	Enzymology
Imam Bakhsh Baloch(M)	Asst. Prof.	32	M.Sc.	Gomal (PAK)	Organic	Terpenoids
Gulzar Hameed (F)	Asst. Prof.	39	M.Sc.	Gomal (PAK)	Physical	Polymers
Muhktiar Hassan (M)	Lect.	33	M.Sc.	Gomal (PAK)	Biochem.	Nutrition
Amin Badshah (M)	Lect.	30	M.Sc.	Gomal (PAK)	Inorganic	Inorganic
Muhammad Ashfaq (M)	Lect.	30	M.Sc.	Gomal (PAK)	Inorganic	Analytical
Muhammed Siddiq (M)	Lect.	29	M.Sc.	Gomal (PAK)	Physical	Physical
Azim Khan (M)	Lect.	29	M.Sc.	Gomal (PAK)	Inorganic	Complexes
Gulrez Fatima (F)	Lect.	27	M.Sc.	Gomal (PAK)	Physical	Polymers
Amjad Kamal (M)	Lect.	28	M.Sc.	Gomal (PAK)	Biochem.	Molecular Biology
Noor-i-Ain (F)	Lect.	28	M.Sc.	Gomal (PAK)	Inorganic	Microbiol Leaching
Muhammad Iqbal (M)	Lect.	29	M.Sc.	Gomal (PAK)	Organic	Magnetic Resonance
Rehana Yasmin (F)	Lect.	26	M.Sc.	Gomal (PAK)	Inorganic	Biorganic

* Moved to Bahauddin Zakaria University, Multan

** Extended Leave

degrees. Six of these degrees were awarded from universities in Europe or Canada, and three were awarded from Universities in Pakistan. The majority of the senior faculty have had postdoctoral experience. All of the lecturers hold M.Sc. degrees from Gomal University. **Thus the overall educational background of the senior faculty is strong, while that of the junior faculty should be strengthened.**

The age range of the professors is from 42 to 51, associate professors from 37 to 42, assistant professors from 32 to 39 and lecturers from 26 to 33. This broad distribution in ages should lead to long-term continuity of the educational and research programs of the Department. There are four female members of the faculty. One of these is an assistant professor while the others are lecturers.

The formal training and teaching responsibilities of the faculty can be divided into the traditional areas of chemistry. In organic chemistry there are five faculty (one professor, one associate professor, two assistant professors and one lecturer). The total number of faculty in the physical chemistry area is six, with one holding the rank of associate professor, two at the assistant professor level, and three lecturers. Biochemistry is represented by six faculty as well, including one professor, one associate professor, two assistant professors, and two lecturers. Analytical chemistry is represented by only one lecturer. However, faculty members in other areas (primarily inorganic) assist in teaching analytical chemistry. In addition, there are plans to train some of the junior faculty in the area of analytical chemistry. The inorganic chemistry area, which has been significantly weakened by the departure of Professor Rauf, currently has six members consisting of two assistant professors and four lecturers.

The expertise of the faculty from a research point of view falls mainly into six areas. They are (1) natural products chemistry, (2) applied biochemistry, (3) solution properties and rheology of polymers, (4) organic synthesis, (5) inorganic chemistry of borane, and (6) mass spectrometry.

The natural products research area is under the leadership of Chairman and Professor Miana, who has published 61 articles, many in international journals. Joining Professor Miana in leadership in this area is Assistant Professor Irshad Ali, who has published twelve papers while a graduate student with Professor Atta-ur-Rahman at the HEJ Institute in Karachi. Assistant Professor Bakhsh also works in this area and is a Ph.D. student at the HEJ Institute. Mr. Iqbal assists in this area as does the full-time research assistant for Professor Miana. Overall, this group has demonstrated ability to collect plant material, isolate compounds, and perform structure

elucidations. This group has been utilizing the photochemical approach (working on classes of compounds such as alkaloids and terpenoids) rather than the bioassay guided approach that is needed to move towards the isolation of compounds with importance to the pharmaceutical and agrochemical industry. Dr. Qazi Najam Saqib (Department of Pharmacy) has experience in brine shrimp bioassays for toxins and works with the natural products group. Further training in bioassay-guided isolation procedures is desirable. **Development of an internationally competitive program in natural products chemistry has been limited primarily because spectroscopic facilities required to identify substances have not been available.** If it were more fully developed, the natural products research effort might lead to identification of new therapeutic drugs, to the discovery of new plant sources of recognized therapeutic agents, and possibly to establishing new money crops for farmers. In addition, natural products research requires developing a high level of skills in analytical chemistry. Graduates with such skills will be important to Pakistan's developing industry.

Another strong area of research at Gomal University is enzymology and applied biochemistry. Despite a dearth of facilities, associate Professor Ahmad Saeed has developed a laboratory for isolating a variety of enzymes of substantial biomedical relevance. He has sixteen publications primarily related to isozymes of acid phosphates and related enzymes from chicken. He has presented papers at national and international meetings. He has also written a monograph on enzyme isolation and bioassay procedures. He is joined in this area of research by Assistant Professor Rahim, who is also a full time Ph.D. student of Dr. Saeed and has six publications. Mr. Kamal, a lecturer with training to the M.Sc. level, also works with Dr. Saeed in enzymology, and in the new biotechnology area. He has two publications in preparation. Mr. Hassan, another lecturer with an M.Sc., has also performed work in closely related areas. Dr. Saeed plans to move toward further emphasis in the biotechnology area in the future. Prof. Zulfaqar Alam Khan is currently on extended leave and appears to have no active research programs in the Department.

Another research group, headed by Professor Abdur Rauf, is working on the leaching of metal ores with microorganisms. Unfortunately, Professor Rauf has moved to B. Z. University in Multan. It is noted however, that Assistant Professor Sher Khan has already been associated with this program and is highly qualified to direct this research. He has been a Fulbright Scholar at Texas A & M University and has eight publications, including one relative to bacterial leaching of low-grade copper ores.

Lecturers Mr. Ashfaq, Miss Noor-i-Ain, Miss Yasmin, and Mr. Khan are very capable and could assist Professor Khan in this area. Thus, overall, the enzymology and applied biochemistry group is strong in faculty expertise and has the potential to produce technology and trained manpower important for Pakistan's industry.

The area of polymer research is important from an industrial standpoint and has a significant potential to contribute to Pakistan's economy. Associate Professor Musa Kaleem Baloch, who has a Ph.D. from Peshawar University, as well as postdoctoral research experience in Germany and Czechoslovakia, is providing excellent leadership in this area. He has 23 publications in solution properties and rheology of polymers. He is assisted in this work by lecturers Miss Gulrez Fatima, Mrs. Gulzar Hameed, and Mr. Mohammad Siddiq.

The field of organic synthesis is represented by two faculty members with outstanding qualifications. They are Associate Professor Nazar-ul-Islam and Assistant Professor Saeed Anwar. Dr. Islam has eight publications in a very interesting area of electrochemical synthesis of organic compounds and has his Ph.D. degree from the University of London. No research has been performed to date at Gomal University. He has, however, recently been awarded a grant to pursue his research. Dr. Anwar is highly qualified with a Ph.D. from the University of Dublin and has worked in Switzerland with Professor Eschenmosher at ETH Zurich. He has six publications in the area of organosilicon synthesis. No research work has been performed at Gomal University.

Mr. Bakhtiar Mohammed is the only faculty member performing basic inorganic research. However, his work on the formation of four member ring boron-nitrogen heterocyclic compounds was carried out in Germany. He is in the process of submitting his Ph.D thesis at Peshawar University.

Dr. Muhammad Subhan received his Ph.D. from Peshawar University with emphasis in field desorption mass spectrometry. The experimental portion of his thesis was performed in Germany. He has eight publications in this field. With his experience in mass spectrometry, he will be an important resource if a spectroscopy laboratory is established in the Department of Chemistry.

Although there is a low level of faculty turnover, job satisfaction is generally low because of inadequate funding. Increased funding for the teaching and research programs, as well as increased salaries would likely improve job satisfaction. Also, better methods of testing students and dealing with their concerns would be helpful. **It appears that the normal workday for many of the faculty is from 9 am**

to 2 pm. If this is the case, it is much too short. If this schedule is continued, it is unlikely that the faculty will ever achieve the recognition they seek from the international research community, nor from Pakistan's industry. Overall, the faculty, particularly younger members, are enthusiastic and have the potential of becoming leaders in Pakistan's research community. Senior faculty are well trained and have the ability to perform at a high level in teaching and research.

2.1.2 Students

All of the seats at Gomal University are for students from the Northwest Frontier Province, except for a few reserved seats. Three students come from the Punjab and three from the Northern Areas. The majority of these come from undergraduate colleges located in the same region as Gomal University. The primary feeder institutions are Government College at Bannu, D.I. Khan, Ghazni Khel, Lakki, Miranshah and Tauk.

Table II gives the characteristics of the students in the Department of Chemistry at Gomal University. The total enrollment is 72 with 16 of these being female. The student population includes two Ph.D. students and 34 at the final M.Sc. level. Of these, ten are specializing in physical chemistry, four in organic, eight in inorganic, and twelve in biochemistry. The remainder of the students are at the M.Sc. previous level. All students are members of the Muslim religion. The age of the M.Sc. students is between 20 and 25. The two Ph.D. students are of the ages 28 and 36.

Table III gives the examination passing rates for the students from 1986 to 1989. The faculty indicate that approximately 80 percent of the students pass each exam. A passing grade is 33 percent. The faculty indicated that all students eventually pass. It also indicated that the students generally do not work while going to school. However, partial scholarships from various sources are provided to about 50 percent of the students. The average scholarship is Rs 250/month. The University Grants Commission (UGC) pays stipends of Rs 900/month for the first year and Rs 1500/month for the following years of the Ph.D. program, and Rs 750/month for the M. Phil. program.

TABLE II Information Regarding Students Enrolled in the Department of Chemistry

Departmental Enrollment:				
Female			16	
Male			56	
Total			72	
Enrollment by Area Specialization:				
M.Sc.Final	Physical Chemistry		10	
	Organic Chemistry		4	
	Inorganic Chemistry		8	
	Biochemistry		12	
	Total:		34	
M.Sc. Previous			36	
Ph.D			2	
Total			72	
Provincial Locations of Students:				
N.W.F.P.			94%	
Punjab			3%	
Northern Areas			3%	
Ethnic Distribution:				
All Muslims				
Age Distribution:				
M.Sc.	Male:	20-25 yr.	Female:	20-25 yr.
			Range:	20-25 yr.
Ph.D.	Male:	28-36 yr.	Female:	28-36 yr.
			Average:	32 yr.

TABLE III Number of Chemistry Students Passing Examinations

Year	M.Sc.	M.Phil
1986	26	1
1987	23	0
1988	26	0
1989	25	0

In regard to selection and admissions procedures, the Department has its own written placement examination for admission to the M.Phil. program. Scores on the exam and the students' M.Sc. academic record is weighed by the Departmental Admission Committee. This committee, which includes the department chairman as well as three senior professors, makes all admission decisions. If a controversy arises, the question goes to the University Admission Committee for a final decision.

Admission to the Ph.D. program requires an M.Phil. degree in a chemistry specialization. A student indicates interest in a research area to the appropriate faculty member. Together they define the topic and prepare a research proposal that goes through the Admissions Committee to the Dean and on to the Board of Advanced Studies and Research (BASR). The BASR will recommend student admission if the proposal is acceptable, and if funding and facilities are available for the research.

While no specific employment data were presented, senior faculty have indicated that the primary employers of their M.Sc. graduates are (1) B.Sc. colleges, (2) high schools, (3) research institutes, (4) industry, (5) university lecturers, (6) higher institutions for advanced training, and (7) public institutions such as ministries and foundations.

2.1.3 Curriculum/Educational Materials

The following degree programs are offered by the Department:

- M.Sc. - Chemistry students are required to take courses in physical chemistry, organic chemistry, inorganic chemistry, biochemistry and analytical chemistry during the first year. Research papers must be submitted in each subject each semester. In addition, there is a practical examination at the end of the second semester. At some point before the end of the first year, a student selects an area of specialization and a research topic. Approval will be subject to availability of an advisor and departmental priorities.

- M.Phil. - Students are required to take 30 hours of course work. The research supervisor will organize a schedule of course work for each student according to the classes offered, availability of faculty and the needs of the student. Three classes are usually scheduled each semester, as well as special seminars and tutorials arranged by each sectional head. The student must pass all course work before beginning a thesis. Near the end of the first year, student and advisor prepare a research proposal and submit it to the departmental Board of Studies and on to the BASR. If the student has passed the course work and the proposal has been accepted, the student works on a thesis during the second year. During the middle of research, the research supervisor prepares an evaluation of programs and this report is passed through the required channels to the BASR. If the student is able to pass the qualifying exam, s/he may transfer to a Ph.D. program. Otherwise, at completion of M.Phil. research, the thesis is passed on to two external examiners recommended by the Board of Studies. If approved by one external examiner and the research supervisor, the student defends the thesis in an oral exam. Examiners include one external examiner, the research supervisor and the department chairman.

- Ph.D. - A Ph.D. program is based on research only, since course work is taken at the M.Phil. level. The acceptance of the research proposal, the preparation and the procedure for awarding the degree is essentially the same as for the M.Phil. program. The major differences are that one of the external examiners must be from overseas, and the oral exam will be open to all interested persons.

The course work required for the M.Phil/Ph.D. levels is given in Appendix C.

Each professor/lecturer is involved in a schedule of teaching theory and practicals, special seminars, tutorials and research advising. On average, s/he spends 10 hours per week teaching, 10 hours on research and the rest on administrative or class related functions. The average class size is 30 students. Since the current M.Sc. program includes a research project, most senior faculty are research advisors. **Textbook availability is poor and needs to be improved. Textbooks are normally issued for one term by the Department for nominal charges to needy students.**

2.1.4 Research

The areas of faculty expertise in research have been described in 2.1.1 according to areas of emphasis within the Department. In general, the faculty are active, as is evident by the research publications mentioned in Section 2.1.1 and ten funded research projects from 1975 to 1993 as shown in Table IV. The current vitality of the Department is indicated by having six proposals funded in 1990. The recent success ratio of proposals funded to proposals submitted, 2 to 1 (67%), is extremely high.

In regard to university research policies and procedures, independent research proposals go through the university channels to outside funding agencies. If approved, funds are maintained by the Treasurers office. The principal investigating officer has total control of spending. Signed contracts include the researcher, funding agency, and the university authorities. The Vice-Chancellor countersigns the agreement.

The Department has an annual grant for purchasing basic supplies for ongoing research. If faculty are interested in research projects that use only these supplies, no formal approval is necessary. The chairman controls store supplies, etc. If items are not available, a formal request is submitted through the chairman to the vice chancellor.

TABLE IV Research Grants Awarded to the Faculty in the Department of Chemistry Since 1975

Title	Date	Rs.	Source	Principal Investigator
Medicinal plants of Pakistan	1975-78	3,050,000	Pakistan Science Foundation	G.A. Miana
Tumor inhibitors from Thymeleaceae	1978	90,000	International Science Foundation, Sweden	"
Tumor inhibitors Diterpenes from Euphorbia	1978-79	50,000	Pakistan Science Foundation	"
Alkaloids from Delphinium	1976	18,000	University Grants Commission	"
Sesquiterpene Lactones from compositeae plants	1990	500,000	Pakistan Science Foundation	"
Pesticides from plants of Pakistan	Pending	15,000	Pakistan Agriculture Research Council	"
Search for Antimesein	1990	75,000	University Grants Commission	"
Microbial Leaching of low-grade copper ores	1990-93	500,000	NSRDB (Pakistan)	Abdur Rauf
Electro-organic Synthesis of Anti-cancer, Estrogens, Anti-estrogens and Carotenoids	1990-93	500,000	NSRDB (Pakistan)	N.U. Islam
Enzymes as catalysts in synthetic organic chemistry	1990-93	438,000	NSRDB (Pakistan)	Sher Khan

2.1.5 Facilities and Equipment

The Chemistry Department has four classrooms and four laboratories. The amount of space, 26,457 sq. ft. in the chemistry building appears to be adequate for current teaching and research activities. Furthermore, with some reallocation of space, the present building should be adequate for the foreseeable future. For example, the central library is currently occupying two classrooms, one large laboratory is used by the Pharmacy Department, and the basement is not being used because of a water seepage problem. Considerable renovation will be required before the Department can assume its role as a modern center for chemical science and technology. Some renovation must be completed before new spectroscopic instruments can be installed.

The four laboratories which are currently available are utilized as follows. One is used for organic research which is primarily natural products chemistry and microbial leaching of ores. This laboratory is equipped with grinders, rotary evaporators, and other routine equipment necessary for natural products research. Another laboratory is entitled the organic laboratory. This laboratory is used for classroom teaching in the morning and for laboratories (practicals) every afternoon. The organic and inorganic practicals are both carried out in this laboratory with one half of the room (15 students) devoted to inorganic chemistry and the other half (15 students) devoted to organic chemistry. Another laboratory is called the instrumental analysis laboratory. Instrumental laboratories are taught in this room as well as physical chemistry and lecture classes. The fourth laboratory is entitled the biochemistry laboratory. This laboratory, which is well equipped for enzymology and protein isolation, is also used for biochemistry practicals and lectures.

In regard to equipment, Table V lists the major items of equipment which are presently available. **In general, the teaching laboratories are poorly equipped. As a result, it is not possible to give students adequate laboratory training. For example, students are not allowed "hands on" use because of a fear by the faculty that the instrument may be broken.**

Gomal University has an excellent computer center which is shared by all of the science departments. This consists of a VAX 11/730 mini-computer and 20 IBM and compatible microcomputers, all of which are located in an air-conditioned facility.

The Chemistry Department has a library with a significant collection of books but very few journals, which is a major problem for the maintenance of a research program. The university library has 6,800 books, 3,442 periodicals and

TABLE V Major Equipment Currently Available in the Department of Chemistry

NMR Spectrometer (60 MHz)	High Speed Centrifuges
Spectrophotometers (Spectronic 20,21)	UV Spectrophotometer
Atomic Absorption Spectrometer (A.A.S)	IR Spectrophotometer
Gas Chromatograph	Digital Polarimeter
Electrophoresis	Liquid Nitrogen Plant
Rotary Viscometer	

journals including 120 periodicals added during 1986-87. Duplication services are available at the library.

2.1.6 Linkages

The faculty at Gomal University have linkages with many universities inside and outside Pakistan. **Strong linkages exist within Pakistan with the HEJ Institute and Peshawar University.** A number of faculty have either worked on collaborative research projects or received their Ph.D. from these two institutions. The HEJ Institute has provided occasional high-resolution spectroscopic analyses. However, 3-6 months are usually required to complete these analyses. The reason for such unacceptable delays is uncertain, but is probably because funds to pay the real cost of these spectroscopic services have not been available.

Linkages also exist with a number of European and American Universities. Various faculty members have either received degrees from or performed postdoctoral work in Belgium (State University of Ghent, University of Antwerpen), United Kingdom (Queen Mary College, London), Canada (University of Calgary), Ireland (University of Dublin), Germany (Karsruhe), and Switzerland. Strong ties have developed with the Department of Medicinal Chemistry at Purdue University and the Department of Chemistry at the University of Central Florida. One faculty member

has been a Fullbright Fellow at Texas A & M University. Several faculty members have strong ties to Saudi Arabia.

Linkages with the public and private sectors in Pakistan are difficult to assess. **The faculty indicated little knowledge of the various industries with which they might collaborate to produce products from their research.** There were no programs through which faculty could regularly visit Pakistan's various industries, nor were industrial executives or scientists ever invited to visit the Department of Chemistry. Likewise, there are no cooperative programs through which students could alternate between classroom studies and on-the-job industrial training. The Chairman, Dr. Miana, seems to have a close working relationship with the public sector since he has been Vice-Chancellor and held many posts in professional societies and community leadership. Although a few of the faculty have attended workshops and conferences in Pakistan and around the world, such activities have been very limited. For instance, only one person from Gomal was allowed to attend an international symposium on "Structure/Function of Proteins" recently held in Karachi.

2.1.7 Professional Environment

The student/faculty ratio is at a highly desirable level (approximately 3:1). The faculty spend a great deal of time with the students in a "hands on" approach to teaching. In fact, in some cases it is almost a tutorial approach. While this is a positive factor, problems do exist in terms of the lack of availability of textbooks, including laboratory manuals for students. Some concern was expressed in regard to student unrest and protests over examination scores. However, this problem seems to be less significant at Gomal University than at many other institutions in Pakistan.

The management capability within the Department seems to be excellent. Dr. Miana has considerable administrative experience and is aggressive in representing the Department to the administration at Gomal University and to the Pakistan Government. In addition, clear goals seem to be set for expectations of the faculty in teaching and research. The chairman sets an excellent example for his faculty by his success in attracting research grants and publishing results.

Promotion policies follow the requirement of the Pakistan Government, which require specific numbers of years of service and research publications. These requirements are provided in Appendix D. The research publication requirement is rather modest. The hiring policies of the Department are to be commended. An

impressive team of senior faculty has been assembled with advanced degrees from distinguished institutions in Pakistan and throughout the world.

Many of the assistant professors and all of the lecturers have their M.Sc. degree from Gomal University. The junior faculty generally have remarkably good skills in the English language, and has a strong determination to improve their own scientific capability as well as the stature of the Department. Almost all would like to receive Ph.D. training abroad.

The support staff seems adequate for the current level of activity. There are many people providing secretarial assistance and building maintenance. An electronic technician from the Pharmacy Department helps with the maintenance of all major equipment. As the Department expands its teaching and research activities, additional support staff will be required.

Incentives for achieving excellence in teaching or research are very limited. There is very little money available for any of the activities usually associated with achieving excellence. For example, funds are generally not available to send faculty to conferences and workshops, even when they are held in Pakistan. Promotions lead to only modest increases in salaries. **Despite the scarcity of funds, many faculty continue to write proposals requesting financial support.** It is noted that any research proposal funded by the UGC usually carries a two-month salary as a bonus. In addition, the faculty are encouraged by the Department to develop their teaching and research skills through advanced degree training and postdoctoral research.

2.1.8 Costs and Financing

Students pay only a very minor tuition fee, and the university disburses about Rs. 47,700 to assist indigent students with the cost of living.

No recent budget information was provided by the Department for the cost per student. However, the departmental supply budget is only Rs. 50,000 ($2273) per year. In addition, the Department receives Rs. 50,000 per year for equipment.

University-wide budget figures were not obtained. However, in 1985-86 the University received all of its money from federal government sources, which was 28.306 million rupees for recurring expenses and 15 million rupees for development.

Appendix E gives the total amount of money which the Department spends on faculty salaries by rank and year. The pay range was Rs. 2,065 to Rs. 3,925 per month for lecturers, Rs. 2,716 to Rs. 4,660 for assistant professors, Rs. 4,130 to Rs. 5,770 for associate professors, and Rs. 4,900 to approximately Rs. 11,000 for full

professors. The yearly increments for those in the lecturer, assistant, associate, and full professors ranks are Rs. 155, Rs. 195, Rs. 205, and Rs. 250 per month respectively until the maximum is obtained.

2.2 SYNTHESIS OF ISSUES

2.2.1 External Efficiency

In this section the concern is primarily with the success of the program from the standpoint of student preparation. This involves curriculum content and an examination of student success in being admitted to the next level of training or to finding suitable employment.

The review team has no factual data regarding job placement of graduates. However, the faculty has indicated that the students are usually successful in obtaining employment in industry, research institutes, universities, and high schools. Most are employed by the Education Department as chemistry teachers and in B.Sc. college programs.

While the majority of students do find employment that relates to their training in chemistry, these jobs often offer low pay and do not fully utilize their skills in chemistry. The under-utilization of trained chemists is partly because the chemical industry in Pakistan is usually organized as a "turn-key" system and is not oriented toward research and development. The scarce opportunities for chemists in Pakistan may be, in part, a result of the educational system which stresses learning factual materials and does not adequately emphasize developing problem solving skills.

It is important for the faculty of the Department of Chemistry to recognize the significance of the profit motivation of industry. Graduates with the ability to increase company profits will be in high demand.

The extreme isolation of the faculty from the world-wide scientific community has contributed to inadequate preparation of students. Gomal University has a very small number of scientists actively engaged in research. Hence there is little opportunity for interdisciplinary research. This is in contrast to large universities in the United States where the most significant research often transcends the conventional disciplines of science (e.g., chemistry, biology, physics etc.). Because of the geographic isolation of Dera Ismail Khan, a seminar program comprised of scientists who are "passing through" the area has not been possible. Likewise, a seminar

program for industrial associates does not exist. Some of the junior faculty have probably never traveled outside N.W.F.P. Most of the senior faculty have traveled, and even received graduate degrees, outside Pakistan. However, there is no regular program for interacting with the world-wide scientific community. The absence of international journals also contributes to the isolation. Although the factual foundation of modern science changes only slowly, creativity, especially with respect to the technological applications of chemistry, requires a constant infusion of ideas.

Although the students at Gomal University may receive adequate training in purely academic chemistry, they may not be receiving sufficient training in areas relevant to the needs of industry. Such training has become an important part of engineering programs in many of the leading universities in the United States. Often referred to as "Industry/university cooperative programs", these programs give students an opportunity to combine traditional academic studies with industrial training. Although students enrolled in co-op programs usually require five years to complete the requirements of the traditional four-year totally academic program, they are heavily recruited by industry upon graduation. It is also noted that joint industry/university research projects, funded by industry, are an added benefit of such linkages. Although co-op programs are less common to chemistry departments, there is clearly a trend in this direction.

2.2.2 Internal Efficiency

Measures of internal efficiency reflect how effectively the educational system has used the available resources to achieve its goals. **The impression of the assessment team was that the Department is generally using its meager resources to provide the best possible education for its students.** Some of the limitations to having an excellent program were discussed during a meeting with the M.Sc. previous and final students. Although these students seemed eager to learn and had high goals, they expressed concern about (1) the lack of "hands on" experience with instrumentation, (2) the small amount of chemicals available for laboratory work, (3) the lack of textbooks and laboratory manuals, and (4) money for living expenses.

The student dropout rate is very low. In fact one of the strengths of the program is that they allow students to take examinations several times until they reach a passing score of 33 percent. Approximately 80% of the students pass each exam. There is concern among the faculty at Gomal University, as well as some other universities, that they must pass every student to avoid being threatened by student

violence. Furthermore, there is evidence that the higher administration does not actively discourage this practice.

The instructional methods used at Gomal University are rather different from those commonly found in the United States. Most learning comes from a direct interaction with the professor. Tools to develop problem solving skills, such as homework problems, quizzes, and assigned reading in textbooks are used infrequently, or not at all. The direct interaction form of instruction, which is very labor intensive, is possible only because of the very high student/teacher ratio (3/1). Although the high student/teacher ratio is generally desirable, there is concern that the current teaching methods over-emphasize memorizing facts and do not encourage the process of creative thinking.

A strength at Gomal University is the rather large amount of unused space in the chemistry building. However, a weakness is the poor utilization of this space.

Material availability is a problem. This is due to cost and the length of time required to obtain many supplies. Indications are that it may take up to a year to obtain certain chemicals required for teaching or research.

The qualifications of the senior faculty are excellent and this is an important strength of the chemistry program at Gomal University. The majority are highly trained with Ph.D.'s from distinguished universities in Pakistan, Europe, or Canada. Many are also actively involved in research, as is evidenced by their publication and funding records. All of the junior faculty have their M.Sc. degrees from Gomal University. This practice of recruiting faculty from one's own students is contrary to current practices in the United States where emphasis is placed on recruiting faculty trained at other universities. The junior faculty are impressive in terms of their spoken English, and their desire for further training in research and teaching. They all seem bright, determined to obtain a Ph.D. degree, and interested in elevating the level of graduate education in Pakistan.

Finally, in regard to the curriculum, the strength is the large volume of factual information which the students learn as well as the almost tutorial style of the faculty. However, this is also the weakness since students expect to be told what to do and, therefore, do not learn to think creatively. There is a tendency to avoid making mistakes at all costs rather than emphasis upon the fact that science is an experimental subject where mistakes are made the majority of the time. The large amount of topic coverage is a strength but also a weakness because it does not provide enough time for adequate in-depth learning.

2.2.3 Access and Equity

The male/female ratio is approximately 3:1. **Women are on the faculty at the junior level. Thus women are allowed to participate. However, there are many barriers to overcome for women due to the local customs.** There appears to be no discrimination in regard to admission and examination procedures. However, because of the typical family structure and customs, women are not encouraged to obtain a higher education. In a positive sense they do participate in the same classrooms and laboratories and are allowed to participate fully in departmental discussions. The present participation is highly encouraging, suggesting a positive trend in this conservative region of Pakistan.

All students are Muslims, and 94 percent come from the Northwest Frontier Province. They are mainly rural since this is a rural province with few racial or religious differences. There are, however, many political differences which seem to come from intense loyalty to local or family controlled regions.

The enrollment by age is normal. The student class size is about 35 for lectures and between 15 and 30 for laboratory.

The number of faculty assigned to the various divisions of chemistry is uniform and appropriate, with the exception of analytical chemistry. Basic principles of analytical chemistry are taught by faculty assigned to other areas. The lack of an analytical chemistry division is unfortunate, since graduates with emphasis in analytical chemistry will be needed by Pakistan's developing chemical industry.

There is a large number of support staff for secretarial, building maintenance, etc. This should be a high priority since the cost of spare parts is high and the length of time to obtain them is sometimes more than a year. Instrument down time affects (1) the entire productivity of the Department, (2) the nature of the faculty-student interaction, and (3) the learning of experimental methods.

2.2.4 Management and Administration

The Department works on a rather informal basis with no division heads. However, the senior faculty member in each division has the responsibility for focusing the activities of his division toward the goals of the Department. This is usually accomplished through rather informal meetings of the division faculty.

The leadership provided by the current chairman is a real strength of the Department. The effectiveness of his leadership is indicated by the recent increase in the number of grants to the Department and his ability to obtain consideration for his

Department by the Pakistan government and the IEP program. His success is due to his administrative experience (he has previously been Chairman of Chemistry and Pharmacy as well as Vice Chancellor at Gomal University), his knowledge of Pakistan's system of higher education, his outgoing personality, and his scholarly leadership. His record in terms of scientific publications and obtaining research funds is commendable, and especially so given the meager research facilities available to him.

Overall, the management structure is reasonable. The faculty seems to work together well with the chairman in regard to salary and promotion policies, which are set by the government with little opportunity for departmental flexibility. There is a defined procedure for review of both academic and non-academic staff. The head of the Department is required to furnish the administration at the close of the calendar year a confidential evaluation report on faculty members. If the report is negative, this has to be communicated to the person who has a right to appeal the authority. The annual increments and promotion to higher grades are based on these reports. The academic positions are all competitive and the in-service person's record during the service is also considered at the interview and appointment at higher positions.

In summary, the Department has a strength in the leadership of Professor Miana. However, the lack of governmental support is a weakness, as is the lack of collective and aggressive discussions among the higher administration, the chairman, the faculty, and students on how some problems can be solved without additional funds.

2.2.5 Costs and Financing

For universities throughout the world, there is generally a direct correlation between their level of excellence and their operating costs. Although many factors contribute to the success of teaching and research programs, adequate funding is a primary requirement. Developing countries, such as Pakistan, are generally unable to fund all, or even many, of their universities to the extent that they can compete with universities in affluent countries. **With a supply budget of $2300/yr, the Department of Chemistry at Gomal University is typical of a severely underfunded department in a developing country. Except for the number of faculty positions, the Department is underfunded in every respect. The library facilities, chemical instrumentation, repair facilities, teaching aids, office equipment etc. are all inadequate for a chemistry department charged with the task of providing manpower to support and lead Pakistan's chemical industry.**

3. STRATEGIES FOR CHANGE

This chapter discusses specific needs of the department and proposes a detailed six-year plan through which IEP will attempt to strengthen the Department of Chemistry so as to maximize its contribution to the economic development of Pakistan.

3.1 PROBLEM ANALYSIS

Excellence in teaching and research occur only in an environment in which there is hope that these goals can be achieved. Without adequate funds, and without the likelihood of having adequate funds in the near future to generate such an environment, the faculty in the Department of Chemistry at Gomal University are working in conditions which do not encourage the pursuit of excellence. As a result, students are not stimulated to achieve even a small fraction of their potential. This under-utilization of Pakistan's most important resource, its people, is limiting the development of chemistry-based industry in Pakistan. For example, despite the need for pharmaceutical products, the pharmaceutical industry in Pakistan functions as a "turn-key" system with no emphasis on research and development.

IEP will address the problem of under-development of the chemical sciences in Pakistan through the Department of Chemistry at Gomal University in two ways: 1) Three primary research programs that already exist despite the dearth of funding will be expanded by providing equipment, supplies and training. 2) In addition to assisting these programs directly, a state-of-the-art analytical spectroscopy laboratory will be established. Not only will this spectroscopy laboratory provide essential services to the three primary research programs, it will stimulate other research programs which do not currently warrant direct support. By providing an atmosphere in which faculty and students can effectively pursue meaningful research, and by providing funds for modest improvements to the Department for teaching chemistry, IEP will stimulate the production of trained manpower in chemical sciences and technology, as required for further development of Pakistan's chemistry-based industry.

3.2 PROGRAM NEEDS

3.2.1 Curriculum/Educational Materials

- The Faculty and administration should seek ways to reduce the isolation of scientists at Gomal University.

- Efforts should be made to give students an opportunity for industrial training because of the emphasis placed on forming linkages to Pakistan's technological development by IEP.

- The faculty should try very hard to ascertain what type of skills are needed by Pakistan's chemical industry and strive to produce students with these skills. Problem solving is just one of the skills that will be required. The ability to select, operate and repair highly technical laboratory equipment will also be important.

- Students should be taught to be more creative; to look for solutions that were not described by an instructor in a course. As the students become more creative, they will generate new opportunities for themselves in Pakistan's chemical industry.

- Students and faculty should be encouraged to become entrepreneurs. For example, they could establish small chemical businesses providing specialty materials that are hard to find in Pakistan. There are excellent possibilities for small industries in food, cosmetics, flavors, pesticides, fungicides, herbicides, polymers, drugs, adhesives, coatings, etc.

- Students' thinking and reasoning skills must be challenged. Students must have "hands on" experience with modern equipment. They must be given the opportunity to make mistakes, even if it means making costly repairs to instruments. Each student must be inspired to develop his/her potential. If students are to achieve these goals, they must have teachers who are equally motivated to achieve excellence in teaching and research.

- Materials, including a laboratory manual, should be made available to each student prior to laboratory sessions.

- The students indicated a desire to have 30-40 copies of each textbook in the library because they do not have enough money to purchase textbooks.

3.2.2 Research

- M.Sc. students should spend more time in research. Emphasis in M.Sc. research needs to be increased, and the government should encourage this by providing higher budget levels for equipment and supplies for science departments.

- Faculty should write more proposals and seek private donations from wealthy individuals to further teaching through research. It is not acceptable to wait for the government to increase funding. The faculty must be active in pursuing all possible sources of support.

3.2.3 Facilities and Equipment

- The faculty should evaluate the current uses of all rooms and, anticipating the implementation of IEP, they should make a master plan for space utilization. Further space needs could be accommodated by dividing some of the large rooms, recovering use of the basement of the building, and using portions of the hallways for more cabinets and lockers for students and faculty.

- Air conditioning will be required for some laboratories which have electronic instrumentation.

- Having multiple pieces of each type of equipment, as well as a full-time electronics repair person, would reduce the consequences of damaged equipment. Students should learn how to use and perform minor repairs to instrumentation since this is essential to implementing modern technology and the learning process.

- **The organic research group needs upgrading of or addition of all of the areas of spectroscopy (NMR, MS, IR, UV, ORD/CD).** They also need improved chromatography equipment (HPLC, etc.). In addition, more rotary

evaporators, glassware, balances, stirrers, heaters, etc. are requested. The organic division also needs more solvents, specialized chemicals and routine chromatographic supplies.

- **The polymer and colloid science area of research can utilize all of the spectroscopic equipment mentioned above to characterize monomers and intermediates required to synthesize monomers.** The division is already very active with limited, currently available equipment such as spec - 21, conductometer, viscosity baths, rheometer, centrifuge, microscope and stirrers.

- **The bio-organic and inorganic laboratories are primarily involved with natural products chemistry and microbial leaching of ores. These products rely heavily upon the spectroscopy equipment currently available. Thus creation of a new spectroscopy laboratory with upgrades in the NMR, IR, UV, ORD/CD as well as the addition of mass spectrometer would significantly improve the productivity of this research area.**

- Liquid helium will be required for the spectrographic laboratory. Liquid helium is not generally available in Pakistan and thus it will be necessary to install and operate a liquid helium plant at Gomal.

- The bio-chemistry and bio-technology group will have need of a cold room. They will also need a variety of equipment in addition such as high speed centrifuges, balances, chromatographic columns, fraction collectors, micropipettes, peristaltic pumps, water baths, amino acid analyzers, etc.

- A glass-blowing facility, electronics expert, and workshop would assist all areas with the special problems of maintaining adequate supplies and equipment. The length of time to order and the cost of glassware are the major reasons that a glass-blowing facility should be considered. Maintenance of instruments is extremely difficult, both from a cost standpoint and the length of time needed to receive spare parts. Thus an efficient operation will need a superb electronic technician that can be ingenious. The fact that the Department of Pharmacy currently has an electronics technician is helpful to the current instrumentation maintenance situation since the NMR, UV and IR are shared by Pharmacy and Chemistry.

3.2.4 Professional Environment

- The faculty of the Department of Chemistry is a substantial strength and national resource which should be encouraged to develop itself to the greatest possible extent.

- At least two faculty members in analytical chemistry should be added or trained as soon as possible.

- Considerable effort should be made by the Department and the university to make participation easier for women and to encourage them to become leaders.

3.2.5 Costs and Financing

- A new procurement system should be developed, with the assistance of the government of Pakistan, to facilitate direct purchasing from international scientific supply companies. This system should be country-wide, transcend certain custom regulations and be available to all scientific departments in universities, colleges and high schools. Such a contract would lower the cost and delivery time.

- The high cost of science has not been adequately acknowledged by the University or government of Pakistan. Because adequate funding for science education is unlikely in the near future, the university administration and the Chemistry Department faculty should make a greater effort to work together to find solutions for problems, even when the necessary funds are not available. For example, it may be possible to obtain back issues of journals from scientists in the United States. Likewise, the administrative procedures for scientists who wish to participate in conferences and seminars should be relaxed.

Financing that will allow the Department of Chemistry to graduate students who will be competitive in the world market should be sought from many places. Research programs that will be of interest to, and eventually funded by industry should be developed. Applications for research grants from the University Grants Commission and the Pakistan Science Foundation should be encouraged. A vigorous effort should

be made to solicit small and large grants from wealthy families. Requests for programs that will make real contributions to the technological development of Pakistan should be made to all levels of government. The success of all of these fund-raising activities will depend in part on the ability of the faculty to express their ideas and enthusiasm through well-written proposals. Although the USAID Institutional Excellence Project may be an important source of funds for equipment and faculty development, it is temporary and should be viewed only as one component of a comprehensive program for financing excellence in education.

3.3 PLAN FOR DEVELOPMENT

In Pakistan, as well as throughout much of the rest of the world, academic chemistry programs are divided into the five areas of organic, physical, biochemical, inorganic and analytical chemistry. Specific research programs within a department of chemistry may be broad, encompassing more than one area, or narrow, focusing on a specific topic. The present organization of the Chemistry Department at Gomal University is illustrated in Figure 1. Instruction at the M.Sc. level is performed through the traditional five areas, as illustrated at the top of the figure. Specific research programs are also listed along the bottom of the figure.

Since the goal of IEP is to build research programs that will be relatively self-sustaining at the end of the project, each of the currently active research programs was critically evaluated to determine which would satisfy this requirement. Recognizing that over-funding of a specific area of chemistry reduces other areas to insignificance, **the team has developed a plan which will not only result in self-sustaining programs, but will also strengthen all of the areas of chemistry. The core of the plan is a spectroscopy laboratory which will serve all areas of chemistry.** In addition, existing research programs in applied biochemistry, natural products, and polymers will be expanded. A scheme illustrating the pivotal role of the proposed spectroscopy laboratory in the Department of Chemistry is illustrated in Figure 2. The analytical capabilities of the spectroscopy laboratory will also be available to Pakistan's academic and industrial research community. Many of the institutions and their research programs that could benefit from the proposed spectroscopy laboratory are given in Figure 3. **It is anticipated that the inter-institutional linkages developed via the spectroscopy laboratory will lead to the formation of important program/program linkages.**

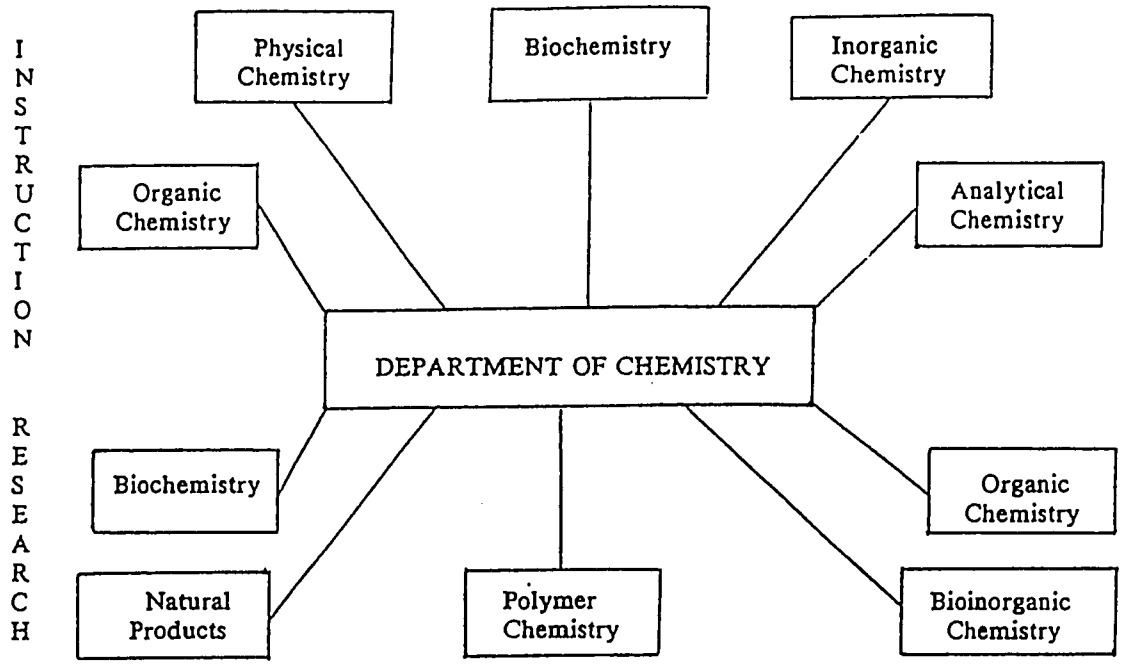

Figure 1 **Present organization of the Department of Chemistry.**

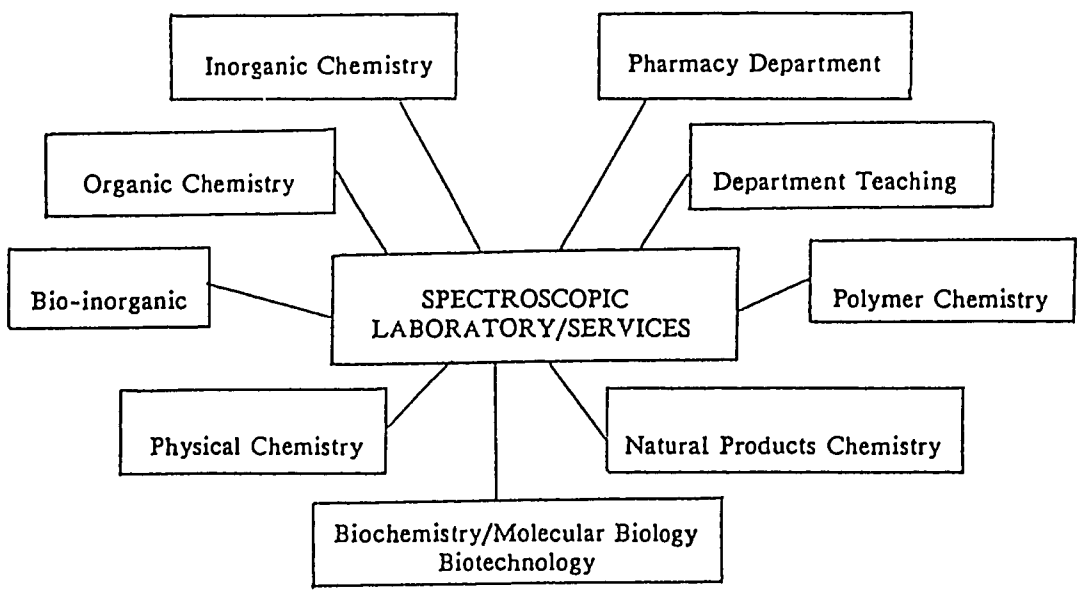

Figure 2 **The proposed spectroscopy laboratory will serve all areas of chemistry and research.**

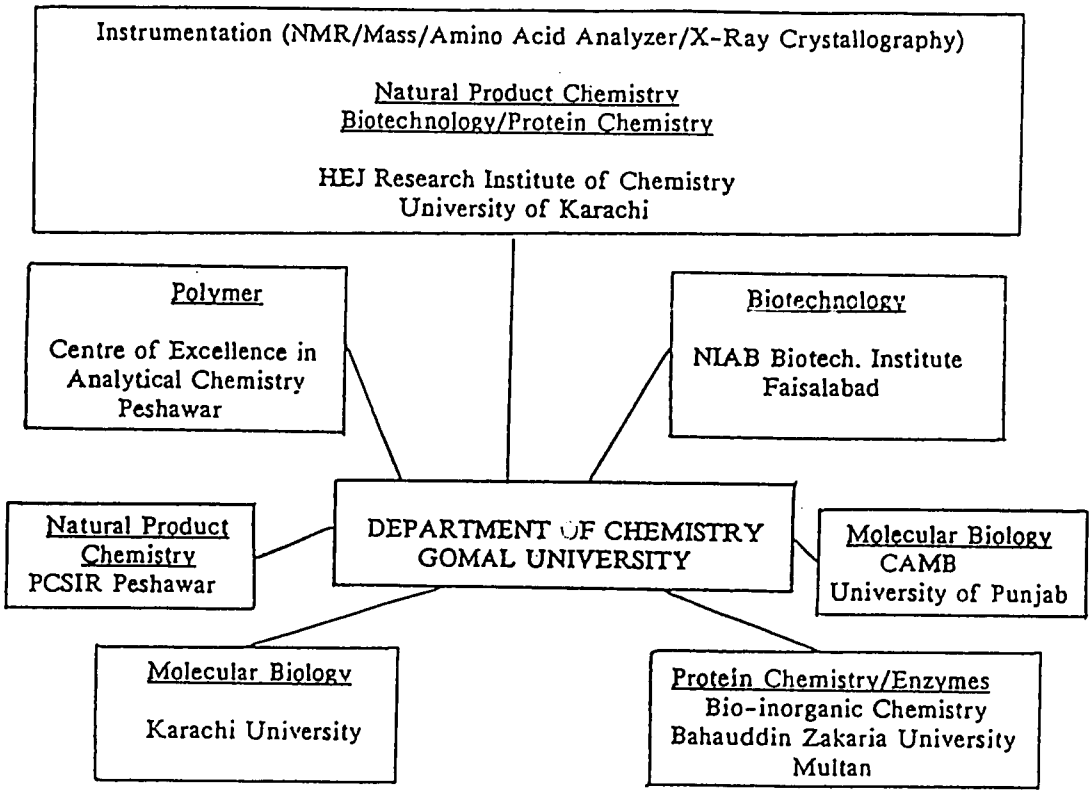

Figure 3 The spectroscopy laboratory will encourage the formation of linkages between research programs throughout Pakistan.

3.3.1 Applied Biochemistry Program

- GOALS

Upon completion of the six year plan, this program will lead to the development of:

1) a state-of-the-art laboratory for isolating, purifying, and characterizing enzymes and other proteins.

2) faculty trained and equipped to teach modern techniques in molecular biology, including recombinant DNA and hybridoma technology.

3) faculty who can teach current methods of biotechnology, and link the research capabilities of this program to the industrial needs of Pakistan.

- SIGNIFICANCE

This program will contribute to the scientific and industrial development of Pakistan by:

1) providing the capability for investigating the structure and function of proteins. Since the facilities required for isolating and purifying proteins can also be applied to nucleic acids, this laboratory will be a valuable resource for faculty who teach the principles of molecular biology and biochemistry. Similarly, many of the facilities in this laboratory could be used to isolate and characterize a wide variety of biopolymers.

2) providing a source of manpower trained to give technical support to industries in the areas of biochemistry, fermentation, microbial leaching of ores, and genetic engineering.

3) providing an environment that will greatly increase the number of qualified science teachers who will play an important role in promoting scientific awareness throughout society.

- STAFF

The goals of the biotechnology program can be achieved with a faculty who have complementary research activities.

Senior Staff

Dr. Ahmad Saeed, who will be responsible for protein isolation, will be the senior member of the team.

Dr. Sher Khan will use his experience in synthetic bio-organic chemistry to link the basic science of the program to the biotechnology industry of Pakistan.

Mr. Abdur Rahim will be responsible for protein characterization by modern spectroscopic methods.

Mr. Amjad Kamal will be responsible for molecular biology aspects of the program.

Miss Noor-i-Ain will be responsible for linking bio-inorganic chemistry to biotechnology.

Junior Staff

2-4 students will eventually be admitted to the Ph.D. program each year.

- SENIOR STAFF TRAINING

Dr. Saeed will work on the isolation of proteins in the US for one year (year 1). In addition, he will make two short term visits (2 mo. each) to the US (years 3 and 5).

Dr. Sher Khan will make three short term visits to the US to learn about possible approaches for linking the basic science of this program to the Pakistani biotechnology industry (years 2,4,6).

Mr. Abdul Rahim will receive his Ph.D. from Gomal University but will perform his thesis research in the US. He will make one short term visit to the US near the end of the project (year 5).

Mr. Muhktiar Hassan will pursue Ph.D. training in molecular biology in the US (year 1).

Miss Noor-i-Ain will pursue Ph.D. training in bio-inorganic chemistry in the US (year 1).

Miss Rehana Yasmin will pursue Ph.D. training in bio-inorganic chemistry in the US (year 1).

- MAJOR EQUIPMENT

Thermostatted cold room (50 ft^2) ($10,000)

Slab gel drying system complete with vacuum pump, trap, and plumbing. ($3,000)

Two Amicon ultrafiltration systems (500 and 50 ml) with filters. ($1,000)

Centrifugal concentrator (Savant) system with two rotors, vacuum pump, trap and plumbing. ($3,000)

Conductivity meter with two probes for determining osmolality of solutions. ($1,000)

Constant temperature water bath (4 ft^2). ($500)

Amino acid analyzer ($25,000)

Ultra Centrifuge with four rotors and other accessories. ($30,000)

High-speed centrifuge with four rotors and other accessories ($5,000)

Gradient HPLC with UV detector and recorder. ($20,000)

Laminar Flow Chamber ($10,000)

Eppendorf microcentrifuge. ($1,500)

Medium power microscope ($5,000)

Four fraction collectors (ISCO). ($1,000 each)

Autoclave ($15,000)

Four peristaltic pumps (ISCO). ($1,000 each)

Two variable temperature shakers ($4,000 each)

- MISCELLANEOUS SMALL EQUIPMENT

  Freezer, refrigerator, blenders, agitators, auto-pipets, magnetic stirrers, hot plates, pH meter, analytical balance, single-pan balance. ($4,000/yr)

- SUPPLIES

  Year 1 ($1,000); years 2-6 ($10,000/yr):

- NETWORKING WITHIN PAKISTAN

  All of the staff will be encouraged to spend two weeks per year visiting research centers and industries within Pakistan.

- NOTES

1) In addition to training programs external to Pakistan, as described above for senior staff, workshops etc. offered within Pakistan should also be used when appropriate.

2) Dr. Zulfaqar Alam Khan, who is presently on leave from the department, has research interests in nucleic acids and may participate in the applied biochemistry program on his return.

3) Funds should be allocated to allow the staff to travel within Pakistan to learn about the needs of industry and to visit other academic institutions with active programs relating to biochemistry.

4) In the middle of year 1, after Dr. Saeed has been in the US for 6 months, the exact specifications of the equipment will be made. Delivery will be scheduled for the beginning of year 2.

3.3.2 Polymer Chemistry Program

- GOALS

Upon completion of the six year plan, this program will:

1) develop capability to synthesize new polymers.

2) develop the ability to characterize various industrial polymers according to molecular weight mean and distribution.

3) develop theoretical models that can be used to correlate rheological and mechanical properties of polymers with their molecular weight mean and distribution.

- SIGNIFICANCE

This program will contribute to the scientific and industrial development of Pakistan by:

1) advancing our understanding of the fundamental chemical and physical properties of industrial polymers.

2) creating manpower with a thorough understanding of physical properties of polymers. This resource may play an important role in supporting and attracting polymer-based industry.

3) providing an academic atmosphere that will attract and motivate faculty in the area of polymer chemistry.

- STAFF

The goals of this program can be achieved with a faculty who have complementary interests.

Senior Staff

Musa Kaleem Baloch, who will be the senior faculty person associated with this program, will develop theoretical methods for characterizing industrial polymers. In addition, he will be responsible for linking the scientific output of this program to Pakistani industry.

Miss Gulrez Fatima will be responsible for developing experimental methods for characterizing polymers.

Bakhtiar Muhammad will synthesize polymers that will be investigated in this program.

Muhammad Siddiq will also participate in this program.

Junior Staff

2-4 graduate students per year will eventually enter this program.

- SENIOR STAFF TRAINING

Dr. Musa Kaleem Baloch will have two short term visits to the U.S (years 2 and 5).

Miss Gulrez Fatima will pursue Ph.D. training in the area of polymer science in the U.S. (year 1).

Bakhtiar Muhammad will pursue Ph.D. in the area of polymer synthesis in the U.S. (year 1).

Muhammad Siddiq will pursue a Ph.D. in polymer science in the U.S. (year 1).

- MAJOR EQUIPMENT

Small-angle laser-light-scattering photometer including the light source, and the facility for polarized and non-polarized light, variable angles (2-10 degrees), variable temperature, organic and aqueous solvents. ($20,000)

Medium power laser beam with accessories. ($4,000)

Personal computer (386-based) with hard drive, graphics, terminal, printer, and software to be used for theoretical calculations. ($6,000)

Rheometer (e.g., Weissenberg) including the facilities to work with steady as well as oscillating shear flows, the viscosity range 10^{-3} to 10^{-4} Pa.S., to work with coaxial cylinder and cone plate system at variable time and temperature. ($30,000)

Dynamic osmometer including facilities to measure the molecular weight of polymers in the range 10,000 to 1,000,000 over the temperature range 20-130 degrees in organic or aqueous solvents. ($7,500).

Differential refractometer/automatic differential refractometer with facility to measure the difference in refractive index up to 10^{-6}, to work over the temperature range 0-100 degrees, and at different wave lengths. ($5,000)

Clear view thermostat for viscosity measurements with temperature range 0-150 degrees, with accuracy and stability of 0.005 degrees. ($6,000)

Ultrafilteration system with capacities for 10 to 500 ml, filter sizes from 0.2 to 1.2 um, and driven by pressure rather than vacuum. ($3,000)

Pyrolysis apparatus. ($15,000)

MISCELLANEOUS SMALL EQUIPMENT:

$7,500/yr. for the duration of the project.

- SUPPLIES

  $5,000/yr. for the duration of the project.

- NETWORKING WITHIN PAKISTAN

  Funds should be allocated for traveling within Pakistan so that the senior staff can learn about existing facilities at other institutions, and to become familiar with the needs of the polymer production and molding industry.

- NOTE

  1) It will be preferable to develop a program in polymer chemistry/technology that will include at least three senior staff, as described above. However, a smaller program in polymer chemistry based primarily on the research of Professor Baloch would be a viable alternative. Requirements for equipment will be the same for either approach.

  2) It will be important to determine that this program in polymer chemistry complements, but does not significantly overlap similar programs at the Center of Excellence in Peshawar.

  3) Since Professor Baloch is already familiar with the types of equipment he will need for his program, it should be ordered in year 1.

3.3.3 Natural Products Program

GOALS

Upon completion of the six year plan, this program will lead to:

1) a state-of-the-art laboratory for the isolation, structure elucidation, and synthesis of biologically active natural products from plants indigenous to Pakistan.

2) faculty trained and equipped to teach modern analytical techniques in 2-dimensional NMR, mass spectrometry, HPLC, and synthesis related to natural products.

3) faculty trained and equipped to develop and teach techniques relative to bioassays in order to target the isolation of natural products with pharmaceutical and/or agrochemical activity so as to link this research to the development of new industries in Pakistan.

- SIGNIFICANCE

This program will contribute to the scientific and industrial development of Pakistan by:

1) providing novel compounds which can be developed as new pharmaceutical agents or agrochemicals by industry in Pakistan.

2) providing better capability relative to plant selection methodology, bioassay technology, isolation, structure elucidation, and synthesis of novel compounds from plants. Such capability will assist the current organic synthesis faculty in utilizing their expertise for the synthesis of novel natural products with biological activity. This capability could also assist the Department of Pharmacy, since Dr. Qazi has expertise in bioassay-guided techniques and natural products in an area of overlap for the Chemistry and Pharmacy Departments.

3) providing a source of manpower for technical support to current industry and development of new industry in the production of pharmaceuticals and agrochemicals.

4) providing an environment that will increase the number of science teachers and the awareness of society to the utilization and potential of plant products.

STAFF

The goals of the natural products chemistry program can be achieved with the following staff:

Senior Staff

Dr. G.A. Miana will be the senior member of the group and will interact with all aspects of the program, including developing a strategy for plant selection.

Dr. Irshad Ali will work on plants that contain alkaloids and will develop bioassays for natural products that may be used as fungicides, pesticides, or herbicides.

Mr. Iman Bakhsh Baloch will develop a natural products research program focusing on terpenoids.

Mr. Muhammed Iqbal, who will be trained as a specialist in NMR spectroscopy, will be an important resource for structure elucidation of natural products.

Dr. Muhammad Subhan, who will be trained as a specialist in mass spectrometry, will use the technique of mass spectrometry/mass spectrometry to search for new sources of important natural products in extracts of plants found in Pakistan.

Junior Staff

2-3 Ph.D. students will be admitted to the program each year.

- SENIOR STAFF TRAINING

Dr. Miana will make two short term visits (3-4 mo. each) to the US for performing work on the structure elucidation of compounds from Pakistani plants, and to learn about new trends in natural products chemistry (years 2 and 4).

Dr. Irshad Ali, who received his Ph.D. degree from the HEJ Institute of Chemistry in Karachi, will work as a postdoctoral research associate in the US for one year (year 2). He will also have a short visit in year 5.

Mr. Iman Bakhsh Baloch has entered the Ph.D. program in natural products research at the HEJ Institute of Chemistry in Karachi.

Dr. Muhammad Subhan and Mr. Muhammed Iqbal will be trained in the US as described in Section 3.2.4.

Dr. Saeed Anwar will either spend one year (or three short-term visits) to the US.

Mr. Azim Khan will be trained for one year in the US.

- MAJOR EQUIPMENT

  Gradient HPLC with both UV and refractive index detectors ($25,000)
  Chromatatron ($3,000)
  Large scale soxhlet extractor (12 liter) ($1,000)
  Rotary evaporator ($1,500)
  Vacuum pumps (2) ($3,000)

- MISCELLANEOUS SMALL EQUIPMENT

  Magnetic stirrers, drying oven, pH meter, balances, vortex mixer ($4,000/yr for the duration of the project).

- SUPPLIES

  $15,000/yr for the duration of the project.

- NOTES

  1) Four additional short term visits, by either Gomal or US scientists will also be scheduled. (years 2,3,4,5)

  2) Funds will be allocated to allow each senior member of the staff to spend two weeks per year visiting various industries and research centers in Pakistan.

  3) All equipment will be purchased in year 1.

3.3.4 Spectroscopy Laboratory

GOALS:

Establish a modern laboratory that will include the following major spectroscopic instruments:

Mass spectrometer
Nuclear magnetic resonance
FT infra-red
Scanning UV/visible

- SIGNIFICANCE

This laboratory will contribute to the development of science and industry in Pakistan by:

1) providing the major spectroscopic instruments required to identify substances such as natural products, proteins, and industrial polymers, all of which are of central interest to the three major research programs.

2) providing the instruments and staff required to identify a wide range of substances, including environmental pollutants, as a service to Pakistani industry. In addition, as the technical stature of Pakistan's industry grows, there will be a corresponding need for students trained in spectroscopic methods of analysis.

3) providing an academic atmosphere attractive to faculty who will be motivated to excel in teaching and research.

- STAFF

<u>Senior Staff</u>

Although the spectroscopy laboratory will have no research programs uniquely designated for it, senior faculty trained especially in the areas of mass spectrometry (Dr. Muhammad Subhan), NMR (Mr. Muhammad Iqbal) and analytical chemistry (Mohammud Ashfaq) will be required.

Junior Staff

An electronics technician who can be trained to make major repairs to the instruments will be required. The electronics technician must understand the basic principles of analog and digital circuits, and must be fluent in English so that he can attend training classes outside Pakistan. Ideally, he will also understand basic computer programming.

2-4 Ph.D. students should be assigned to the spectroscopy laboratory to operate the mass spectrometer and NMR, to perform routine operator maintenance to the instruments in the laboratory, and to instruct other students in the use of the instruments.

- STAFF TRAINING

Dr. Muhammad Subhan, who has had approximately two years of experience operating a relatively simple mass spectrometer in Germany, will be trained in modern methods of analysis by mass spectrometry for one year in the US in year 1, and two short visits in years 3 and 6.

Mr. Muhammad Iqbal will pursue a Ph.D. degree in the area of NMR/organic chemistry in the US.

Mr. Mohammud Ashfaq will pursue a Ph.D. degree in analytical chemistry in the US.

The electronics technician will be trained by the manufacturers of the mass spectrometer and NMR. (3 short visits)

- NOTE

Since some of the staff in the Chemistry Department already have experience operating NMR spectrometers, the new NMR spectrometer can be delivered prior to his return of Mr. Iqbal.

- EQUIPMENT

Triple quadruple mass spectrometer system with electron, chemical, and fast atom bombardment ionization sources, a computerized data acquisition system, 2000 mass unit upper mass limit, gas chromatograph and probe inlets, and spare

parts. Dr. Smith (Department of Medicinal Chemistry, Purdue University) will be the technical consultant for this instrument. (Finnigan MAT, San Jose, CA, $450,000)

300 MHz nuclear magnetic resonance spectrometer system. (Varian Instruments, Palo Alto, CA or Bruker Instruments, Germany; $350,000)

Fourier transform infra-red spectrometer. ($25,000)

Scanning UV/visible spectrometer. ($20,000)

Carbon-hydrogen-nitrogen elemental analyzer ($40,000)

- MISCELLANEOUS SMALL EQUIPMENT
  $15,000/yr for years 2-6.

- SUPPLIES
  $30,000/yr for years 2-6.

- NOTES

  1) Electronic technicians are usually better trained than electronic engineers for repairing instruments.

  2) Using technicians, in lieu of graduate students, to operate the instruments is a less desirable method of staffing the spectroscopy laboratory because technicians usually do not understand how the data will be used by the researcher. As a result, optimum instrumental parameters may not be used. In addition, Ph.D. students trained in the operation and routine maintenance of these instruments will be highly sought by industry. The most sophisticated mass spectrometric and NMR measurements will most likely be made by, or under the direct supervision of the senior staff of the laboratory.

  3) Since the HEJ Research Institute in Karachi has several Bruker NMR spectrometers, a Bruker instrument may be preferred. Perhaps Prof. Atta-ur-Rahman, or one of his staff, could be the technical consultant for this instrument.

4) An unusually large supply of spare parts, including printed circuit boards in some cases, will be required for each instrument.

3.3.5 General Equipment and Facilities Improvement

Two air conditioned rooms (500 ft^2) which will be equipped with an uninterrupted supply of stabilized power, air conditioning, and a dust-free atmosphere, new laboratory benches, a dropped ceiling (10 ft), and storage cabinets. One room will be used for the spectroscopy laboratory (mass spectrometer, NMR, IR, and UV) and the other will be used for other electronic instruments, such as amino acid analyzer, HPLCs etc. Electrical power for these rooms will be provided by a stabilized power supply including provision for ac-dc-storage-ac and a diesel powered generator for approximately 10 KW. The required capacity of the system will be determined when the instruments have been selected.

Liquid helium generator for the NMR.

High frequency oscilloscope for repairing the NMR.

The existing liquid nitrogen generator will be tested to determine its reliability and capacity.

Dry ice generation (Because of the availability of liquid nitrogen, a source of dry ice may not be necessary.)

Wet ice generation

Compressed air system (Compressed gasses are available in cylinders.)

Glass blowing shop including an annealing oven, small lathe, and assorted tools.

Ion exchange/glass distillation system for generating highly purified water for HPLC. (1 l/hr capacity)

Electronics shop including voltmeters, oscilloscope, power supplies, and general supplies.

FAX machine

Typewriters

Small computers for word processing (4)

MacIntosh SE computer with laser printer for drawing structures

Laboratories used for organic chemistry or fractionation of natural products will be equipped with fume hoods and adequate ventilation.

Library acquisitions ($5,000/yr)

3.3.6 Linkages Between the Department of Chemistry and Industry

- GOALS

Upon completion of the six year plan, this program will:

1) give the faculty an opportunity to learn about the technological and manpower needs of Pakistan's industry;

2) give leaders in Pakistan's chemical and biological industry an opportunity to recognize the Department of Chemistry at Gomal University as a research and educational facility important to the technological development of Pakistan.

- SIGNIFICANCE

This program, which is specifically designed to develop a strong linkage between the Department of Chemistry and Pakistan's industry, will contribute to Pakistan's technological development in many respects, and will provide a mechanism for the long-term support of research programs established through IEP.

- IMPLEMENTATION PART I

The first step in developing a strong university/industry linkage will focus on educating the faculty on the needs of industry so that their resources, especially research programs initiated by IEP, can be configured to be attractive to industry. Specific recommendations follow.

1) The senior faculty will spend two weeks per year visiting various industries in Pakistan. Reports describing chemicals consumed and produced, quality control procedures, sources of chemicals, manpower

requirements etc., will be prepared after each visit and circulated among the faculty.

2) Two industrial consultants will be invited to visit the Department of Chemistry each year. These consultants will be asked to present a lecture to the faculty and students on the needs of their particular industries, and to meet with small groups of the faculty for further discussions.

3) Develop a cooperative work/study program with key industries so that students can work in industry for 2-6 months before receiving their M.Sc. degree.

4) In Year 5 of IEP, a delegation of three industrial scientists from the US will visit three industrial facilities in Pakistan, and then advise the Chemistry Department faculty on general approaches for working with industry.

5) In Year 6 of IEP, a symposium including the three industrial scientists from the US and many industrialists from Pakistan, will be held to further the development of linkages between the Department of Chemistry and Pakistan's industry.

6) A report describing the progress in developing linkages with industry will be prepared by the head of each research program annually. These reports will be reviewed by the Department Head and appropriate IEP representatives.

- IMPLEMENTATION PART II

The second step in the linkage program will focus on the flow of information from the Department of Chemistry to industry <u>for a fee.</u> Specific recommendations follow.

1) Offer consulting services oriented toward solving problems encountered with processes currently used by Pakistan's industries. Awareness of industry's needs, availability of an entire faculty trained in modern chemical methods, and access to the unique analytical instruments in the

spectroscopy laboratory will make services provided by the faculty very attractive to industry. Direct links with academic or industrial consultants in the US may also be possible.

2) Research programs focusing on basic science or technology development related directly to and funded by specific companies will be established.

3.4 IMPLEMENTATION AND EVALUATION OF PROGRAMS

3.4.1 Year by Year Implementation

A schedule for implementing each step of each program is given in **Section 3.2.**

3.4.2 Inputs Required to Implement the Programs

The major expenses (inputs) that will be required to develop the three research programs and the spectroscopy laboratory are given in Table VI. The cost of major equipment does not include special costs associated with delivery to Pakistan and is only approximate. Costs for improving or providing general equipment and facilities (Section 3.2.5) are not included in Table VI. Likewise, costs relating to developing linkages with industry (Section 3.2.6) are not included.

TABLE VI

Major Inputs Required for Developing the Three Research Programs and the Spectroscopy Laboratory.

Input	Applied Biochemistry	Polymer Chemistry	Natural Products	Spectroscopy Laboratory
5 yr. Ph.D. Training	4	3	-	2
1 yr. visit	1	0	3	1
2 mo. visit	9	4	9	9
Major equipment	$147,000	$96,500	$33,500	$845,000
Minor equipment	$4,000/yr[a]	$5,000/yr	$4,000/yr	$15,000/yr
Supplies	$10,000/yr[b]	$7,500/yr	$15,000/yr	$30,000/yr

[a] Delete for year 1
[b] Reduce to $1,000 for year 1

3.4.3 Criteria for Measuring the Success of the Project

The IEP/Chemistry Program should be considered only as the first-step in a much larger effort to increase the scientific literacy of Pakistan's people and to provide manpower trained in chemistry, both of which will be required for Pakistan's technological development. Although there are no perfect indicators for quantitatively determining the contribution of the IEP/Chemistry Program to the technological development of Pakistan, there are a number of indicators which can be used to establish the level of productive activity of this program. Indicators which will be used annually to determine the progress of the IEP/Chemistry Program toward achieving its goals are listed below:

1) Implementation of the **six-year program.**

2) Development of linkages with industry. Specific data to be reported will include the number of University/industry visits, the number of students placed in industry, and the number of cooperative research projects.

3) Development of linkages with other academic institutions.

4) The number of research proposals submitted or funded.

5) The number of students enrolled in the M.Phil. and Ph.D. programs.

6) The number of M.Sc. students enrolling in M.Phil. and Ph.D. programs.

7) Total research funds awarded to the Department annually.

8) Utilization of the spectroscopy laboratory facilities. Specific data to be reported will include the number of analyses performed with each of the major pieces of equipment.

APPENDICES

APPENDIX A. Interview Schedule

APPENDIX B. Biodata of Senior Faculty

APPENDIX C. M.Phil/Ph.D. Courses

APPENDIX D. Requirements for Appointment of Faculty to the Department of Chemistry

APPENDIX E. Total Salaries Paid by Rank by the Department of Chemistry

APPENDIX F. Review of Six-Year Development Plan By the Chemistry Department of Gomal University

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APPENDIX A

INTERVIEW SCHEDULE

Monday, October 1	Travel to D.I.Khan Evening (6:00 pm) with Prof. Miana
Tuesday, October 2	Presentation of the "Goals of IEP" to the Chemistry Department faculty. Tour Chemistry Department and computer center facilities. Meet with junior faculty (M. Sc.) in **physical chemistry**.
Wednesday, October 3	Presentation by Prof. Miana of the major needs of the Chemistry Department. Meet with junior faculty (M.Sc.) in **biochemistry**. Assessment team meets to discuss Prof. Miana's requests.
Thursday, October 4	Meet with Prof. Miana to discuss: (1) advanced training for junior faculty; (2) prioritization of general equipment required by the Department; and (3) major research program in natural products. Meet with junior faculty (M.Sc.) in **organic chemistry** and **inorganic** chemistry.

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	Meet individually with Profs. Nazar-ul-Islam and Musa Kaleem Baloch.
Friday, October 5	Meet individually with Profs. Ahmad Saeed, Sher Khan and Saeed Anwar. Inventory teaching and research facilities.
Saturday, October 6	Meet individually with Profs. Irshad Ali, and Muhammad Subhan.
Sunday, October 7	Tour the Pharmacy Building. Meet with M.Sc. students.
Monday, October 8	Summary statement to the faculty. Return to Islamabad.

APPENDIX B

BIODATA OF SENIOR FACULTY

NAME:	Dr. Ghulam A. Miana
POSITION:	Professor
[redacted]	[redacted]
[redacted]	[redacted]
ACADEMIC QUALIFICATIONS:	M.Sc.(PESH) Ph.D (Calgary, Canada)
POST GRADUATE TRAINING:	Post Doc. USA 1 yr., Germany 1 yr. 3 mo., Canada 1 yr., UK 3 mo.
ADMINISTRATIVE EXPERIENCE:	Vice Chancellor,4 yr.; Dean, 1 yr.; Chairman, 6 yr.; Provost, 2 yr.
AWARDS:	Sitara-e-Imtaiz, Cash Prize National Book Council

PUBLICATIONS:

(A) Conferences/Seminars 7
Review Articles 7

(B) Total Research Publications: 61

1990

1989 (1) Tscheschamine: A new 14-membered Cyclopeptide alkaloid from the root bark of Zizyphus nummularia, A.H. Shah, V.B,. Pandey, G. Eckhardt and G.A. Miana, Planta Medica, 1989. (Submitted)

1988 (1) Tscheschamine: A new 13-membered Cyclopeptide alkaloid from the bark of Zizyphus Sativa, A.H. Shah, V.B. Pandey, G. Eckhardt and G.A. Miana, Heterocycles, 27, 1777, (1988).

1987 (1) Phthalide Isoquinoline alkaloids from Corydalis ramosa, G.A. Miana, N.K. Hakan and A.H. Shah, Fitoterapia, LVIII, 210 (1987).

NAME: Dr. Nazar-ul-Islam

POSITION: Associate Professor

[redacted] [redacted]

[redacted] [redacted]

ACADEMIC QUALIFICATIONS: M.Sc. (PESH) 1975; Ph.D. (LOND.) 1985

POST GRADUATE TRAINING:

ADMINISTRATIVE EXPERIENCE: Warden - 3 yr.

PUBLICATIONS:

Total Research Publications: 8

1990 -

1989 -

1988 (1) The Applications of Difunctional Organosilicon Compounds to Organic Synthesis; 1,3-Asymmetric Induction in the Reduction of -substituted -Hydroxyketones, S.Anwar and N.U.Islam, Gomal Univ. J. Res., 1988, 8, 41.

(2) Intramolecular Hydrosilylation - Oxidation of Acyclic Secondary Allylic Alcohols, S.Anwar and N.U. Islam, Gomal Univ. J. Res., 1988, 8, 35.

1987 (1) Design, Construction and Testing of A Versatile Flow Cell, N.U. Islam, K.G. Ellis and S. Nazar, J. Eng. Appl. Sciences, 1987, 6, 104.

(2) Reductive Dimerization of Aromatic Aldehydes in the Presence of Dibasic Acid, N.U. Islam and C.Z. Smith, Physical Chem., 1987, 6, 77.

(3) Electro-Organic Reactions. Part 30. Cleavage and Coupling of Some Biomass-derived Organic Compounds, K.G. Ellis, N.U. Islam, D.W. Sopher, H.L. Chum, M. Ratcliff and J.H.P. Utley, J. Electrochem. Soc., 1987, 134, 3058

(4) Electro-Organic Reactions. Part 28. Preparative Applications of the Oxalate Cathodic Cleavage Reaction involving One-Pot Conversion of Aldehydes and Ketones, N.U. Islam, D.W. Sopher and J.H.P. Utley, Tetrahedron, 1987, 43, 2741.

(5) Electro-Organic Reactions. Part 27. The Mechanism of Cathodic Cleavage of Activated Esters; Oxalates, Squarates and Oxamates, N.U. Islam, D.W. Sopher and J.H.P. Utley, Tetrahedron, 1987, 43, 959.

NAME: Dr. Sher Khan Sadozai

POSITION: Assistant Professor

[redacted]

[redacted]

ACADEMIC QUALIFICATIONS: M.Sc. (Quetta), D.Sc.(Ph.D) (Antwerpen, Belgium)

POST GRADUATE TRAINING: Czechoslovakia - 1 yr., Post Doc. USA - 1 yr.

PUBLICATIONS:

(A) Conferences 1
(B) Total Research Publications 7

1990 (1) Enzymatic "in vitro" reduction of Ketones, preparation of (1S,2S)-2-Fluorocyclohexanol. Accepted for publication in the proceeding of 1st National Conference on Chemistry (Chemical Society of Pakistan).

1989 (1) Bacterial Leaching of low grade copper ores. Journal of Pure and Applied Sci., Pakistan, 8(1), 39, (1989)

1988 (1) Asymmetric Reduction of -Chlorochyclohexanone catalyzed by a local dehydrogense in a Biphasic system. J.Sc. Res. Vol XVII (122), 47 (1988).

(2) Isolation and Characterization of Nummularine-E from the stem bark of Zizyphus Nummalaria. Journal of Pure and Applied Sci., Pakistan, 7(1), 31 (1988).

1987 (1) Biphasic One-pot Synthesis of two useful and Separable compounds using nicotinamide Co-factor-requiring enzymes: Syntheses of (S)-4 hydroxy hexanoate and its lactone. Enzyme Microb. Technol.; 9, 564 (1987).

NAME: Dr. Saeed Anwar

POSITION: Assistant Professor

[redacted] [redacted]

[redacted] [redacted]

ACADEMIC QUALIFICATIONS: M.Sc. (Pesh.), 1976; Ph.D (Dublin), 1987

POST GRADUATE TRAINING: Switzerland - 2 yrs.

PUBLICATIONS:

(A)	Conferences	3
(B)	Total Research Publications	6

1990 -

1989 -

1988 (1) M.R. Jan, M.Daud, S. Pervez and S. Anwar, J.Chem.Soc.Pak., 1988, 10, 431.

1987 -

NAME: Dr. Musa Kaleem Baloch

POSITION: Associate Professor

[redacted]

ACADEMIC QUALIFICATIONS: M.Sc. (Pesh.), Ph.D. (Pesh.)

POST GRADUATE TRAINING: Czechoslovakia - 1 yr. (1979); Germany - 1 yr. (1981); Post-Doc - 2 yrs. (1986)

ADMINISTRATIVE EXPERIENCE: Warden (1983) - 1 yr.

PUBLICATIONS:

(A)	Conferences	6
(B)	Total research publications	23

1990 (1) Unperturbed Chain Dimensions of Poly(iso-butylene) in Different Solvents and at Different Temperatures. Polymer Bulletin. (in press)

(2) Light scattering from semi-dilute dispersions of non-spherical latex particles subjected to an electric field. J. Colloid & Interface. Sci. 135(2), 594 (1990).

(3) Frequency dependence of electrically induced alignment of anisometric colloidal particles. J. Colloid & Interface. Sci. 136(2), 494 (1990).

1989 (1) Steady shear behavior of Coal-oil Suspensions, M. Kaleem Baloch. Rheological Acta. 28, 316 (1989).

1988 (1) Transient Light Scattering of Suspensions of Charged non-spherical Particles Subjected to an Electric Field; M. Kaleem Baloch and T.G.M. van de Ven. J. Colloid & Interface Sci. 129, 91 (1988).

(2) Rheological Properties of Moderately Concentrated Solutions of Polystyrene-block-polybutadiene-block-polystyrene in Different Selective Solvents and at Different Temperatures; M. Kaleem Baloch and A. Rauf, Makromol. Chem. 189, 1517 (1988).

(3) The Newtonian Viscosity of Polymer Solutions: Scaling Relationship; M. Kaleem Baloch, J. Macromolecular Sci. Physics B 27(2&3), 151-180 (1988).

(4) The Newtonian Viscosity of Polymer Solutions: M. Kaleem Baloch; J. Macromolecular Sci.Chem. A 25(4), 363 (1988).

(5) Determination of Molecular Weight Distribution Curves and their Relation to Different Parameters; M. Kaleem Baloch and N. Ahmad; J. Chem. Soc. Pak. 10(1), 1-9 (1988).

1987 (1) Photochemical Crosslinking and Isolation of Poly (styrene/butadiene/styrene) Triblock Copolymer in Selective Solvents: M. Kaleem Baloch and N. Ahmad, J. Surf. Sci. Tech. 3(2), 85 (1987).

(2) Viscometric Estimation of Unperturbed Chain Dimensions of Polymers; N. Ahmad and M. Kaleem Baloch, J. Macromolecular Sci. Chem. A 24, 1241 (1987).

NAME: Dr. Ahmad Saeed

POSITION: Associate Professor

[redacted]

ACADEMIC QUALIFICATIONS: M.Sc. (Pesh.), D.Sc. (Ph.D) (Ghent, Belgium)

POST GRADUATE TRAINING: Pakistan, 1 mo., 1 wk. - 1981; Malaysia, 1 wk. - 1986; Italy, 1 yr.

PUBLICATIONS:

(A) Conferences 5
(B) Total research publications 16

1990 (1) Chicken Brain Acetylocholinesterase Inhibition by Tetrabutylammonium ion and N,N,N,N-tetramethylethylene diamine. M. Amjad Kamal, S.M. Abbasi and Ahmad Saeed. (submitted) Pak. J. Sci. Ind. Res.

(2) Extraction of Acetylcholinesterase from Chicken Brain. Ihtisham-Ul-Haq, M. Amjad Kamal and Ahmad Saeed. (Submitted) Journal of Pure and Applied Chemistry.

(3) Bovine Brain Low Molecular Weight Acid Phosphatase - Purification and Properties. A. Saeed, E. Tremor, G. Manao, G. Camici, G. Cappugi and G. Ramponi. (Accepted) Physiol. Chem. Phys.

1989 (1) Purificazione e proprieta di Fosfatasi Acida di Basso Peso Molecalare da Cervello bovino. A. Saeed, E. Tremori, G. Manao, G. Camici, G. Cappugi and G. Ramponi. Riunione Annuale Dell, TUM, Societa Italian Biochemica Perugia, 26 maggio 1989.

1988

1987 (1) Isolation of highly active papain from dried papaya latex. Ikramullah Khan, Ahmad Saeed and Zulfaqar Alam Khan. J. Chem. Soc. Pak.; 1987, 9(2) 207-211.

(2) Purification and Characterization of Acid phosphatase from sorghum (sorghum ulgare) seeds. Ahmad Saeed, Zulfaqar Alam Khan, Ikramullah Khan and Masood R. Baig. Pak. J. Sci. Ind. Res.; 1987, 30(6) 411-416.

NAME: Dr. Irshad Ali

POSITION: Assistant Professor

[redacted] [redacted]

[redacted] [redacted]

ACADEMIC QUALIFICATIONS: M.Sc. (Gomal), Ph.D. (KHI)

PUBLICATIONS:

Total research publications 12

1990 -

1989 -

1988 (1) Lleurosinone - a new binary indole alkaloid from Catharanthus roseus, Atta-ur-Rahman, Muzzafar Alam, Irshad Ali, Habib-ur-Rahman and Intekhabul Haq, J. Chem. Soc., Perkin 1, 2175-2178 (1988).

(2) Desmethyl-peceyline, A new dimeric indole alkaloid from Petchia ceylanica. Atta-ur-Rahman, Azra Pervin, Irshad Ali and Anjum Muzaffar, Planta Medica, 45(1), 37 (1988).

1987 (1) Aspiodospermidose - a new alkaloid from the leaves of Rhazya stricta, Atta-ur-Rahman, Habib-ur-Rahman, Irshad Ali, Muzaffar Alam and Shahnaz Pervenn, J. Chem. Soc. Perkin Trans. 1, 1701-1704, (1987).

NAME: Dr. Muhammad Subhan

POSITION: Assistant Professor

[redacted]

ACADEMIC QUALIFICATIONS: M.Sc. (Pesh) 1979, Ph.D. (Pesh) 1990

PUBLICATIONS:

(A) Conferences 1
(B) Total research publications 8

1990 (1) Comparison of the Negative Field Desorption and Positive Fast Atom Bombardment Mass Spectra of Haematoporphyrin. F.W. Roellgen, M. Subhan and Noor Ahmad (Submitted for publication).

(2) Negative Field Desorption Mass Spectrometry of Nucleotides. Noor Ahmad, M. Subhan and F.W. Roellgen (Submitted for Publication).

(3) Negative Field Desorption Mass Spectrometry of some sulfonic acids and sulfonates. M. Subhan, Abdur Rauf and F.W. Roellgen (Submitted for Publication).

APPENDIX C

M. PHIL/Ph.D. COURSES

(all four credit hours)

PHYSICAL CHEMISTRY

Mathematics

Chemical kinetics

Thermodynamics and statistical thermodynamics

Statistical methods of handling experimental data (Theory of probability and empirical formulas and curve fitting)

Thermochemistry

Catalysis

Polymer and macro molecular chemistry

ORGANIC CHEMISTRY

Structure elucidation of organic compounds

Reactive intermediates: carbenes, nitrenes

Chemistry of free radicals

Mechanism in organic chemistry

Chemistry and biosyntheses of natural products - alkaloids, terpenes and acetogenins

Preparation organic photochemistry

Steroid drugs

Name reactions: introduction, mechanisms and synthetic applications

Anti-cancer drugs from plants

INORGANIC CHEMISTRY

Structural inorganic chemistry

Inorganic reaction mechanism

Advanced thermal analysis

Applications of group theory to inorganic compounds

Inorganic chemistry in biological systems

Organometallic chemistry

Transuranic elements

Special topics of current interest

BIOCHEMISTRY

Biochemistry of natural products

Molecular biophysics

Advanced knowledge in body fluids

Comparative biochemistry of digestion, absorption and metabolism of carbohydrates, protein and lipids

Advances in enzymology

Biochemical and molecular genetics

Neurobiology

Advances in nutrition

Advances in molecular biology

Antibiotics

Drugs

Microbiology

Advances in cancer research

Modern food technology and nutrition

APPENDIX D

REQUIREMENTS FOR APPOINTMENT OF FACULTY TO THE DEPARTMENT OF CHEMISTRY

1. **PROFESSOR (BPS-20)**

Statutory Requirements:

(a) First Class Master's Degree with 18 years teaching/ research experience in a recognized University or a post-graduate institution or Professional experience in the relevant field in a national or international organization plus 8 research publications in Journals of international repute, or

(b) Master's Degree (Foreign)/M.Phil with 16 years teaching/research experience in a recognized University or a post-graduate institution or professional experience in the relevant field in a national or international organization plus 8 research publications in Journal of international repute, or

(c) Ph.D with 15 years teaching/research experience in a recognized University or a post-graduate institution or professional experience in the relevant field in a national or international organization plus 8 research publications in Journals of international repute.

2. **ASSOCIATE PROFESSOR (BPS-19)**

Statutory Requirements:

(a) Master's Degree/LL.B in the First Division with 13 years teaching/research experience in a recognized University or a post-graduate institution or professional experience in the relevant field in a national or international organization plus 5 research publications in Journals of international repute, or

(b) Master's Degree (Foreign).M.Phil/LL.M with 11 years teaching/research experience in a recognized University or a post-graduate institution or professional experience in the relevant field in a

national or international organization plus 5 research publications in Journals of international repute, or

(c) Ph.D. with 10 years teaching/research experience in a recognized University or a post-graduate institution or professional experience in the relevant field in a national or international organization plus 5 research publications in Journals of international repute.

3. **ASSISTANT PROFESSOR (BPS-18)**

Statutory Requirements:

(a) First Class Master's Degree/First Class LL.B or equivalent qualifications and 6 years teaching/research experience in a recognized University or a post-graduate institution as a Lecturer or Professional experience in the relevant field in a national or international organization, or

(b) Master's Degree (foreign) or M.Phil/LL.M from a Pakistani University plus 4 years teaching/research experience in a recognized University or a post-graduate institution as a Lecturer or professional experience in the relevant field in a national or international organization, or

(c) Ph.D. with 2 years teaching/research experience in a recognized University or post-graduate institution or professional experience in the relevant field in a national or international organization.

4. **LECTURER (BPS-17)**

Statutory Requirements:

First Class Master's Degree in Arts/Science, First Class LL.B or equivalent qualifications.

APPENDIX E

TOTAL SALARIES PAID BY RANK BY THE DEPARTMENT OF CHEMISTRY

	Lecturer Rs.	Asst. Prof. Rs.	Assoc. Prof. Rs.	Full Prof. Rs.
1984-1985	103,720	169,480	92,160	57,480
1985-1986	153,800	132,280	141,130	59,640
1986-1987	211,530	161,410	98,551	62,680
1987-1988	400,155	267,110	61,935	149,190
1988-1989	346,050	395,072	150,820	152,850
1989-1990	281,670	393,077	179,430	81,360

APPENDIX F

I. REVIEW OF SIX YEAR DEVELOPMENT PLAN BY THE CHEMISTRY DEPARTMENT OF GOMAL UNIVERSITY

Dr. McCormick, chief-of-party (IEP) visited with the staff of the Chemistry Department; with Dr. Miana, vice-chancellor of Gomal University; and with Dr. Saeed, chairman of the department of Chemistry on January 11-13, 1991, concerning their views of the report. They had both general and specific concerns.

The assessment team has included most of the departments desired changes in the report. The changes with which the team were not in agreement have been left on Appendix F (I). The assessment team's response to these items in Appendix F (II).

GENERAL COMMENTS

1. The staff feels it would be better to have short term visitors stay for 3 or 4 months rather than the 2 months that are listed. They feel by the time a visitor gets settled he would only get started before preparing to leave.

2. They have need for an electronics technician.

3. The staff wants to be sure American scientists spend time at Gomal University.

4. They would like to have 10 post doctoral appointments amounting to 1 year each which could be broken into 3 or 4 month segments over several years. These would be in addition to 10 Ph.D. degree positions.

5. Their priorities are:
   a) Ph.D. training
   b) specialized machine training
   c) post doctoral programs

6. They would like to have one Ph.D. candidate from each of the 3 sections recommended for support per year starting from year 1.

7. They must have an uninterruptable power supply for recommended analytical equipment.

8. Concern that additions to the library need to be made and there were no recommendations in this regard.

SPECIFIC COMMENTS

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a) Dr. Sher Khan prefers a 1 year post doc in 2nd year of the program.

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b) Miscellaneous Small Equipment - add the following: (Dr. Ahman Saeed)

Freezer

Blender

Agitator

Magnets (1 lot)

Magnetic Stirrer

Two-pan rough balance (to equilibrate centrifuge bottles or tube for centrifugation) loading capacity ≈ 1 kg.

Refrigerator

Mincing machine

Analytical balance

Single-pan balance

pH meter

Micro pipetters 0-20 ml, 50 ml, 100 ml, 200 ml, 500 ml, 1000 ml, 5 ml (adjustable gilson)

Dispensing flask 0-10 ml, 0-25 ml, 0-50 ml (adjustable)

Voztexmixer (test tube mixer)

Dialyzing tubes (cellophane tubes) 1 lot

Stop watch

Timer

Water Distillation plant (glass)

Chromatographic Columns different size with plunges (LkB)

Tygon tubing 1000m quantity

Pressure rubber tubing 2500 quantity

High vacuum tubing (lot)

Teflon tubing (lot)

Ultrasonic cleaner

Clavs ware washer & dryer

Test tube racks type 1 (small tuber) 12 in No

Test tube racks type II (large tubes) 12 in No

Isoelectric focusing pH gradient kit

Calibration kit (lot)

Block heater (1)

Block (3)

Microlitre syringe (10)

Silicone grease for light vacuum

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Major Equipment

The staff feels more is needed of each item. The following list is from Professor Atta-Ur-Rahman's letter.

1. You should acquire a high-resolution mass spectrometer with computer system fitted with EI, FI, FD, CI and negative and positive FAB so that you can get molecular formulae of the substances.

2. You should obtain a Bruker 400 MHz NMR Spectrometer fitted with a long-time helium hold Dewar with dedicated 5 mm ^{1}H-NMR probe as well as a dual ^{1}H-NMR and ^{13}C-NMR Probe and inverse NMR facilities. Since we already have several Bruker NMR spectrometers, we could train your technician if you too acquire a Bruker system.

3. I suggest you should get three or four different HPLC systems instead of just the one system indicated.

4. You should have at least 12 rotary evaporators complete with water baths, closed circuit chilling systems and vacuum pumps. I would also suggest that you should acquire at least six trolley type high vacuum pumps.

5. I suggest you should acquire glassware for your laboratory worth about 20,000/- U.S. dollars.

6. Your laboratory should also have a gas chromatograph as well as a modern microanalytical instrument with a microanalytical balance.

7. I would strongly recommend that you obtain a helium liquification plant since we will not be able to supply you with liquid helium. Regular transportation of liquid helium from Karachi to N.W.F.P. would also be very problematical.

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Equipment

a) 300 MHZ NMR should be a minimum of a 400 MHZ.

b) If there is a necessary choice between mass spectrometer or NMR the mass spectrometer would be (1) and NMR (2)

c) Need columns for the gas chromatographic

d) Need a micro analytical balance.

II. FOLLOW-UP RESPONSE OF ASSESSMENT TEAM

The Assessment Team is pleased that the faculty of the Department of Chemistry at Gomal University has found the preliminary "Six-year Development Plan" a useful guide for IEP activities in chemistry. Most of the changes and additions recommended by the faculty have been incorporated into the body of the revised plan. Some of the additions which do not appear to be directly related to the goals of IEP, but may nevertheless be appropriate, are discussed below. Changes and additions that are considered to be directly related to the goals of IEP have been made to the plan without any additional response.

RESPONSE TO "GENERAL COMMENTS"

Specification of short-term versus long-term visits depends on the goals of the visits. Short-term visits are recommended for senior faculty and should emphasize "intellectual exchanges" with their US counterparts. Senior faculty should use these visits to attend scientific conferences, to develop research proposals, to initiate collaborations, and generally to observe how science is performed in the US. A typical visit may involve attending a meeting, and visiting 2-4 laboratories. It is not anticipated that short-term visitors will actually spend much time working in a laboratory. Hence, a period of 2-3 months has been recommended for short-term visits. Long-term visits should emphasize learning new skills and working on a specific research project in one laboratory. These activities usually cannot be completed successfully during a 4-6 month visit, and should therefore be allotted one year.

Addition of an electronics technician has been recommended for the spectroscopy laboratory. It is anticipated that this person will also be able to repair all of the electronic instruments in the Department.

Although long-term visits by US scientists to Gomal could be within the goals of IEP, assurance that such visits can be arranged is not possible. Given the highly competitive nature of research in the US, it is extremely difficult for active researchers to leave their research groups for more than a few weeks. With the possible exception of the natural products area, long-term visits to Gomal by US scientists with highly productive research programs are unlikely. Hence, short-term visits by US scientists from universities and industries have been included as part of the "Linkages" program (Page 46).

Most of the Ph.D. training has been scheduled for the first year for administrative reasons. Since Ph.D. training in the US usually requires 5 years, students enrolling in these programs must start in either the first or the second year if they are to complete the programs before the end of the six-year program. Perhaps funds for students enrolling late in the program could be carried beyond the six-year period.

Library acquisitions costing up to $5,000/yr have been added to the plan. Since the UGC has developed a program to make access to the scientific literature easier, the faculty is encouraged to subscribe only to those journals that they feel they will be able to continue at the close of IEP.

RESPONSE TO SPECIFIC COMMENTS

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Since there was no response to the role we proposed for Dr. Sher Khan in the applied biochemistry program, we have not made any changes in this area. This position is also consistent with the goals of short and long-term visits, as discussed above. It is also noted that Dr. Sher Khan has already had a year of postdoctoral experience in the US.

Funds ($4,000/yr) for miscellaneous small equipment to be used in the applied biochemistry program have been recommended. Specific apparatus to be purchased with these funds should be determined by the faculty with the approval of the facilitator.

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One year of training in the US for both Dr. Saeed Anwar and Mr. Azim Khan has been recommended. However, it is noted that their roles in any of the three research programs has not been described.

RESPONSE TO PROF. ATTA-UR-RHAMAN'S LETTER

Funds to purchase a triple quadruple "MS/MS" mass spectrometer with EI, CI and FAB ionization sources have been recommended in lieu of a high resolution mass spectrometer. Purchase and operating costs were factors in this decision. More importantly, it is noted that MS/MS has become an important tool in analytical chemistry, and that there are no MS/MS mass spectrometers in Pakistan. Hence this is

an opportunity to establish a new resource in Pakistan. When high-resolution measurements are required, supply funds should be used to pay for these analyses which can be performed at the HEJ institute (or perhaps in Peshwar).

The highest-field NMR spectrometer consistent with the available funds should be purchased. 300 MHz is considered to be a minimum requirement.

The Department already has a new gas chromatograph. Supply funds should be used to purchase materials to pack columns for the existing instrument.

A carbon/hydrogen/nitrogen analyzer has been added to the list of major equipment. However, the purchase and operating costs of this instrument will have to be justified in terms of the number of samples to be analyzed and the cost of having these analyses performed elsewhere in Pakistan. A new Perkin Elmer elemental analyzer costs $40,000 and will require approximately $4,000/yr of supplies. In addition, its operation will require a chemist specially trained for its operation. In the US, samples are often sent to commercial labs which specialize in these analyses. Are there commercial labs in Pakistan offering this service? If not, addition of their capability could be justified as a new national resource.