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PHILIPPINES PHARMACEUTICAL INDUSTRY DEVELOPMENT STUDY

DP/PHI/87/019

PHILIPPINES

Technical Report: Relevance of Genetic Engineering to the Philippine Health Program and Food Industry in the Philippines*

Prepared for the Government of the Philippines
by the United Nations Industrial Development Organization
acting as executing agency for the United Nations Development Prgramme

Based on the work of Professor A. Therwath
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United Nations Industrial Development Organization
Vienna

* This document has not been edited.

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I N D E X

PREAMBLE

This report is based on a six week stay (July-August 1988) in the Philippines under the United Nations Industrial Development Organization's program DP/PHI/87/019.

I was a member of a team of international experts assigned to prepare a *"Master Plan"* for the development of an integrated pharmaceutical industry in the Philippines. My job title was *"Expert in Genetic Engineering"*.

The composition of the expert team was such that it could cover a wide range of areas such as Biotechnology, Fermentation, Natural products etc.. As far as I was concerned, this enabled me to focus attention on genetic engineering technology in the Philippines and its relevance to drug industry and the health program.

The information collected are from on site visits to research institutions, medical and teaching centers as well as from a few published documents which often contained contradictory or incomplete data. Over a hundred scientists, teachers and research students from 11 different institutions were interviewed. The geographic regions covered are exclusively Metro Manila, Alabang and Los Banos.

This report did not benefit from any possible inputs from the National experts.

SUMMARY

This report is based on data obtained through interviews of over a hundred scientists, teachers and research students in the Philippines. Long and elaborate discussions with some small scale industrialists such as the Prawn cultivators and exporters, Plastic ware manufacturers and resale firm executives dealing with medical diagnostics, fine chemicals, enzymes etc.

The research and teaching institutions that I visited several times and at which I have spent considerable time are located mainly in Metro Manila, Los Banos and Alabang.

I have surveyed the educational levels of the Universities with respect to teaching in Biochemistry, Molecular Biology and Genetic Engineering with the aim of identifying qualified man-power resourses suitable for the pharmaceutical and auxilliary industries. Biotechnology and Genetic Engineering Research & Development in the Philippines and their industrial potential in selected areas have also been assessed. An evaluation of existing facilities including available equipment, analytical instruments, fine chemicals etc. have been made.

I have suggested a comprehensive R & D program of Biotechnology/ Genetic Engineering for the pharmaceutical industry and its auxilliary industries in the country.

This comprehensive report containing my observations and recomendations can serve in the elaboration of a policy for the over-all development of the pharmaceutical industry in the Philippines.

Genetic Engineering, as such, in basic research or in the applied field is non existent in the Philippines to-day. There are a few research scientists (mostly in the universities) who have the necessary training to undertake biotechnology R&D. However, since a long time, these scientists are tied up with laboratories in Australia and the US and engaged in collaborative work, carried out in major part, outside the Philippines. The inadequacy of research grants, salary incentives, laboratory infrastructure compounded with a total dependancy on imported basic ingradients such as enzymes, fine chemicals and plastic ware, makes undertaking research and development in Genetic Engineering an overwhelmingly difficult task. Given the actual situation, undertaking the production of pharmaceuticals and antibiotics through genetic engineering will require the Philippines anywhere between 5 and 10 years from now. In case if one nevertheless decides to go ahead, I am afraid that the outcome may be undesirable,in that the product may not be able to face the competitive international market. I must recall here that high yield antibiotic producing micro-organisms have been developed through many years of intensive research by pharmaceutical firms abroad and these firms are not likely to give away their strains to any one. Antibiotics through classical fermentation technology has, however been dealt with in detail, by other members of our expert team.

I feel that in case the Philippines goes in for R&D in the pharmaceutical sector, then they must think of screening the locally available, and so far unexploited varieties and strains of micro-organisms which abound their tropical climate. Marine sponges, many of which have not yet been classified by Zoologists, and some of which are suspected

to produce antibiotics , must be subjected to intensive and systematic scientific investigation. This approach may in the long run prove to be rewarding provided in the course of the investigation they can identify and isolate hithertho unknown agents posessing anti microbial activities. This may constitute a novel niche for the Philippines and shelterd from a very demanding international competition.

About 30 varieties of plants having medicinal values have also been catalogued and vaguely studied in the Philippines. Much remains to to be worked out on their pharmacclogically active components. Some of these plant extracts can be purified to homogeneity at little cost and can serve for the treatment of common ailments. This again is an area for consideration for future R &D.

My recommendations for the immediate future is that, in parallel with the initiation of a R & D in biotechnology/genetic engineering program the Philippines seriously consider local manufacture/production of diagnostic tools (kits) in the field of health and food production.

The thrust areas identified are:

1) Diagnosis and treatment of Schistosomiasis

2) Diagnosis of Hepatitis B

3) Diagnosis of Tuberculosis

and

4) Diagnosis of Prawn diseases (microbial).

Based on the need and feasibility within the local context, I have made several recommendations under the following chapters:

A) Qualified Man power out-put from the universities

B) Auxilliary industry for support to Biotechnology/ Genetic Engineering

C) Early Detection method for Vibrio and Salmonells in prawn cultures.

D) Detection and diagnostic kits in Medicine

E) Miscellaneous recommendations

Recommendation A Qualified Man-power out-put

1) A 3 to 4 year training program, culminating in a PhD in Biotechnology/ Genetic Engineering has been advocated in my report for a total of 10 students per year at the NSRI- UP Diliman.
The forcast of yearly expenses per student is about US $ 30.000

2) Four to five short intensive training courses (3 to 4 weeks) per year in Biotechnology for post-doctoral scientists. These courses can be conducted at the University of Philippines, Diliman or at the Research Institute for Tropical Medicine, Alabang.
Rough estimate of expenses per course is of the order of US $ 30.000

3), Accent on Doctoral training abroad and fellowships for young graduates as well as senior scientists (who often do not have a PhD).

4) I have proposed an overall reduction in the total number of research projects to be granted per year and however a substantial increase in the amount allotted to each project.

5) Finally my proposition is to provide an honorable and competitive salary to scientists engaged in productive research.

Recommendation B Auxilliary Industry for support to applied Biotechnology/Genetic Engineering Program

Setting up of auxilliary industries to support R & D in Biotechnology is essential to any developing country for venturing into the front line areas of modern scientific technology. Such industries can make considerable profit , save foreign exchange and contribute to self reliance. Two specific areas identified are:

1) Manufacture of single usage plastic-ware for serology, microbiology and experiments involving molecular biology. The type of plastic-ware, their market size and the quality of raw material to be used are detailed in this report.

2) Production of Restriction Endonucleases. The Biotech Laboratory in Los Banos is ideally suited for inexpensively producing the much needed restriction enzymes for sale across the country. The magnitude of the current need for meeting research requirements in the Philippines is estimated. A total of 7 different and easily producible enzymes and the microbial strains for source are recommended. Addresses of institutions from where these organisms can be obtained are also included.

Recommendation C. Early detection of Salmonella and Vibrio in Prawns.

1) A photoluminiscence emission detection method for Vibrio contamination and thereby early treatment of prawn fries are outlined. Two complementary methods with guideline protocols are also described.

Cost of experimental procedures and standardization: US $ 5.000

Time requirement : 6 months.

2) A polymerase chain reaction (PCR) amplified and avidine-biotine labelled DNA Kit assembly for detection of salmonella in pond water and growing prawns is proposed. A working protocole is outlined. Also during my stay in Manila, I have held extensive discussions on the detailed methodology to be adopted with the research group at UP Diliman (Professor A. Nazarea).

Expected cost for experiments leading to the kit assembly: US $ 50.000

Time requirement : 1 to 2 Years

Recommendation D. Detection and Diagnostic Kits in Medicine

SIX very specific medically and industrially important diagnostic kits/ tools are identified and recommended . Their significance and relevance are outlined briefly. The kits proposed are:

1) Use of cloned mycobacterium DNA fragment, labelled and amplified employing the polymerase chain reaction technology as a probe for diagnosis and detection of tuberculosis in the sputum of suspected individuals.

This is a simple and easy to carry out test if the kit is available. A mass population survey for tuberculosis can be carried out at little cost and more-over clinicians and paramedical personnel in remote areas can do the test on the spot thus avoiding expenses incurred in travelling upto a hospital in big towns.

Expected expenditure US $ 75.000

Time requirement :2 years.

2) Isolation, Purification of Animutagens from plants Bawang Kalachuchi and Niyog-Niyogan: These plants contain hitherto little characterized constituents that have anti-mitotic activity and therefore have potential use in cancer chemotherapy.
Expected cost for experimental work: US $ 40.000
Time duration : About 3 years.

3) A method for carrying out Sensitisation against Schistosoma infection and a Vaccine Strategy against Schistosomiasis has been proposed that employs Biotechnology/ Genetic Engineering in a collaborative effort with the Walter Eliza Institute in Australia.
Completion of the project is likely to take3 years
Expected cost US $ 120.000

4) Production of Monoclonal antibodies through hybridoma technology for for Transferin, Ferritin and urine Gonadotrophine (Nutritional assessment and Population Control respectively) are outlined in this report.
Their relevance in the Philippine context are underlined and the dollar saving that can be envisaged are mentioned.
The project is expected to cost US $ 60.000
Time duration for completion: 2 years.

5) The production of Hepatitis B Antigen through genetic engineering of cloned Hepatitis B genome and its use in the diagnosis and detection of HBV antibodies in patiebts are proposed. A working experimental protocol is outlined.
Expected cost of the project is US $ 60.000, time requirement: 1 to 2 yrs.

6) Production of Polymerase Chain Reaction (PCR) amplified DNA probe kit for Hepatitis B detection in liver biopsies is proposed. The availability of molecularly cloned Hepatitis B DNA genome makes this approach feasible and profitable. It is a highly sensitive technique and the cost of detection is relatively low as compared to the classical antibody detection method.
Expected Cost: US $ 30.000
Time duration : About 1 year

E) MISCELLANEOUS RECOMMENDATIONS: Under this heading I have made the following suggestions:

1) Commercial production and sale of Germ-free mice by the Research Institute in Tropical Medicine, Alabang where adequate facilities for this exists.

2) Screening of Marine Sponges for detecting antibiotic producing species.

3) AIDS monitoring through the use of cloned and expressed p^{24} antigen. The p^{24} antigen can be locally produced using cloned HIV DNA subfragment. The p^{24} anti-idiotype can be employed in detecting HIV specific products in suspected blood samples.

4) Finally, I think that the chemists in the Philippines should seriously consider elaborating an easy calorimetric (colour reaction) test for the detection of Aflatoxin contamination in rice and other edibles. This test should be such that it could be made in simple homes by house-wives.

INTRODUCTION

Status of Research in Biochemistry in the Philippines

Biotechnology is defined as the application of scientific engineering principle to the processing of materials by biological agents to provide goods and services. The advent of genetic manipulations and recombinant DNA technology has made it possible today to produce health relevant drugs and diagnostic tools at a larger scale and often at remarkably low cost inputs. New varieties of plants with higher yield and better resistance have been produced. Livestock and marine products suited to the individual requirement of any area have similarly benifited from gene tailoring techniques Today enormous emphasis is given to genetic engineering, particularly by the pharmaceutical industry, and the animal and plant food industries. The dawn of genetic manipulations in 1976 was however a result of an excellent high quality biochemistry research program underway during the 60s and 70s in the western countries.

It is therefore but logical at the very outset to look at Biochemistry and Molecular Biology research in the Philippines. Biochemistry as a course is taught at the undergraduate and graduate levels by the different Universities. The teaching program, in its content, is comparable in quality to many western Universities. Biochemical research is done mostly in the Universities. Other institutions involved in biochemical research are those under the Department of Science and Technology, the South East Asian Fisheries and Development

Centre in Iloilo and the International Rice Research Institute (IRRI) in Los Banos. Much of the research activities can be described as mission-oriented, even the most basic of them have some foreseen application.

A review of the topics of research reveals a concentration in the agricultural and medical sciences. Most of the projects fall within the priority areas defined by different research councils such as PCHRD and PCARRD.

In agriculture work is done on biochemical mechanisms of plant resistance to pests and diseases, post harvest biochemistry of fruits and vegetables, polyclonal antibodies for diagnosis of crop diseases, genetic polymorphism, hybridity and genetic variability - all towards increased food production and productivity.

Bioresources and waste products utilization have included work on alcohol production from saccharine and starchy materials, genetic improvement of cellulose degradation and production of a few biochemicals and enzymes.

Human nutrition is an area covered by many biochemists. There are ongoing studies on inborn errors of metabolism, diagnostic tests using biochemical tools, potential mutagenic agents and antimutagenic effects of indigenous plant materials.

Two groups in the Philippines are very actively involved in the study of Schistosomiasis.
The one led by Dr. Edito Garcia at the Institute of Public Health, Up Manila, has established a viable and extremely usefull collaboration with the laboratory of Dr. Graham Mitchell at the Walter Eliza Institute in Australia. The second one led by Dr. Oveida at the Institute for Research in Tropical Medicine has also a very successful ongoing research collaboration with the Brown University in the USA. These two stand out as examples of high level collaborative research by Philippines Scientists on an equal basis with their counterparts from abroad.

Drs. Marita Reyes and Dr. Augusto Lingao's group from the UP College of Medicine have established successful collaborative work on the molecular cloning and sequencing of the Hepatitis B virus from the Philippines with the laboratory of Dr. Makota Mayumi in Japan.

Work on marine products include toxins and phosphodiesterases from Conus venoms. This is an area, once again in which the Philippine scientists under Dr. Lourdes Cruz have been able to excel thanks to a long standing bilateral collaboration with the University of Utah in the USA.

Biochemical research in industry has been limited to the Pharmaceutical sector, with their work on drug bioavailability and drug potential of indigenous materials.

Availability of Manpower for Genetic Engineering

Within the different research establishments and University Centers, one can identify a non negligible force of excellent biochemists. The undergraduate and graduate training programs at the Universities, with a little up-dating and need-oriented courses can continuously feed young talents into the existing pool of biochemists.

A UP - ADMU - DLSU consortium exists for a Ph. D. program in Mathematics, Chemistry and Physics.

A similar programs in the life sciences was launched last year under a consortium arrangement between UP NSRI and the National Kidney Institute. This program called MBB or Molecular Biology and Biotechnology is the conception of and is spearcheaded by a talented and dynamic molecular biologist, Dr. Apolinario Nazarea who has spent several successful research years in the US and Europe. He has been able to procure the active participation of a large number of laboratories in Manila and Los Banos in the MBB program. On successful completion of course work and research dissertation through 4 years, this program offers a Ph. D. degree in Molocular Biology and Genetic Engineering. Having familiarized with the MBB, I feel that for the 1st time the Philippines can hope to produce Molecular Biologists and Genetic engineers trained at home.

In UP, Diliman, Pedro hill as well as in the RITM in Alabang some teaching cum laboratory courses, at irregular intervals, are conducted for a very limited number of students. These courses are in the field of health with particular emphasis to tropical diseases. These are financed in most cases and in major parts by international or foreign agencies. Institutes like RITM conduct courses for training field technicians. The Philippines Institute for Pure and Applied Chemistry (PIPAC), on payment, offers training services to technicians from industries in analytical chemistry and chemical methods.

A small percentage of doctoral students manage to obtain, through national or international agencies, funds for advanced training and go abroad. Many of these who are exposed to the science in an affluent country, when they return are disillusioned and either go to the privatve sector, fall in line and adopt a fatalistic attitude or simply return to the west or to Japan. This amounts to flagarant wastage of trained man power.

My personal impression, is that the main bulk of scientific resources in the Philippines are women in their 40's and 50's. These are on the whole dedicated scientists, but their training requires updating.

Salary of Scientists

Salary earning of scientists that I have interviewed are low by national standard and certainly by any international standards. It does not reflect the number of years nor the quality of training. Take home salary of a researcher in public sector is much below the one that he would obtain from a non academic sector. Thus a senior scientific investigator earns only about 35-40% of what he would get in the private sector. This again may explain that within a working couple, the lady turns to science as a profession and not the man. At the IFH and UPMC I was told that some of the scientific assistant were living for several months out of their own pockets or from an advance provided by the chief investigator.

Research Grants

Any substantial and meaningful research is heavily dependant on foreign grants such as USAID, JICA, Canadian Aid, WHO, UNESCO, UNDP etc. I feel that many more industrialized nations could be invrlved in participating in the research and development programs of the Philippines.

The national agencies distribute token amounts to many too many research groups ₱ 25,000 per year or 80). In a diluted way the targetted amount may be infufficient to meet laboratory requirements.

Both from literature and from my personal conversations, I learned that grants sanctioned in 1988 will be available to the grantee only in 1990 i.e. after two years. By this time project objective often becomes outdated and even obsolete.

Research Project: Number and scope

My observation is that the majority of the projects proposed are very much relevant to areas covering public health, food, plants and animals and natural resources. My remarks are that there are too many projects, however relevant they are, all at one time. There are, on paper, at least 34 projects at the Biotech in Los Banos. 31 projects in all (5 in agriculture, 10 in Medical Biotechnology, 16 in industrial biotechnology have been approved by the PCASTRA Technical committee for the current year). Duplicate and parallel research was observed which in my judgement can be ill afforded by the present economic situation.

Laboratory facilities for Research

Excellent buildings and room spaces are available at almost all the institutions visited. The most outstanding among them are the laboratory of RITM, Biotech in Los Banos, NKI and PIPAC. The labs. at the College of Medicine and Institute of Public health are crowded and lacks proper maintenance. The laboratories at the NSRI are adequately maintained while those at the Institute for Nuclear Research are below standard.

Equipment

In some of the research institutions I have come across an impressive display of sophisticated modern instruments. I note that the accumulation of instruments do not necessarily reflect the intensity of research activities, the research output nor the number of trained personnel making use of it. The UP College of Medicine and IPH have excellent scientists but poor and very old

equipment. They could well afford, in the interest of science, to obtain a new array of essential items. I feel that research grants to these two institutions in the future will be meaningful if only a special budget for purchase of equipments is sanctioned.

Availability/Procurement of fine Chemicals Glassware and Plastic ware

Pure grade chemicals and enzymes that are essential for molecular biology and genetic engineering are not manufactured locally. They have to be imported and therefore involves delay and out of proportion costs. Glassware as well as disposable plastic ware in the form of titration wells, syringes, centrifuge tubes must come from overseas. Chemical are provided by local suppliers of Merck, Dome & Sharp, SIGMA and Bethesda Research Laboratories. Enzymes are are supplied by BRL and Amersham England (Distributor: BELGOR INC., Intramuros)

Conclusion: My conclusion at this point is that in the Philippines one is satisfied to find an educational system having the potential to provide the trained man-power, and institutional infrastructure adapted for venturing boldly into a new field, that of biotechnology and genetic engineering.

SOME QUESTIONS FOR REFLECTION

At this point it is essential to ask the following questions:

1. Should the Philippines go in for advanced biotechnology and genetic engineering
2. Or alternatively import advanced biotechnology and genetic engineering by purchasing it from abroad as the Japanese did in the past.
3. Is the Philippines ready to set up companion and auxilliary industries to provide raw and consumable materials for R & D in Genetic engineering.

My answers to these three questions maybe briefly put down as follows:

1) If access to proper health care is the fundamental right and the eradication of poverty one of the prime national goals, then these two can only be achieved through self reliance and self sufficiency. These noble objectives cannot be achieved by any developing nation today if it does not develop its own R & D in the frontier areas of science. There is absolutely no reason why the Philippines cannot achieve what their neighbours like Taiwan and Korea were able to do in a short span of time. It is an established fact that Philippines scientists do extremely well abroad. There is no reason that the same breed of people given the opportunity, cannot do well at home. I feel that the national goal in Medicine and nutrition in the coming years can rely considerably on the local R & D.

I would like to mention that at none of the research laboratories that I have visited had any experiment involving genetic engineering underway. Many groups had project proposals that called for genetic manipulations and biotechnology. The laboratory of Dr. Marita Reyes has some personnel (TWO) having exposure to Genetic Engineering in Japan and Dr. A. Nazarea at NSRI has the potential to start a research project in the immediate future. Dr. Edito Garcia's laboratory at the IPH, under the Supervision of Dr. Wilfred Tiu, will probably be the first to carry out genetic manipulation experiments on Schistosomiasis within months from now, thanks to the chemicals, enzymes and other precious tools provided by Graham Mitchel's laboratory and a WHO grant.

2) Buying imported technology may look attractive as a short term solution. However, application of purchased know-how will still require trained local scientists and research workers. I think the option of importing, for a short period such as 5 years, of high quality products needed for genetic engineerin must be considered favorably. During this period a contingent of local man-power can be trained and in parallel the auxilliary industries for enzymes, chemicals and disposable lab. ware can be set up.

3) The opportunity for setting up companion-auxialliary industry and the market for the products exist. The answer to the 3rd question will really dependant on the policy makers and how successful they are in convincing private small scale industrial to make the ventures.

SUGGESTIONS/RECOMMENDATIONS

1. Man-Power Training

The Molecular Biology and Biotechnology (MBB) program with extensive laboratory excercises in Genetic Engineering, organized by Dr. A. Nazarea at the UP Diliman is best suited for providing trained man power in biotechnology and Genetic Engineering in the future. The completion of a course culminates in the award of a Ph. D. degre and will take 3 to 4 years. About 10 students can be enrolled each year. The success of this program will depend, at this stage, on the financial backing that can be obtained.

Excluding salaries for teaching staff, the expected expenses for laboratory work per student per year is about US $ 30.000.

Total yearly cost for a batch of 10 students is 10 X 30.000 = 300.000 US $.

The expenses are the following

- Enzymes
- Fine chemicals
- Nucleic Acid derivatives
- Radioactive precursor and tracer elements
- Disposable plastic ware
- Vectors, Plasmids
- Small equipments

2. Short Term Training Courses

I feel that there is an absolute need for organizing 4 to 5 intensive laboratory training courses per year in biotechnology/genetic engineering. The courses must cater for about 20 students at a time and must be run by a very competent staff of about 4 teachers, aided by 2 to 3 technical assistants. At least one of the teaching staff must be a Filipino settled abroad or a foreigner actively involved in recombinant DNA research.

The course should devote 1/3 of the time for theory and 2/3 for actual laboratory excercises.

In case local hospitality can be provided free to the participants and teachers, the actual cost of running one course would be (1988) US $ 30,000.

The course can be run along these guide lines

a. Introduction to the importance of Genetic Engineering and its application.
b. Different types of vectors and hosts-how to make a right choice
c. Plasmid vectors
d. Phage vectors
e. Viral vectors
f. Construction and screening of genomic DNA libraries
g. Construction and screening of DNA and expression libraries.

h. Southern, Northern and Western Clotting and hybridization.

i. Invitro translation by Hybrid-arrest technique.

This type of course can be jointly sponsored, as is the practise in many countries, by the Universities, Research Institution, Government agencies and local foundations. Firms such as Bethesda Research Labs. (USA) Grand Island Biological Co. (USA), Amersham (England), Sigma (USA), often provide as gift much of the tools and chemicals for courses. Foreign agencies such as USAID and international agencies such as UNDP are quite sensitive to demands for organizing and financing work-shops and courses.

3. <u>Doctoral Training Abroad & Fellowship</u>

The existing fellowships and training programs for Filipino scientists require revival and serious invigoration. Students must be sent abroad with a commitment to come back to their parental institution and work there for a period of 3 to 4 year at least.

Some of the Filipino scientists who are abroad and would like to come back must be encouraged by giving appropriate incentives. (eg. adequate salaries and grants).

A scientific pool-officer system can be established in the Philippines (as done in India, Pakistan & Nepal) whereby home coming foreign trained scientists are

assured a decent salary for 2 years and assigned to one of the suitable laboratories of their choice, till they can firmly establish themselves in the research environment of the country.

4. Training of Women abroad

The major task force in the Philippine Research is women. They are in their mid 40's and 50's. These ladies are dedicated and hard working but require up-dating of their training and new exposures. Irrespective of their age, there are ways of finding fellowships and travel grants for them to spend 6 months or a year in a foreign laboratory.

These ladies, for reason abvious, are bound to return to their home country at the end of their stay abroad and therefore will no constitute Brain-drain.

5. Salaries

This is a serious handicap and an incentive killer today for the scientific community. If the Philippines want to go ahead into the front-line areas of moderm biotechnology then they will have to do it by beginning to pay their scientists a decent wage that they could otherwise obtain from the private sector. My suggestion is that a person having 4 to 5 years of post-doctoral experience should be able to earn 7-8000 Pesos per month.

6. Number of Research Project & Grants

It is essential, at the present, for the authorities to zero in on a few specific and mission oriented projects. Otherwise the danger is that many tiny groups with little means will be doing each a project with the ultimate objectives far from being accomplished.

Finally I must add that any meaningful research can only be done if the scientists have the financial resources and the means to do it. It is imperative that the amount of grant given per project be sufficient to carry the project to completion and on schedule.

The following pages contain Recommendations

They all have undeniably academic and research value.

I must emphasise that in addition, the recommended projects have immediate application to small scale industry in Medical and Biological Diagnosis in the area of health and food production.

Achievement of the goals Outlined in the recommendation are certain not only to save foreign exchange expenditure but also make considerable profit.

Objective:

Manufacture of Laboratory Plastic Ware.

Disposable, single use plastic ware is an absolute necessity in any research and biochemical teaching. The fledgling scientific community in the Philippines imports them from NUNC Corporation, Denmark (Local supplier: MED-TEST INC., Makati, Manila). Much of the needed plastic ware are also obtained as gifts from laboratories abroad. I have noted that some of the plastic ware, meant for single use exclusively, are recycled by washing and used several times over and over again by laboratories in the Philippines. Such a practice is unacceptable and even dangerous for high quality Genetic Engineering work.

I propose that as a support for the build-up of Genetic Engineering/Biotechnology Capacity, the Philippines seriously consider manufacturing locally some of the essential material.

The type of plastic ware that could be manufactured by local plastic producers are:

1) 2, 5 and 10 ml serological tubes

2) 1, 5 and 10 ml syringes

3) low speed centrifugation tubes for capacities of 5, 10, 25, 50, 250 and 500 ml.

4) Flat bottom plastic petri-dishes of 60 cm and 100 cm diameters.

5) 2.5 ml volume Eppendorf centrifugation tubes

6) Tips for Gilson adjustable pipettes

These items can be manufactured from Polyethelene and/or Polypropylene.

The cost of each item, to the local purchaser, could easily be reduced to 20% of the current market price in the Philippines. It can avoid dependence on perpectual gifts from benevolent laboratories abroad. It will enable Philippines Scientists to avoid recycling of already used material and thereby avoiding risks.

It leads to self reliance and enables to create jobs and a small scale industry capable of making profit at the same time rendering a much needed service.

My rough estimate for 1989, of the requirement of 12 research and teaching institutions, excluding the hospitals and clinics in Manila and Los Banos, are:

1.	Serological tubes	-	6 million
2.	Centrifuge tubes	-	3 million
3.	Petri-dishes	-	3 million
4.	Eppendorf tubes	-	12 million
5.	Pipettman Tips	-	30 million

I recommend that a feasibility and market study be done to get a more precise picture.

Already established and well functioning set-up such as MED-TEST, Manila, which is already engaged in the distribution of biomedical tools are quite capable of sales of Plastic ware for laboratories in the Philippines. They have an excellent network of sales and promotion personnel across the country. They might be in a joint venture along with plastic manufacturers.

Objective: Production of Restriction Endonucleases.

Background: Any experimental work in Biotechnology/ Genetic Engineering necessarily demands a large use of DNA modifiying and restriction enzymes. Current expenditure for the purchase of enzymes by the research institutions, including the International Rice Research Institute (IRRI), is of the order of 50-70,000 US dollars per month. Besides actual purchase, an equal quantity of enzymes are availed of through gifts, donations, dollar grants etc. The local distributors of the enzymes are Belgor Investments Inc., Intramuros (Amersham product England) and MED-TEST, Makati, Manila (Bethesda Research Laboratories, USA, and Grand Island Biological Company, USA). The purchase price from the local distributors is 1.82 times the actual catalogue price.

Considerable foreign exchange in this sector can be saved and the cost of research expenditure reduced if the enzymes can be made locally. Besides ensuring self reliance, it can create 2 to 3 job opportunities for Philippine enzymologists/microbiologists and at the same time make a substantial income.

In my assessment I have noted that the Laboratories of the Microbiology Department of BIOTECH, Los Banos is ideally suited for this venture. They have the qualified manpower and infra-structure. The initial cost of going into enzymes production is practically negligible. I am surprised that so far this Institute has not considered making use of their infrasture for a such a project.

The enzymes that could be produced from bacterial strains are the following

Pst I

EcoR I

Hind III

Hae III

Mbo I

Ava I

Xho I

The microbial strains are very easy to obtain. They are cheap (about US $ 10 per organism). They can be cultivated in a simple un-sophisticated laboratory and grow well.

Purification procedures are extremely classical. In fact the entire outline of preparing the enzymes are published in many Microbiology Annual Reviews and in the different volumes of Methods in Enzymology, Academic Press. USA.

The time required for successful production of all the 7 enzymes - About 6 months.

The bacterial strains can be obtained freely from

1. Department of Microbiology or Department de Production, Institute Pasteur, 15 rue de Dr. Roux 75015 PARIS
2. Professor A. THERWATH
   UFR de Biochimie
   Universite' Paris 7
   2 Place Jussieu
   75005 PARIS
3. American Type Tissue Culture Collection (ATTCC), USA

Recommendations for the Prawn Industry

Prawn growing and cultivation is one of the major idustries in the Philippines. It certainly is a prime dollar earner for the provincial areas. The Philippines earned 150 million US $ in 1987 from prawn exports.

15,000 tons of dressed prawns were exported during the last year alone. The earning obtained being US $ 10,000 per ton; Land surface area devoted, notably in the Visayas and Negros is between 20-30,000 hectares, employing an average of 2 persons per hectare. The development cost per hectare is between 12.-20.000 US dollars. (Data obtained from the Prawn Exporters Consortium, Makati)

This lucrative industry has two immediate problems facing it and which demands an urgent solution. They are.

1) Contamination by the bacteria Vibrio harveyii

2) Contamination by Salmonella.

Vibrio is pathogenic to prawn and can destroy entire ponds containing prawn fries or larvae. Salmonella is non pathogenic to prawns but the buyers in foreign markets, for obvious reasons, refuse Prawn contaminated by Salmonella.

Besides being an immediate threat the presence of these two micro-organisms associated with prawn growing is poses yet another general health problem. This stems from the clandestine use of high doses of antibiotics by prawn farmers to destroy the micro-organisms. The problems posed are.

- Development antibiotic resistant strains of Vibrio:
  Recent field survey has shown that some of the vibrio isolated from the prawn ponds to be resistant to
  Oxytetracyclines
  Erythromycin
  Chloramphenicol

- Antibiotics treated pond water is being released into streams and rivers and paddy fields. This may have drastic consequence to the natureal flora and fauna, including man.

In this recommendation I propose the development of methods for early detection of Vibrio and Salmonella. Contaminated ponds can then be destroyed in time, avoiding umbearable cost and certainly avoiding the use of antibiotics.

Objective: Development of sensitive detection method for Vibrio in prawn cultures

Background: Vibrio is a photoluminiscent organism capable of emitting light and uses Adenosive Triphosphate, (ATP) as the energy source. This property can be exploited for their early detection.

a) - Suspected prawn fries are withdrawn from the pond
   - An acellular lysate of the prawn larvae are made by mechanical disruption
   - ATP and other energy sources used in vitro protein synthesis is added to the lysate
   - The lysate is incubated at 37°C for 1/2 hour to 2 Hrs.
   - Bioluminiscence of the incubation product is tested on a sensitive X-ray film along with standard controls.
   - This, I will be indicative of the presence or absence of vibrio in the larvae.

b) Water from ponds suspected of Vibrio be removed
   The water is centrifuged at high velocity (ie. approximately 30,000 rotations per minute for 15 minutes at 4°C) The sediment is diluted in Commercial Microbiological cell culture medium
   ATP is added to the culture and incubated at 37°c for 12 to 24 hours.
   - Cultures are exposed to X-ray film for detecting bioluminiscence.

Objective: A DNA probe Kit for detecting Salmonella Contamination

Background: Salmonella can be isolated from the flush-out of the intestinal tracts of prawns or larvae. The genome of Salmonella can be detected by the use of PCR (Polymerase chain reaction) amplified DNA probe.

Salmonella genome has been molecularly cloned and is available on request or on payment of about US $ 100 from the American Type Tissue Culture Collection (ATTCC).
The experimental protocol for detection of Salmonella is as follows:

1. Flush out the intestinal tract of randomly picked out prawns from the pond.
2. Obtain pellets after high velocity centrifugation
3. Resuspend the pellet in saline
4. Spot aliquote of the solution on nitrocellulose membranes.
5. Treat the nitrocellulose with 2 cycles of 0.5 Molar Sodium Hydroxide solution.
6. Subject the nitrocellulose sheets to hybridization reaction using cloned labelled Salmonella DNA probes for 24 - 48 hours.

7. Expose the nitrocellulose sheets to X-ray film and carry out an autoradiography.

8. Analyse spots for hybridization signals.

The Salmonella DNA probe that should constitute the essential item of an eventual Kit can be made as follows:

1. Obtain cloned Salmonella genome.

2. Excise out Salmonella specific unique DNA sequence.

3. Sub-clone this fragment

4. Amplify the-cultures and mass produce the cloned fragment

5. Subject the cloned fragment simultaneously to Polymerase chain Reaction amplification and labelling using the Avidine-Biotine labelling technique.

6. Use an aliquot of the labelled DNA as probe in the hybridization-detection method.

Time required for project	:	1 - 2 year
Cost of Project (1988)	:	US $ 50,000

Objective: The polymerase chain reaction (PCR) as a diagnostic tool for tuberculosis

Significance: Tuberculosis is a serious public health problem in the Philippines affecting a large percent of the population in urban and rural areas. One of the major difficulties in diagnosis is that early signs of the disease may easily be mistaken for other respiratory infections. Current diagnostic tools for the disease are X-ray and culturing of Mycobacterium from the patient's sputum. Immunological tests have limitations since a high fraction of Filipinos are positive for antibodies to the organism. Recently a new rapid gene amplification technique, the *"polymerase chain reaction"* (PCR) developed by Cetus corporation, has found use not only in basic molecular biology but also in medicine and forensic science. The methods is relatively simple and its sensitivity has been estimated to allow the detection of one to ten copies of viral or bacterial DNA per 1 million cells; these original copies are specially amplified over a billion-fold in a few hours by the PCR method. It may therefore allow detection of infection in sputum even at earlier stages. Athough the technique is still currently expensive, it should be possible to develop it as a cheap and rapid diagnostic tool which can be performed in provincial hospitals for a number of infectious diseases such as tuberculosis.

One clear advantage is that because DNA is stable to alkali or to fixing, sputum can be added to alkali and can then be stored at room temperature. Samples from remote areas can be collected and stored for amplification and testing in provincial hospitals, for example. The patient does not have to travel to the hospital. It should be noted that once a sufficient number of personnel are trained in the basic technology, the polymerase chain reaction method can be used to locally make kits against other important bacterial and viral infections; once established, the basic techonology could become far cheaper than an average X-ray, and much easier to carry out than standard microbiological methods for *Mycobacterium*.

Work Plan:

The success of the project will depend on technology transfer and collaboration with established molecular biologists. Initially it will involve the cloning of genes from *Mycobacterium tuberculosis* then sequencing of selected regions of the DNA in collaboration with foreign laboratories. Primer and probes corresponding to small segments of DNA regions should be synthesized and used for amplifying DNA from control cultures and verifying the presence of *M. tuberculosis* DNA in sputum

samples. AB diagnostic kit containing everything needed to perform the test in any hospital can be developed. The heat-stable DNA polymerase purified by Cetus Corporation from the bacterium *Thermus aquaticus* may possibly be used for the kit with proper licensing from the corporation. The PCR technique can be compared with the usual methods for TB diagnosis in collaboration with the Research Institute for Tropical Medicine (RITM) or the Lung Center in Metro Manila.

Cost of 50 test kit and Pesos savings using the kit: A near approximate figure is not possible to compute at present by this expert within the Philippines. My guess is that the kit could be produced relatively cheaply. In any case the test, besides being much more sensitive and precise, will be cheaper than the classical microbiological method for Mycobacterium

Expected expenditure for putting an assembly of the PCR Tuberculosis	: US $ 75,000
Time requirement	: 2 to 3 years.

Objective: Isolation, Purification and Characterizaion of Antimutagens from Bawang, Kalachuchi, and Niyog-Niyogan

SIGNIFICANCE OF THE PROJECT:

Cancer treatment today relies heavily on expensive chemotherapy. Aside from the exorbitant cost of anit-cancer drugs, some of them also lead to the death of normal cells. A study of antimutagens from indigenous medicinal plants may lead to the isolation, purification and characterization of better. antimutagenic compounds.

BACKGROUND:

Some thirty medicinal plants have been found to reduce the induction of micronucleated polychromatic erythrocytes by mitomycin C, dimethylnitrosamine and tetracycline showing that these plants have antimutagenic effects. These plants include akapulco, ampalaya, atis, avocado, banana, bawang, bell pepper, campanilla, comfrey, duhat, ipil-ipil, kalachuchi, kamatsile, kamias, mangosteen, melon, mongo, niyog-niyogan, papaya, radish, sambong, sinegualas, sibuyas puti, squash, suha, tomato, tsaang gubat and yerba buena (Sylianco et al., 1986).

Ampalaya fruits have been studied in greater detail and it has been found to be antimutagenic. The structure of the antimutagen is found to be a sesquiterpene (Guevarra and Sylianco, unpublished).

Three medicinal plants (bawang, kalachuchi and niyog-niyogan) may be chosen for study for the simple reason that of the plants tested, these were found to possess the strongest anti-mutagenic properties.

PROCEDURE/METHODOLOGY:

1. EXTRACTION:
   a) Solvent extraction - alcohol fraction
      ethyl acetate fraction
   b) Bioassay of the two fraction - micronucleus test
   c) Thin layer chromatography using silica gel
      chloroform: absolute ether (9:1)
   d) Bioassay of spots - micronucleus test
   e) Pool active spots
2. Purification of active spots
   a) HPLC
3. Structure determination of the pure fraction
   a) uv
   b) IR
   c) NMR
   d) mass spectrometry
   e) structure-activity relationship
4. Determination of effects of structurally determined anti-mutagens on different tumor cell lines and induced tumors in mice.

Expected Cost	:	US $ 40,000
Time Table	:	3 years.

Objective: 1) **Sensitisation against Schistosoma Infection**

2) **Vaccine strategy against Schistosomiasis.**

This project was undertaken in collaboration with Dr. Graham F. Mitchell of the Walter and Eliza Hall Institute of Medical Research, Melbourne, Australia, with funding from the UNDP/World Bank/WHO Special Progam for Research and Training in Tropical Diseases. It was initially and still is concernced with the detailed dissection of the immunology of resistance to infection and disease due to Schistosoma japonicum with the ultimate objective of developing a vaccine to prevent establishment of infection and also a vaccine to modulate pathology to prevent severe hepatosplenic disease among those who get infected.

The basic approach towards the attainment of the project objective must include:

1) identification of functional anti-parasite immune responses responsible for manifestation of resistance to infection;
2) isolation and identification of the target antigens;
3) production of identified target antigens if these are protein by recombinant DNA technic;
4) assay of the degree or amount of resistance induced by sensitization or vaccination with the isolated or produced target antigen(s) or molecule(s) and
5) establishment of a cloned DNA expression library and screening of the different proteins for capacity to induce resistance.

Relative to development of a vaccine to prevent establishment of infection, identified an adult worm antigen of Mr26,000 (Sj26) which is recognized by a resistant mouse strain (WEHI 129/J) and by presumed immune humans is already identified. It has been cloned, produced by recombinant DNA technic and identified as a glutathione S-transferase enzyme. Initially vaccination trials indicate development of resistance from 40 to 60%. Further trials using different adjuvants and with Sj28, should be carried out.

Also a large group of successfully treated patients in an endemic area, Sorsogon, are being followed-up to identify those who apparently are resitant to reinfection. The antibody specificities of those presumed resistant should be compared to those not resistant for identification of antigens for possible use as vaccine. Also the isotypes and titres of antibody response of these patients to isolated antigens should be assessed.

The immune response which prevents maturation and cause early destruction (anti-embryonation immunity) of S. japonicum eggs have been demonstrated. Inhibition of maturation of eggs prevent their development into rich producers of immunopathologic

antigens responsible for granuloma formation. Sensitization of mice with immature eggs prior to infection has prevented development of hepatosplenic disease. With evidence that induction of anti-embryonation immunity is a sound basis for vaccination to prevent hepatosplenic disease it is now planned to identify, isolate and produce excretory or secretory antigens of immature eggs for vaccine trials.

Cost of Project	: US $ 120,000
Expected Time Period:	3 years.

Objective: **Production of Monoclonal Antibodies for Some Proteins for Use in Nutritional Assessment and Population Control Programs in the Philippines**

Significance:

I. Nutritional deficiencies are among the major health problems of the Philippines. The prevalent nutritional problems are protein-calorie malnutrition, and deficiencies of iron, vitamin A, and iodine.

A program of control of nutritional deficiencies requires an efficient monitoring system. Prevalence studies are needed to provide data useful for initiating and evaluating effectiveness of intervention programs, setting national target goals for relevant agricultural production, and determining which population groups require focus for supplementation as well as nutrition education programs.

In the case of iron-deficiency, prevalence studies using hemoglobin level as parameter have shown an incidence of from 44-52 % among pregnant women, and 43-82 % in infants 6-12 months of age in different regions of the Philippines (Food and Nutrition Research Institute, 1986 survey). It is probable that the data reflect only *"the tip of the iceberg"* and the incidence is higher if more sensitive parameters are used. It is now considered that iron deficiency is best detected by using a

number of tests, including that of serum ferritin which is reflective of body iron stores. In the forthcoming follow-up of the HANES survey in the U.S., serum ferritin determination reportedly will be included.

Previous surveys in the Philippines have drawn upon a total of approximately 10,000 subjects for blood studies from the different regions and from different age groups to acquire a statistically valid nationwide assessment of the magnitude of the country's nutrition problems.

The estimated cost of including serum ferritin assays in such a survey at P 200 per subject is approximately P 2,000,000 using current costs of kits imported from abroad.

To include transferrin determinations to assess probable concurrent inadequancy of the iron transport system (because of protein deficiency), an additional P 500,000 would be needed assuming assay of only a subsample of 2,500 at a similar cost of P 200 per assay using imported kits.

The cost for these two assays will be recurrent because of the need for a resurvey which is currently being done approximately at 5 year intervals.

Should a national iron food fortification program be initiated, monitoring its effectiveness would need more frequent assays, and because of their sensitivity, these two assays would be the more appropriate methods rather than hemoglobin determinations.

II. Confounding the Philippines nutrition problems is the continued high rate of population growth. According to the Medium Term Philippine Development Plans (1987-1992), the population is growing rapidly at 2.5% per year. Assuming that 8% of the population are fertile women of child bearing age, then the target population for fertility control programs number about 4.64 million women. A component of this program should include a pregnancy test that is necessary to identify appropriate candidates for the initiation of fertility control methods, exclusion of those who are already pregnant and to monitor failures of the methods. Assuming an estimated modest incidence of a 2% need for a pregnancy test of the fertile population, this will entail tests numbering P2,800 per year. If tests based on chorionic gonadotropins excretion in the urine using imported kits are used at current costs of P 80 per test, the total estimated costs would amount to P 7.44 million per year.

Because of the prohibitive costs of using assays for ferritin and transferrin as well as doing pregnancy tests based on urinary assay of human chorionic gonadotropin as discussed above, one should aim at producing these locally using biotechnological procedures, i.e. preparation of monoclonal antibodies.

Production of local testing capacity (Kits) for Ferritin, Transfer (each P 200 per test) and chorionic gonado trophims P 80 per test) can reduce the expenses to 50 Pesos and 20 Pesos for each respective test. Thus a 75% saving can be envisaged.

General Methodology:

1. Immunization of Mice with Antigen (Protein)
2. Preparation of Media for Fusion and HAT Selection
3. Cell Fusion with Polyethylene Glycol and Culturing
4. Screening of Cultures for Relevant Antibodies
5. Culture Transfer and Screening
6. Freezing of Hybridomas
7. Cloning of Hybridomas (Limiting Dilution Method)
8. Propagation of Hybridomas Cells
9. Isolation and Characterization of Monoclonal Antibodies

Estimated Project Cost:	(1988)
US	$ 60.000
Time period	2 years.

Objective: **Production of Hepatitis B antigen through the use of recombinant DNA technology**

Background: Hepatitis B virus infection and its consequence on liver cirrhosis, chronic hepatitis and hepatocellular carcinoma are important health problems in the Philippines. This has been demonstrated by the high Hepatitis B surface antigen (HBs Ag) carrier rate of 14% and an exposure of 60% in the rural population (R. C. Estacio et al 1988).

The Philippine strain of Hepatitis virus B has been molecularly cloned and sequenced recently through a collaboration between scientists of the Philippine University College of Medicine and the laboratory of Dr. Mayumi in Japan. The sequence analysis provides invaluable information on the possible protein coding regions within the viral genome.

Significance: The control of Hepatitis virus B in the Philippines will require large quantities of reagents and vaccines for screening and immunization. The present high cost of commercially available HBs Ag reagents and vaccines has limited the wide spread use of these tests. Currently HBs Ag is obtained through the classical, time consuming and costly procedure that essentially involves collection of high titer HBs Ag positive plasma from voluntary donors and its physico-chemical purification to monospecificity.

Proposal: I propose that an effort be made to produce HBs Ag using the techniques of genetic engineering. The following are the reasons that may prompt in undertaking this approach:

1. HB virus is cloned and its sequences are known
2. It has been done by the Filipino scientists recently. So they have the know-how.
3. Large scale production of cultures can be set up at very little cost
4. High quantity of HBs Ag can be purified in simple straight forward steps
5. Monospecific HBs Ag can be easily purified through adsorption and column chromatography
6. The cost of producing the HBs Ag reagent can be reduced 4 to 5 fold at least.

Methodology

1. Careful identification of HBs Ag coding sequences in the cloned and sequenced Philippine virus.
2. Excision of the HBs Ag determinant sequences.
3. Recloning of the DNA fragment into appropriate expression vectors

4. Isolation and purification of the protein produced by the recombinant DNA

5. Chemical and biological tests for assertaining purity, authenticity and specificity of the protein in comparison to classically produced HBs Ag from plasma.

6. Dispensing of the quality controlled antigen in a reagent kit form to clinicians and hospitals in the country.

Cost of the project (1988)	US $ 60,000
Time required	1 to 2 years.

Objective: **Production of Polymerase chain Reaction (PCR) amplified DNA probe kit of Heapatitis B.**

Background: The PCR technique, recently devoloped by the Cetus Corporation of USA, is an extremely sensitive method and allows detection of as little as one or two copies of viral DNA molecules. The reagent for PCR can be obtained from Cetus. The Filipino strain of Hepatitis virus B has been cloned and sequenced by collaborators of Prof. Marita Reyes at the UP College of Medicine.

Significance: The cloned DNA can be excised out using appropriate restriction endonuclease cleavages. The excised DNA can be concomitantly amplified in copy numbers and labelled. The amplified and labelled DNA may be used as molecular probes for detecting the presence of HBV DNA in imprints of cells from needle biopsies of liver of suspected patients. This approach could serve as complementary diagnostic tool for the Hepatitis B program which currently employs immunological method in diagnosis.

Expected duration of Project :	1 year
Expected Cost (1988) :	US $ 30,000

Miscellaneous Recommendations.

1) Production and sale of Germ-free mice by the Research Institute for Tropical Medicine, Alabang

Two excellent facilities for animal breeding and care actually exists at Alabang. It is manned by a staff that includes 3 veterinary doctors. They have the potential and capacity to undertake breeding of germ free animals.

Germ free animals are essential biological tools in all biological research, pharmacology and drug industry. I note that a real need exists for laboratory animals in the Philippines. The RITM can render a service to the nation and at the same time make money through sales, that can be used for furthering the research capacities of the institution.

2) Sreening of Marine sponges for detecting antibiotic producing species.

Several hundred species of marine sponges abound the shores of the Philippines archipelago. Some of these are not even identified and properly classified. From my discussions with scientists at Biotech (Los Banos) and UP Medical College, I gathered that many of the species produce antimitotic substances. I suggest that scientists in Philippines look closer into this and make a detailed study of the anti-mitotics from these sponges and its pharmacological significance. With some luck one may even discover a yet unknown substance of antibiotic value, in which case, in the

face of international competition, the Philippine scientists may come up with a new drug, carving an exclusive niche for themselves.

3) AIDS Monitoring

AIDS and HIV monitoring is undertaken in the Philippines by the Department of Virology at the RITM. They depend totally on reagents donated by agencies abroad. Thus the HIV/AIDS monitoring system is not self reliable.

I propose that the p24 antigen be prepared locally using cloned HIV p24 sub-fragment DNA. This could be mass produced with negligible cost input and can serve as a sensitive test for the AIDS diagnosis.

The p 24 DNA can be obtained from

1) Dr. Robert Gallo
National Cancer Institute,
Bethesda
USA

2) Dr. Sarngangadharan
National Institute of Health
Bethesda
USA

3) Professor Luc Montagnier

Department of Virology

Pasteur Institute

15 rue Dr. Roux

75015 Paris, France

4) Calorimetric reaction test for Aflatoxin

Contamination by Aflatoxin is a problem in Copra (coconut), Ground-nut, Corn and rice. It is particularly important in household storage of the staple food grain-rice. The house wife has at present no way of telling whether or not her rice stock is edible or not. Consumption of contaminated rice is a major health hazard.

I feel that a simple way for detecting aflatoxin can be developed.

Aflatoxin is made of 5 flat carbon rings. It is possible to intercalate chemical molecules between these rings. Intercalation reaction can be coupled to a colour change reaction. If such a reagent solution in sealed tubes are provided to households, the women at home can assertain whether or not the rice they will be using is edible or not.

My suggestion is that Dr. Chua of the Philippine Intitute for Pure and Applied Chemistry, is the best suited person to undertake such a project.