

BOSE RESEARCH INSTITUTE

ANNUAL REPORT
and
ACCOUNTS

For the Year 1940-41

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REPORT OF THE GOVERNING BODY 1940-41

The Director begs to present the annual report on the working of the BOSE INSTITUTE for the session 1940-41.

1. The Governing Body as on 1st April, 1940, consisted of the following members, and there has been no change in the personnel during the year.

1. Dr. Rabindra Nath Tagore, D.Litt. N.L.
2. Lady Abala Bose.
3. Sir Nilratan Sircar, M.A., M.D., D.Sc., LL.D. etc.
4. Mr. J. N. Basu, M.A., B.L., M.L.A.
5. Prof. P. Parija, M.A., I.E.S. Principal, Ravenshaw College, Cuttack.
6. Mr. S. C. Mukherji, I.C.S. (Retd.)
7. Mr. B. M. Sen, M.A. (Cantab), M.Sc. (Cal.), I.E.S., Principal, Presidency College, Calcutta.
8. Mr. S. K. Mandal, Solicitor.
9. Mr. S. M. Bose, M.A., LL.B. (Cantab), Member, Public Service Commission, Bengal; Secretary, Bose Institute.
10. Mr. A. N. Mitter, Superintendent, Bose Institute.
11. Prof. N. C. Nag, M.A., F.I.C. Asst. Director, Bose Institute.
12. Dr. D. M. Bose, M.A., Ph.D., F.N.I., Director, Bose Institute.

Four meetings of the Governing Body were held during the year.

2. *Sir J. C. Bose Memorial Lecture*—Dr. Sir S. S. Bhatnagar, O.B.E., D.Sc. delivered the third Sir J. C. Bose Memorial lecture on 30th November, 1940. The subject of his discourse was "Scientific Research and the Future of Indian Industry."

3. *Staff*—During the year under review the following changes have taken place.

On the termination of his two years tenure, Dr. N. K. Saha, research fellow in Physics, vacated his Fellowship in September, 1940 and accepted a lectureship in Physics in the Scottish Church College. He is continuing his work in the Institute as an honorary research worker.

Mr. Sudhir Ranjan Das has been appointed a research scholar in his place from the 1st February, 1941. Mr. Bonbehari Ghosh, research scholar in Physics has been appointed a research worker under the scheme of

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research in Ultra-sonics subsidised by the Department of Scientific and Industrial Research with effect from 1st February, 1941.

Mr. Ram Parshad, M.Sc. honorary research worker has been awarded the scholarship vacated by Mr. Ghosh.

Dr. R. L. Sen Gupta, M.Sc., Ph.D. (Lond.) has been working in an honorary capacity in the Institute since September, 1940.

Mr. Kalyan Kumar Purkayastha, M.Sc. Sir J. C. Bose Research Scholar in Botany has resigned his appointment after the completion of one year.

4. *Report of the Reviewing Committee*—The report submitted by the Committee appointed by the Government of India to visit the Bose Institute and review its working was forwarded to the Governing Body for its views. Negotiations are proceeding with the Central Government regarding their proposals for changes in the constitution and working of the Bose Institute. It is expected that during the course of the coming year a definite arrangement will be concluded.

5. *New Constructions*—The equipment of the room erected over the workshop last year as a Chemical Laboratory has been completed. A small room has been equipped for low temperature work.

The electrical wiring of the main laboratories is being rearranged with a view to enabling the Institute to take advantage of the special rates which have been offered by the Calcutta Electric Supply Corporation for the supply of electricity for power, refrigeration and heating purposes.

6. *Co-operation with other Scientific Institution*—The Institute has received a grant from the Government of India through the Department of Scientific and Industrial Research for the construction of a high power generator of *ultra-sonic waves*. The work is proceeding satisfactorily.

It is proposed to submit other schemes of applied research in Physics, Bio-chemistry and Botany for grant in aid from different Research Councils.

Facility for work has been given to a chemist belonging to the Department of Sericulture, Bengal. Investigation on vegetative methods of propagation of chincona plants is proceeding in collaboration with the Government Chincona Plantation at Mungpoo.

*7. *Research Activities*—Department of Plant Physiology and Genetics.

The pulsatory activity of the leaves of *Desmodium gyrans* which was the subject of a classical investigation by Sir J. C. Bose is being continued with a view to discovering the source of energy of the pulsatory activity. Evidence has been collected which go to show that in isolated young leaflets

* For detailed report see Appendix I.

this activity is due to photosynthesis of carbohydrates by the motile leaf. The period over which the pulsatory activity continues in the dark depends on the amount of sunshine received by the leaf during the day. In the dark the activity can be prolonged beyond this period by adding glucose to the water in which the leaflet stem dips. There is some characteristic difference in the pulsatory activity in young and old leaflets which require further investigation. Effort is being made to make quantitative measurements of the relation between the energy absorbed and the work done by such motile leaflets.

The study of the effect of auxins on root formation in plants is being pursued successfully. The carbohydrate metabolism and histology of the formation of roots in *Impatiens* (*Dopati*) has been studied. It is concluded that growth promoting and root forming hormones are due either to the action of one and the same substance or if different they are produced in the same part of the plant.

Experiments on the propagation of mango plants from marcotte and cuttings by treatment with high concentration auxin have produced some important results. Roots were formed in the marcotte of young plants within a fortnight of the treatment with auxin and plants were raised successfully from 80% of them. This gives a much better method of plant propagation than by inarching. Plans have been completed for trying similar experiment with young chincona plants at the Chincona Plantation at Mungpoo this summer with a view to devising a satisfactory method of vegetative propagation of chincona plants.

Researches on Jute—Jute, the most important economic plant of Bengal, has been the object of several investigations in our Institute. The vitality of jute-seed is very short, extending normally to about ten months. Investigations are being undertaken to study the influence of different conditions of storage, viz., of temperature, humidity, the nature of gaseous environment on the period of vitality of jute-seeds. Some definite results have already been obtained; the investigation is being further continued.

Investigations have been undertaken on the variations with the time of the day of the carbohydrate content in different tissues of both normal and ringed jute plants with a view to finding out the mechanism of translocation of carbohydrates in this plant. It is concluded that the bark is the main channel for the translocation of sugar. Investigation regarding the nitrogen content of the different plant tissues is being continued.

Experiments have been commenced on the effect of light and temperature treatment of germinating jute seeds and seedlings on the growth and development of jute. The manurial experiments with this plant is being continued on an extended scale.

Investigations have also been carried out on the boron requirement of jute plants. It has been found that a definite optimum concentration of the trace element boron, between 0.01 ppm. to 0.1 pp., is necessary for the growth of jute plants in sand culture. Further the 'dieback' effect observed under certain condition in jute plant is not due to a deficiency of boron in the soil. The cause of this effect has been investigated and certain provisional conclusions have been obtained, which are being further verified. Experiment has been planned to study the influence of the pH values of the nutrient salt solutions in the case of sand culture investigations on the growth of jute plants. Similarly for plants grown in field the relation between the pH value of the soil solution and growth will be studied this summer.

Plant tissue culture—The investigations, on the tissue culture with different plant roots mostly of indigenous variety in nutrient solutions, which were undertaken during the last two years have now yielded some definite results. At present the influence of accessory growth factors like thiamin, nicotinic acid, glycin, and the relative efficiency of glucose and sucrose are being investigated.

Vernalisation—The experiments on the vernalisation of Indian crops such as wheat, barley, oats, cicer and peas were extended this year and detailed results on wheat have been published. It was found that in the case of wheat, cold vernalisation supplemented with long photoperiod showed significant earliness of 15 days compared to non photoperiodically treated plants.

Investigation has been commenced at Falta for a detailed study of the production of sap in date palms during the course of the whole year with a view to obtaining information on the daily yield of sap in the various seasons, on the influence of temperature on its sugar content and the source of the sugar in the sap. Interesting results have already been obtained.

Physiology of Tropical Fruits—The investigations on the physiology of tropical fruits have been continued and some of the results obtained with mango and guava have been published. In mango, investigations have been undertaken for the study in detail of the catalase activity, the evolution of volatile products in relation to respiratory activity of the fruit, and the effect of ethylene vapour on the latter.

Besides catalase the role of saccharase and alcohol dehydrogenase in the metabolism of mango during the climacteric has been studied. The influence of other metabolites are being investigated. It has been found that tryptophane which is structurally related to the indole molecule is present in the leaf and stalk of the mango tree.

Department of Bio- and Agricultural Chemistry—Investigations have been published on the mechanism of vegetable tissue respiration, and a comparative study with the respiration in animal tissue has been made. The mechanism of the synthesis of amino acids in plants has also been studied.

Studies on filarial tissues have been continued. A new investigation has been commenced on the mineral content of blood in Bengali subjects in normal and pathological conditions.

The work of extraction of the crystalline constituents in the medicinal plant *Drona* is being continued. When sufficient material is available the chemical composition of these crystals will be undertaken.

Agricultural Chemistry—The nitrogen and mineral content of jute plant is being determined. The effect of different artificial manures on the growth and development of jute fibre is being continued.

The soil composition, fertility and pH values in certain barren patches in the Falta farm have been investigated.

Department of Physics—Cosmic ray investigations—A series of investigations with photographic plates kept at Darjeeling (7,000 ft.) at Sandakphu (12,000 ft.) and at Phari Jong (14,500 ft.) have led to certain definite conclusions on the origin and nature of the particles which produce heavy ionisation tracks on these plates. From their extremely heavy absorption in water compared to that in seven times the mass of air, the conclusion is drawn that the primary rays are chiefly neutrons. A mass of evidence has accumulated which show that the secondary particles observed in the photographic emulsions are mesotrons which are created as showers chiefly by the action of the fast primary neutrons. Recently an estimation has been made of the mass of the mesotron by the determination of their energies from the multiple scattering suffered by them in the photographic emulsion. With the help of a calibration curve giving the mean grain spacing along proton tracks as function of the energy of the proton, it has been possible to determine the velocity of the mesotrons which have similar grain spacings in the photographic emulsion. The four estimated values of the mesotron mass are consistent within ten percent with each other and fall within the range of the determined values of mesotron mass by other methods.

Attempt to detect doubly charged protons, produced by the passage of the high energy Cosmic ray protons through hydrogenous matter (*e.g.* 20 cm. of water), whose occurrence is predicted according to recent theories of Bhabha and Heitler, has led to negative results. We are indebted to the postal and censor authorities for the facilities offered by them to carry on a part of these investigations in Phari Jong (14,500 ft.) in Tibet.

The low energy neutrons present in the atmosphere at different altitudes up to Darjeeling has been studied with the aid of ionisation and proportional counters filled with Boron Trifluoride. For a more accurate study of the spectral distribution of neutron energy in the Cosmic ray, a loop recording oscillograph has been constructed in our workshop and is at present being tested. A continuously recording automatic Wilson apparatus for Cosmic ray investigations has been constructed in the Workshop with the collaboration of Dr. R. L. Sen Gupta. It will be sent to Darjeeling after some preliminary investigations in Calcutta.

Artificial Radio-activity—Study of radio-active atoms produced by the bombardment by α -particles or by slow neutrons is being continued. The radio-activity of Na^{22} produced by the bombardment of Fluorine by α -particles from Po, and the nuclear isomerism of radio-active Br^{80} have been investigated. Several radio-active organo-bromo compounds have been prepared, and the strength of different types of bindings in such compounds has been investigated by the use of radio-active Bromine as trace element. We require more copious source of neutrons for the production of radio-active trace elements of sufficient intensity to follow up important chemical and biological processes. The construction of a low voltage discharge tube neutron generator which is expected to give a neutron production equivalent to that produced by one gram of Radium, has been taken in hand and is expected to be completed in a few months. Preliminary work is being undertaken for the construction of a high voltage electrostatic generator.

The relative stability of the two neighbouring isobars, ${}^3_1\text{H}$ and ${}^3_2\text{He}$ has been the subject of many interesting discussions recently. A general criterion for the relative stability of such isobar pairs has been put up. It is shown that such a criterion is applicable when the difference in the binding energies of two isobaric nuclei is either very large or small compared with the difference in the proton and neutron mass. When these differences become nearly equal as in the present case nothing can be said on their relative stability.

An investigation has been undertaken on the interaction of electrons with the longitudinal component of the electro-magnetic field, according to a

method given by Heitler. The self-energy of an electron due to such interaction has been calculated. The interaction matrices in the different processes involving the interaction of mesotron with electro magnetic and nuclear fields are being calculated.

Astrophysics—The possibility of neutron formation in course of stellar evolution as discussed in recent theories of Zwicky and Baade has been followed up and the physical conditions under which they can be formed have been studied. An attempt has been made to reformulate the theory of Vogt and Russel on the course of stellar evolution in light of Bethe's theory of energy production in stars.

A formula for the derivation of the polytropic index(n) has been given by assuming a general law for the dependance of opacity co-efficient and the rate of energy generation in stars on temperature and density.

Ultrasonics—Investigations with ultrasonic waves are proceeding satisfactorily. In view of the doubts thrown on the reality of dispersion in water of ultrasonic waves found by one of our workers, the investigation has again been repeated with a new set of apparatus; the results obtained are in agreement with those obtained previously. The dispersion of such waves in aqueous solutions containing different electrolytes is being determined. The results obtained is expected to give data for a theory of the structure of water and of ultrasonic dispersion in it.

Variation of velocity of the ultrasonic waves in different sets of organic liquid mixtures have been studied leading to the discovery of certain maxima and minima velocities in them. A successful attempt has been made to interpret the results quantitatively in terms of the theories of molecular field developed by Debye, Keesom and London.

A high power supersonic wave generator yielding between 2-3 kilowatt of energy is under construction under a scheme of research financed by the Department of Scientific and Industrial Research. Investigation of certain problems of technical and biological importance will be taken up when the apparatus is ready.

Bio-Physics—The recording of electrical rhythm of the brains of un-anæsthetized human being through the unopened skull under different experimental conditions is being continued. As part of the expansion work lately undertaken with the electroencephalographic machinery, the only one of its kind in this country, brain rhythm is being recorded from Deaf and Dumb School students sent here through the courtesy of the Principal of the school, from normal and abnormal adults and children and also from

patients with a clinical history of cerebral trauma, Parkinson's disease, epilepsy, and other nervous and mental diseases.

Department of Anthropology—Blood group investigations have been carried out amongst the Oraons. With the assistance of the authorities of the Calcutta Medical School blood group investigations of the Vaidyas of Bengal and of the twins born in the hospital are being carried on.

We are collecting data about twins from the Calcutta Medical School and from the Department of Maternity and Child Welfare of the All India Institute of Hygiene and Public Health and also from private clinics. Twin pedigrees and also pedigree of various hereditary anomalies are being collected. The question whether the phenomenon of twin births is hereditary in man or not is being investigated.

Department of Zoology—The problem of artificial hatching of fishes of economic importance is engaging our attention. Different varieties of fishes are being reared in experimental tanks and their habits and outer sex characters studied. In certain species it has been possible to identify the female and to extrude mature eggs from them by suitable manipulation; but the problem of the artificial supply of milt has not yet been solved.

Investigations on the cause of sex differentiation and caste distinction in the variety of red ants *Oecophylla smaragdina* Fabr. has been continued. Artificial formicaries have been built to study their behaviour under controlled environmental conditions. The parthenogenetic production of males from unfertilised eggs of the queens has been established. It has been found that in colonies containing only workers, which possess well developed ovaries filled with eggs, larvæ of queens appear with the advent of summer, the cause of which we are inclined to believe to be trophogenic (due to influence of environment).

Seminar and Symposiums—The physics seminar started in 1938 in co-operation with Department of Physics and Applied Mathematics University College of Science is being continued successfully. Dr. H. J. Bhabha, F.R.S. gave three of his Calcutta University Readership lectures and one address before the Indian Physical Society in the rooms of the Bose Institute. (App. III).

Publication—Vol. XIV of the Transactions of the Bose Institute is being published by the Baptist Mission Press. A good number of papers embodying research carried out by the workers of the Institute have been sent out for publication in well-known scientific journals.

Library—At the close of the year 1940-41 the Library possessed 2,008 volumes of books and journals. During the year under review, 77 books and 63 bound volumes of journals have been added to the stock.

The number of current periodicals received by the Library, exclusive of serials, is 47, of which 31 are subscribed and the rest received in exchange. A list of the periodicals is given in Appendix II.

Workshop—The workshop under the charge of Dr. J. P. Sircar has been kept fully employed in the construction of special apparatus required for research work undertaken here. In some cases the workers requiring the apparatus took active part in their construction. Amongst the apparatus constructed during the last year mention may be made of the following (i) Duddell type of loop oscillograph (ii) Automatic continuous working Wilson chamber (iii) Demountable metal oscillator valve (iv) Low voltage neutron generator (v) Apparatus for the continuous photographic record of the pulsation of leaflet of *Desmodium gyrans* and of recording the intensity of diffuse light incident on the leaflet.

Audited Accounts—The audited income and expenditure account of the Institute is given in the following pages. The Institute has received a grant of Rs. 50,000/- from the Government of India for the year 1940-41.

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Balance Sheet as at

LIABILITIES.	Rs.	A. P.	Rs.	A. P.	Rs.	A. P.
<i>Liability for Provident Fund Account—</i>					4 13 0	
<i>Provision for Contingent Liabilities</i>						
<i>Staff Retirement Bonus Fund—</i>						
<i>Fund—</i>	....		....		4,257 0 0	
As per last Balance Sheet ..	3,500	0 0				
Addition this year ..	1,000	0 0	4,500	0 0		
Less paid this year ..	....		1,500	0 0	3,000	0 0
<i>Investment Fluctuation Fund—</i>	....		....		1,29,104	5 7
<i>Sir J. C. Bose Research Scholarship Trust Fund—</i>						
Capital Account ..	....		....		50,000	0 0
Interest in deposit as per last						
Account ..	437	8 0				
Interest received this year ..	1,750	0 0	2,187	8 0		
Less Scholarships paid this year	....		1,624	12 3	562	11 9
<i>Physical and Biological Dept.</i>						
<i>Capital Account—</i>						
As per last Balance Sheet ..	....		5,775	3 8		
Less transferred to Income						
and Expenditure Account to						
meet deficit ..	....		4,642	12 11	1,132	6 9
<i>Donations</i>						
As per last Balance Sheet ..	....		....		11,03,165	12 5
<i>Amount Accumulated for Trust</i>						
<i>Fund—</i>						
During 23 years (1917-1940)	....		4,67,335	4 3		
Add Balance of Income and						
Expenditure Account for						
1940-41 ..	....		Nil		4,67,335	4 3
TOTAL ..	....		....		<u>17,58,562</u>	<u>5 9</u>

D. M. BOSE,
Director.

A. N. MITTER,
Superintendent.

INSTITUTE

31st March, 1941.

ASSETS.	Rs.	A.	P.	Rs.	A.	P.	Rs.	A.	P.
<i>Fixed Assets—</i> (as per statement annexed)									
<i>Land—</i>									
At Calcutta	1,65,613	0	0						
At Darjeeling	16,000	0	0	1,81,613	0	0			
<i>Buildings—</i>									
At Calcutta	2,27,326	0	0						
At Darjeeling	19,925	0	0						
At Falta	33,231	0	0	2,80,482	0	0			
<i>Furniture and Fixtures</i> .. ..	.....			9,187	0	0			
<i>Apparatus</i> .. ..	.....			17,178	0	0			
<i>Books and Journals</i> .. ..	.....			7,565	0	0	4,96,025	0	0
<i>Investments—</i>									
Rs. 12,09,200 3½% G. P. Notes (of which 8,800/- with A.G.B. Account. Urmilla Devi Benevolent Fund)	.....			9,44,574	6	4			
" 1,35,100 4% Govt. Loans	.....			1,27,585	1	0			
" 70,000 4½% Govt. Loans	.....			66,450	12	6			
" 10,000 5% Govt. Loans	.....			9,787	8	5			
" 20,000 7½% Preference shares	.....			20,000	0	0	11,68,397	12	3
<i>Interest Accrued on Investments</i>	.....			.....			12,749	15	8
<i>Sir J. C. Bose Research Scholar- ship Trust Fund—</i>									
Rs. 50,000 3½% G. P. Notes	.....			.....			50,000	0	0
<i>Ground Rent Outstanding</i> .. ..	.....			.....			450	0	0
<i>Security Deposits</i> .. ..	.....			.....			75	0	0
<i>Scientific and Industrial Research Scholarship—</i> (To be recouped from next year's grant on this account)	.....			.....			200	0	0
<i>Advance to Scholar (for Foreign Education)—</i>									
As per last Account .. ..	.....			775	0	0			
Less recovered this year .. ..	.....			300	0	0	475	0	0
<i>Cash—</i>									
Trust Fund Account at Bank	.....			28,440	4	5			
Establishment Account in hand and at Bank .. ..	.....			1,749	5	5	30,189	9	10
TOTAL ..	.....			.....			17,58,562	5	9

We have examined the above Balance Sheet of the Bose Institute and beg to report that the same is correctly stated according to the best of our information and explanations given to us and as shown by the books of account of the Institute. We have also verified the Investments with the Bankers' lodgment certificates.

Central Bank Buildings,
100, Clive Street,
Calcutta.
The 7th May, 1941.

P. K. GHOSH & Co.,
Registered Accountants, (India)
Registered Accountants,
Auditors.

INCOME.	Rs. A. P.		Income and Expenditure Account		Rs. A. P.	
<i>Income on Government Grant Account—</i>						
Grant from Government of India—						
For Research Work ..	....		50,000	0	0	
Calcutta University's Contribution towards works done for them .. ..	....		22	2	3	
Miscellaneous Receipts ..	....		306	9	6	50,328 11 9
<i>Income on Trust Fund Account—</i>						
Interest (General) ..	53,126	0	0			
Less Sir J. C. Bose Scholarship Fund Rs. 1,750/- and Urmilla Devi Benevolent Fund Rs. 308/-	2,058	0	0	51,068	0	0
Interest (Urmilla Devi Benevolent Fund) .. ..	....		308	0	0	
<i>Dividend</i>						
(for Birla Scholarship) ..	....		1,500	0	0	
Refund of Income Tax ..	....		494	4	0	
House Rent .. ..	....		300	0	0	
<i>Ground Rent</i>	1,480	0	0			
Add outstanding this year	450	0	0			
	1,930	0	0			
Less outstanding last year	130	0	0	1,800	0	0
Miscellaneous Receipts ..	....		23	15	0	55,494 3 0
<i>Amount transferred from Physical and Biological Capital Account</i> .. ..	....		....			4,642 12 11
TOTAL ..	....		....			1,10,465 11 8

D. M. BOSE,
Director.

A. N. MITTER,
Superintendent.

INSTITUTE

for the year ended 31st March, 1941.

EXPENDITURE.	Rs.	A.	P.	Rs.	A.	P.	Rs.	A.	P.
<i>Expenditure on Government Grant Account—</i>									
Scholarships and Allowances (Director's and Staff's) ..	58,228	1	9						
Less Sir J. C. Bose, Birla and Scientific and Industrial Research Scholarships, last year's unpaid Salaries and Staff Retirement Bonus ..	4,679	9	9	53,548	8	0			
Wages of Mistries and Servants ..	....			6,422	1	0			
Provident Fund Contribution ..	....			2,387	11	0			
Staff Retirement Bonus Fund ..	....			1,000	0	0			
Laboratory Expenses ..	10,067	4	6						
Less transfer to Trust Fund Account for Urmilla Devi Benevolent Fund, Biological Research ..	308	0	0	9,759	4	6			
Purchases of Apparatus ..	....			3,475	12	9			
Purchases of Books and Journals ..	....			1,981	4	0			
Purchases of Furniture ..	....			634	14	6			
General Expenses (including Printing, Stationery, Electric, Telephone, Staff's Tiffin, etc.) ..	....			3,944	1	3			
Sir J. C. Bose Memorial Lecture ..	....			118	3	0			
Travelling and Conveyance ..	....			1,532	11	3			
Rents, Rates and Taxes ..	....			775	10	10			
Repairs to Buildings ..	....			6,154	5	0			
Publication ..	....			1,000	0	0			
				92,734	7	1			
Less Deficit recouped from Trust Fund ..	....			42,405	11	4	50,328	11	9
<i>Expenditure on Trust Fund Account—</i>									
Birla Scholarship ..	....			1,200	0	0			
Urmilla Devi Benevolent Fund Biological Research Expenses ..	....			308	0	0			
Bank Charges, Renewal Fees, etc. ..	....			146	10	4			
Income Tax Deduction ..	....			721	10	3			
Depreciation ..	....			21,446	13	3			
Deficit on Government Grant Account as above ..	42,405	11	4						
Less Capital Expenditure ..	6,091	15	3	36,313	12	1	60,136	15	11
TOTAL ..	....			....			1,10,465	11	8

Examined and found correct.

Central Bank Buildings,
100, Clive Street,
Calcutta.
The 7th May, 1941.

P. K. GHOSI & Co.,
Incorporated Accountants (Lond.),
Registered Accountants, (India)
Auditors.

BOSE INSTITUTE

Re: Balance Sheet as at 31st March, 1941.

Statement showing how the values of the Fixed Assets have been arrived at.

Particulars of Assets	Revaluation price at 31-3-31 after adjustment of additions and sales to 31-3-40 at cost.	Additions (Capital Expenditure) in 1940-41	Total Gross Value at 31-3-41	Depreciation to 31-3-40	Depreciation for 1940-41 and rates thereof	Total Depreciation to 31-3-41	Net Balance at 31-3-41 (as shown in annexed Balance Sheet)
	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.
Land at Calcutta ..	1,65,613 0 0	....	1,65,613 0 0	....	....	....	1,65,613 0 0
Land at Darjeeling ..	16,000 0 0	....	16,000 0 0	....	....	....	16,000 0 0
Buildings at Calcutta ..	2,89,620 4 0	....	2,89,620 4 0	56,502 4 0	5,792 0 0 (2%)	62,294 4 0	2,27,326 0 0
Buildings at Darjeeling	27,566 0 0	....	27,566 0 0	6,952 0 0	689 0 0 (2½%)	7,641 0 0	19,925 0 0
Buildings at Falta ..	49,992 0 0	....	49,992 0 0	15,261 0 0	1,500 0 0 (3%)	16,761 0 0	33,231 0 0
Furniture and Fixture (excluding those made in the Institute) ..	19,015 13 3	634 14 6	19,650 11 9	9,480 13 3	982 14 6 (5%)	10,463 11 9	9,187 0 0
Apparatus (excluding those made in the Institute) ..	71,814 15 3	3,475 12 9	75,290 12 0	48,700 15 3	9,411 12 9 (12½%)	58,112 12 0	17,178 0 0
Books and Journals (excluding those published by the Institute)	22,588 12 0	1,981 4 0	24,570 0 0	13,933 12 0	3,071 4 0 (12½%)	17,005 0 0	7,565 0 0
TOTAL ..	6,62,210 12 6	6,091 15 3	6,68,302 11 9	1,50,830 12 6	21,446 15 3	1,72,277 11 9	4,96,025 0 0

D. M. Bose,
Director.

A. N. MITTER,
Superintendent.

The Annual Meeting of the Governing Body of the Bose Institute was held on Thursday the 17th July, 1941 at the Bose Institute at 5-30 p.m.

Present—

Mr. J. N. Basu (*in the chair*).

Lady Abala Bose.

Mr. S. M. Bose.

Prof. N. C. Nag.

Mr. A. N. Mitter.

Dr. D. M. Bose.

Mr. A. N. Mitter presented the audited accounts for the year 1940-41.
Resolved that the audited accounts be passed.

APPENDIX I

ABSTRACT OF PAPERS AND REPORTS

A. Department of Plant Physiology

1. *Effect of High Concentration Auxin on the Growth and Root formation in Impatiens.* By B. K. DUTT and A. GUHA THAKURTA (A note on this paper has been published in 'Science and Culture' Vol. VI. 547-548. 1941, and the full text has been sent for publication in Vol. XIV of the Bose Institute Transactions).

The reactions of the effect of high concentration auxin on both growth and root formation were simultaneously studied in the stem of *Impatiens* in order to understand whether specifically different substances in the plant are the causes of the different reactions or the same substance is the potent factor underlying both the reactions. The reactions were studied at different regions of the stem under varying morphological conditions of the plant. The study of the carbohydrate metabolism in the treated and untreated regions and the histology of the formation of root in the treated region were also undertaken as an additional investigation.

It has been concluded that both the growth promoting and the root forming activities brought about by the application of high concentration auxin, are similarly effected by the morphological condition of the plant and that the source of hormone supply, whether specific or general, are the leaves and the apical bud, since the removal of them affect both the activities alike. The root formation is related not merely with the increased carbohydrate content at the treated region but with the high value of the ratio of the total carbohydrate to the reducing sugar.

In the treated region the roots develop from the interfascicular cambium. The rudiments of roots were found even on the third day of treatment.

2. *Propagation of Mango Plant from Gootes (Marcotte) and Cuttings by Treatment with High Concentration Auxin.* By A. GUHA THAKURTA and B. K. DUTT. (Sent for publication in Vol. XIV, Trans. Bose Institute) Roots were formed in the gootes of young plants (2-3-year old) within a fortnight of treatment with auxin and plants were successfully raised from 80% of them. Some of the untreated gootes of the young plants also rooted but insufficiently after a much longer period varying from 6 to 9 weeks; only one plant out of 25 was finally established in the soil.

In the gootes of a twenty-year old plant, treatment with auxin induced insufficient root formation in some of them after a very long period of time; no plant could be raised from them. Untreated gootes formed no root.

In the cuttings of young plants, roots were formed by the application of 1 and 3% indole acetic acid, the latter producing better result; by treatment with 3% indole acetic acid plants have been established in the soil. No root formation was observed in the plants not treated with auxin.

Treated and untreated cuttings from the aged tree died within a month without producing any root.

3. *Investigation on the vitality of jute seeds stored under different temperature and moisture conditions.*

The vitality of Jute seed is very short, extending normally for a period of about ten months. The surplus stock is wasted every year. This investigation has been undertaken to find out some means of stopping this annual wastage by prolonging the vitality of the seed.

It has already been found that the vitality can be prolonged by storing the seed under suitable temperature and humidity conditions. The observation is being further continued.

4. *Investigation on the diurnal variation of the pulsation of Desmodium leaflets.*

It has so far been found that the isolated young leaflet can normally pulsate when kept with its stem in tap water for a longer period (20 days) as compared to that of isolated older leaflets (2-3 days).

The young leaflet stops pulsation at night and resumes after day break whereas, the older one continues to pulsate at night either from the energy absorbed during day time or from its store of carbohydrate.

The young leaflet supplied with glucose solution can pulsate, though feebly, in complete darkness for a long time. The investigation is being further continued.

5. *Studies on the growth and development of Jute, etc.* (sent for publication in Vol. XIV Transactions of the Bose Institute). By B. K. PALIT.

In the year 1939 in the course of investigation on jute plants grown in pots filled with manured soil and kept in open, it was noticed that many plants suffered from 'dieback' effect. In the course of investigation whether the deficiency in certain trace element, namely boron, was responsible for the injury produced in these plants, it has been found that boron has some beneficial effect on the growth of jute. A short note of this investigation appeared in Current Science, November, 1940.

In the present investigation in sand culture it has been found that there is a definite requirement of boron on the growth of jute plants, the optimum range of boron concentration lies between 0.01p. p.m. to 0.1p. p.m.

The rates of diurnal growth of plants grown in July, 1939 in sand culture and in composted soil show a similarity. Periodicity in growth is observed in the case of plants grown in sand culture but no such periodicity is observed in soil grown plants.

The 'dieback' effect is found to occur in plants grown under three different conditions, viz. (1) in sand culture experiments, (2) in soil grown controls in pots and (3) in the open field. The probable causes of 'dieback' observed in jute plants grown on soil may be (1) change in pH of the soil solution near the roots of the plants or (2) an increase in the concentration of the salt in the soil solution. The cause of the 'dieback' in the case of plants grown in sand may be that the solution which was used for three consecutive days may have undergone some change in the pH value.

6. *Investigations on plant tissue culture.* By B. K. PALIT.

Investigations are being carried out in this laboratory with a clone of 'telegraph' pea roots in a solution containing adequate amounts and suitable combinations of salts, thiamin, nicotinic acid and sucrose; it has been found that these salts and accessory materials are capable of supporting fairly satisfactory growth of these pea roots for a few consecutive passages. These experiments on tissue culture are being carried out with roots of various other plants. Arrangements for conducting these investigations in a purely aseptic condition and with thermostatic control of temperature in the region of 25°C are being completed.

7. It has been observed that the ash of the leaves of betel plant contained high percentage of calcium and magnesium. The problem whether there is any selective absorption of inorganic salts by this plant is being investigated by allowing these plants to grow under controlled laboratory condition in sand culture. The solutions that will be used in its growth will contain varying amounts of calcium and magnesium.

Besides these investigations, jute will also be grown this year in pots and in the open field to investigate more thoroughly the cause of the 'dieback' effect. For this, particular attention will be given to ascertain the pH value of (1) the solution of salts which will be used in the sand culture experiments and (2) also of the soil solution in the case of plants grown on the field, at the commencement of the investigation and afterwards at periodic intervals.

8. *Variation of carbohydrates and nitrogenous substances and their translocation in the Jute plant* (*Corchorous capsularis*, Linn). By J. K. CHOUDHURY. Sent for publication in Vol. XIV Trans. Bose Institute).

Analytical data for the variations of carbohydrates were obtained and the results obtained have been incorporated in a paper which has been sent for publication. A summary of this work is given below:

Estimations were made of reducing sugars, sucrose and starch present in leaf, bark and wood of both normal and ringed jute plants at different periods of the day. Reducing sugars and sucrose were found in all the tissues analysed, but starch was present only in leaf and was altogether absent in mature bark and wood.

Under normal conditions the quantities of reducing sugars, sucrose and starch present in leaf and bark showed an increase in the morning and a decrease towards the evening. The reducing sugars present in wood also underwent similar variations, but the quantities of sucrose present in this tissue continued to maintain an increasing course throughout the experiment. The time of the day when the highest level is attained by the total sugars of the leaf was earlier than that for the bark. Maximum quantities of both reducing sugars and sucrose were found in the leaf and a minimum in the wood. Sucrose was present in very large quantities and underwent maximum variations.

In the ringed plants there was an accumulation of sucrose in the bark above a ring and a depletion below it. From this and other considerations it is concluded that sucrose is the sugar of translocation.. In the wood above a ring, however, there was no simultaneous increase of sucrose and this suggests that there may not be any lateral translocation of their sugar from bark to wood. There was, however, an accumulation of starch in leaf from the ringed plants. There existed also a positive gradient of sugar from leaf to bark and from the upper part of the bark to the lower.

From various considerations it is suggested that although the bark is the main channel of translocation of sugar, wood may also play a minor part in it; there was some evidence that a parallel current with a very small quantity of sugar travels along the wood. The data presented are not conclusive yet, they do not however seem to be inconsistent with the theory of diffusion.

For the variations of nitrogenous substances present in the jute plant, samples of leaf, bark and wood were collected at different periods of the day and also throughout the season at weekly intervals. These samples are being analysed by the standard Kjeldahl's technique for total nitrogen.

Studies in the physiology of tropical Fruits:—

Series of investigations were conducted on some Indian fruits such as Mangoes (*Mangifera indica*) and Guavas (*Psidium guyava*) with a view to investigate (a) the essential metabolic changes in the fruit during its course of growth and development and (b) the significance of such metabolic changes on the storage life of the fruit. The results so far obtained from the experiments conducted on the above lines are incorporated in the following papers entitled:

9. *The available substrates in a developing fruit and their behaviour under conditions of storage and the ethylene treatment* (sent for publication in Vol. XIV Transactions of the Bose Institute). By B. K. KAR and H. K. BANERJEE.

The metabolic drifts in the fruits of *Psidium guyava* were traced from petal-fall to the ripening stages. Definite stages of growth and development with characteristic phases of metabolic changes were obtained. The behaviour of the fruit under different storage conditions and ethylene treatment were dependent upon the stage and the corresponding metabolic phase of the experimental fruit. Detailed results were obtained in case of such metabolites as protein, starch, sucrose, glucose, free acid and alcohol insoluble residue. The difference in results of ethylene treatment found by earlier workers were explained in terms of the available substrates and the metabolic phases of the fruit at the time of the experiment.

10. *Catalase activity in *Mangifera indica**. By B. K. KAR & H. K. BANERJEE.

The natural drift of such enzymes as catalase, oxidase and per-oxidase in the life of the mango fruits from fruitsetting to ripening were investigated. The catalase and peroxidase activities showed a close correlation with the distinct metabolic phases of the fruit. The maximum catalase and peroxidase activities were found to be in the region of the climacteric and the higher respiratory efficiency of the fruit. Together with this, a positive correlation of the catalase and peroxidase activity of the fruit with hæmin Fe content of the tissue at that stage was found. The behaviour of these enzymes under cold storage and ethylene treatment were also investigated.

11. *Effect of ethylene on *Mangifera indica**. By B. K. KAR and H. K. BANERJEE.

The different stages of the fruit showed different reactions to ethylene treatment. The reaction was found to be maximum with fruits of mature stage, than in any other stage as was found in the case of *Psidium guayava*. The significance of the mature stage being associated with higher ethylene reaction

led to further investigations on the nature of the metabolites, the evolution of volatile products and the respiration rate of the fruit.

12. *The evolution of volatile products and the rate of respiration during the different stages of Mangifera indica.* By B. K. KAR and H. BANERJEE.

The rate of respiration and the simultaneous evolution of total volatile products with relation to different phases of the fruit were investigated. The influence of storage on the emanation of volatile products and formation of volatile substances within the tissues were analysed. The storage quality of the different varieties of mangoes (collected from the markets) were worked out with reference to their emanation of volatile products.

13. *Vernalisation of Indian crops.* By B. K. KAR.

The last two years work on vernalisation of Indian crops such as wheat, barley, oat, cicer and pea were extended this year also, and the detailed results on wheat are now available in a publication form. It was suspected that non-response of Indian wheat varieties to the process of vernalisation by cold-treatment was perhaps due to its later photophase. The vernalised plants supplemented with long day photo periods showed significant earliness of 15 days than non-photo periodically treated plants. The effects of thermal and photophases were analysed on vegetative growth, tiller formation, length of the ear and number of grains per ear. It was found that cold treatment has no effect on the earliness, but it affects the period of flush of ear emergence where majority of the tillers come into ears within a narrow period and in photoperiodic treated plants this period is further narrowed down, when compared to the non-treated ones where the ear emergence in majority of the tillers are far more extended over a longer period.

14. *Specific light and temperature treatment of germinating jute seeds and seedlings and their effects on the growth and development of the plants.*
By J. K. CHOWDHURY.

Arrangements have been made to study the effects of temperature and light on the germinating seeds and seedlings and their after-effects on the mature plants.

15. *Enzymes in tropical fruits.* By H. K. BANERJEE.

The following enzymes have been found to play an important part in the metabolism of the mango during the climacteric.

(a) Saccharase.

(b) Alcohol dehydrogenase.

In case of (a) it has been found that the potential saccharase activity is far in excess of the total reserve of sucrose in the fruit at any state of its

growth. The simultaneous presence of sucrose inspite of the saccharase may be due to the presence of some agent strongly inhibiting the saccharase activity or may be due to the "Organisation Resistance" offered by the protoplasmic membrane. Investigations are being carried out to elucidate the above possibilities.

(b) The alcohol enzyme is very active during active zymasis when alcohol is being converted to acetaldehyde during the post-climacteric phase of the fruit.

Chemical aspect of the periodic bearing in Mangoes. By H. K. BANERJEE.

Such active metabolites as Cystin, Cystein, Glutathione and Ascorbic acid must play an important part in the metabolism of the tree, the seasonal metabolic drift of these agents and their relation to growth and bud differentiation is being investigated. Tryptophane which is structurally related to the indole molecule is present in the leaf and stalk. Its variation may have something to do with the production of the hormones which ultimately induce bud formation.

16. *Studies in the carbohydrate metabolism of the Indian Date-palm tree (Phoenix sylvestris).* By A. K. PAIN.

Large quantities of sugar containing sap from the date-palm tree are gathered yearly for "Gur", making a considerable portion of sugar supply in Bengal. This paper gives an account of experiments undertaken to find out some information about the sugar content in the sap which are extensively given out by each date-palm tree for 4 to 5 months in a year.

Investigation has been commenced at Falta to keep detailed records of the yield of sap from a selected number of date palms with a view to obtaining information (i) on the daily yield of sap at different seasons of the year (ii) on the dependence of the relative proportion of reducing and non-reducing sugar in the sap on temperature (iii) on the source of the sugar contained in the sap. For this purpose samples of sap are collected in a control vessel and also under sterile condition, and the sugar content in each is determined. It is found (i) the ratio of total sugar to reducing sugar is always greater in the sterile sap than in the control (ii) rise of atmospheric temperature results in an increase in the percentage of reducing sugar, in the case of the control to the extent of 70% to 80% and in the sterile sap up to 20%.

In a tree from which all the mature leaves were stripped off leaving a few tender ones, the sap yield is not much diminished, but it contains less reducing sugar. The invertase content of the leaves is being determined as also carbohydrate contents of the leaves, and other tissues of the palm.

B. Department of Bio- and Agricultural Chemistry.

17. *Studies on the mechanism of vegetable tissue respiration.* By N. B. DAS and P. K. SEN (communicated to Annals of Biochem. and Expt. Medicine).

Investigations have been carried out to study the roles of C_4 -dicarboxylic acids and cytochrome in the respiration of vegetable tissues. It has been found that a part of the total respiration proceeds through the Warburg-Keilin-Szent-Gyorgyi cycle. Discussions have also been made on the mechanism of synthesis of asparagine in plants during germination.

- 17a. *Mechanism of synthesis of amino acids in plants.* By N. B. DAS and P. K. SEN.

In continuation of our work reported last year further researches have been carried out in order to study the mechanism of "Transamination" both in vegetable and animal tissues. A cell free enzyme has been prepared from both sources. This enzyme can be preserved in the dry state. The naturally occurring variety of α -amino acid has been found to be more active in transferring its amino group to oxalacetic acid. It also seems to indicate that different enzymes are responsible for donating amino groups from different α -amino acids to oxalacetic acid.

18. *Studies on the respiration of animal tissues.* By N. B. DAS and A. ROY.

Investigations have been carried out to study if all the hydrogen atoms donated by the "Food stuff" and reaching cytochrome are carried over by C_4 dicarboxylic acid systems alone. It has been found that in most of the animal tissues about 90% of the total hydrogen mobilised is carried over C_4 -dicarboxylic acid systems. This investigation thereby supports the "Warburg-Keilin-Szent-Gyorgyi" system.

19. *Studies on Filarial tissues.* By N. B. DAS, S. SARKAR and A. ROY.

In continuation of our previous work investigations were undertaken to study the total protein, fat and glycogen content of Filarial tissues and to compare them with those of normal tissues. This investigation has been very slow as sufficient tissues were not available.

20. *Investigations on the mineral content of blood in Bengalee subjects in pathological and normal conditions.* By A. ROY.

The total iron, non-hæmin iron and copper content of new born child, tubercular patients and of normal subjects have been determined. A significant rise in the copper and non-hæmin iron content occurs in the tubercular patients when compared with normal subjects.

21. *Study of medicinal plants.* By H. K. BANERJEE.

The plant *Drona* has been extracted in different organic solvents and the various extracts thoroughly scrutinised. Ethereal extract yields a quantity of amorphous organic matter which on repeated crystallisation from alcohol (charcoal) yields a quantity of colourless needle shaped crystals. This is being repeatedly worked to collect more material for chemical studies.

22. *Nitrogen and mineral content in Jute plant.* By A. K. PAIN.

Preliminary investigations were undertaken to get some information about the assimilation of nitrogenous and mineral matters in jute plant during its growth.

Two specimens of Jute (*C. Olitorius* and *C. Capsularis*) were grown in experimental plots and samples collected at regular intervals throughout their growth. At each stage, growth of the plant and the weight of dry matter are noted. Total nitrogen content and chemical examination of the more important mineral matters in the ash of the plant determined.

Some field experiments with the better qualities of rice collected from different places. By A. K. PAIN.

Kala Nunia rice was grown in Falta Agricultural farm from the seeds obtained from the Falta grown paddy of 1939. The plants grow well like the original Jalpaiguri rice and gave a better yield than some of the local varieties. This has attracted the attention of local cultivators, several of whom took this rice for cultivation in their lands. All of them got satisfactory results in yield and a demand was created in the locality for this rice.

Cultivation of two varieties of Gauhati rice and Brimful rice were continued and satisfactory results were obtained in one of the Gauhati rice and Brimful rice.

23. *Manurial experiments with the Jute plant (*Corchorus capsularis*, Linn).* By J. K. CHOWDHURY.

Last year some preliminary experiments were started at Falta to study the effects of different artificial manures on the growth and development of jute fibre. Arrangements are being made this year also to repeat these experiments and to extend them wherever necessary.

23(a). *Barren patches in the Falta Farm, pH value, soil composition and fertility.* By N. C. NAG (ready for publication).

C. *Department of Physics.*
Cosmic Ray.

24. *Photographic plates as detectors of mesotron showers.* By D. M. BOSE and BIBHA CHOUDHURI (Nature Vol. 145, p. 894, 1940).

In this investigation following the procedure of Blau and Wambacher, who exposed Ilford Halftone plates at Hafelekar to Cosmic Rays, similar plates were exposed at Sandakphu (12,000 ft.) and at Darjeeling (7,000 ft.). In agreement with the results obtained by these investigators, single and multiple heavy ionisation tracks were obtained on the exposed plates. From a study of the narrow angular separation observed in the pair tracks, the conclusion was drawn that they were due to secondary mesotrons, created by the action of some hard component of the primary cosmic radiation; this conclusion is contrary to that of Blau and Wambacher, who supposed these tracks to be due to protons.

From the relative number of tracks per unit area found in the plates kept at Sandakphu and at Darjeeling, the conclusion is drawn that they are due to the photon component of the cosmic radiation.

25. *Origin and nature of the heavy ionising particles detected on photographic plates exposed to cosmic radiation.* By D. M. BOSE and BIBHA CHOUDHURI. (Nature Vol. 147, p. 240, 1941).

Further evidence is given on the mesotron origin of the heavy ionisation tracks found in photographic plates exposed to cosmic radiation. This conclusion is based on the observed fact that some of these tracks show an amount of curvature due to multiple scattering in the photographic emulsion, which is very much greater than that shown by similar lengths of proton tracks, in which the mean grain spacing is much smaller. Such observations are not compatible with the assumption that the former tracks are due to protons.

From the observation of the large absorption of the radiation, responsible for the production of such ionising particles, in 20 cm. of water at Sandakphu, with that in 140 gm/cm² of air, the conclusion is drawn that at least a large portion of these ionising particles are due to high energy neutrons present in the cosmic rays. Attempt to detect the presence of doubly charged protons on these plates whose existence in the cosmic radiation has been predicted by Bhabha and by Heitler has led to negative results.

26. *The use of photographic plates as an aid to cosmic ray investigation—*D. M. BOSE, Presidential address before the annual meeting of the Indian Physical Society held in Benares on January 6th, 1941. (To appear shortly in the Indian Journal of Physics).

27. *Mean grain spacing along proton tracks in Ilford Halftone plates as function of the initial proton energy.* By BIBHA CHOUDHURI (ready for publication).

If in a track of length, l , n silver grains are found, then the mean grain spacing in this track is $\frac{n-1}{l}$. According to many investigators, including

Blau who used the photographic plate method, the neutrons emitted from a (Ra Be) tube, contain about ten different groups with energies varying from 2.5 to 9.5 MeV. The mean grain spacings in the recoil proton tracks produced in Ilford Halftone plates exposed to such neutron radiation, as function of the energy of the several neutrons groups, have been determined, and the resulting curve obtained has been found to be a straight line. This relation is of great importance, as with its help the kinetic energies of protons with large m.g.s. can be obtained by extrapolation. An application of this has been made in the following communication in determining the mass of the mesotron.

28. *A photographic method of estimating the mass of the mesotron.* By D. M. BOSE and BIBHA CHOUDHURI (sent for publication).

As reported previously a large number of ionisation tracks on the photographic plates exposed to cosmic rays are found to be curved, due to multiple scattering of the ionising particles in the photographic emulsion. The mean energy of these particles assuming them to carry a single charge can be determined by using the formula deduced by Williams $\theta = \{3.69 + 0.28 \log_{10} (Z^{1/3} P.t / A \beta^2)\} Ze^2 \sqrt{nt}$ where θ is the mean angle of scattering of the

charged particles of energy W , in a medium of thickness t , containing N atoms per c.c. each with a mean nuclear charge Ze . If from another investigation the velocity of these particles can be determined then the mass of the particles can be estimated. Such an investigation is one connecting the mean grain spacing along the tracks of these particles as a function of their initial velocities. For this purpose we make the assumption that the mean grain spacing along the tracks of particles with the same charge and the same initial velocities will be the same and be independent of their respective masses. Assuming that the mesotron and the proton have the same charge, we can from the calibration curve obtained in the previous paper, connecting the initial kinetic energy of a proton with the mean grain spacing along its track, determine the relative kinetic energies and therefore the relative masses of the mesotrons and protons having tracks with the same mean grain spacing. The estimation of mesotron mass from four sets of data come out in terms of the electron mass m to be 173, 149, 158, 153, 167 with a mean value of 160.2 ± 4.7 in fair agreement with the most reliable previous estimations of the mesotron mass, which give $\mu = 150-220 m_0$.

29. *Study of thermal neutrons in the Atmosphere at different altitudes.* By S. D. CHATTERJEE. (Indian Journal of Physics Vol. XIV, 435, 1940).

The intensities of thermal neutrons in the atmosphere have been measured at Calcutta and at Darjeeling (elevation 7,000 ft.) using a boron lined proportional counter. A preliminary measurement of the size frequency distribution of the energies of the disintegration particles of boron by the action of atmospheric neutrons has been carried out at the higher altitude with an ionisation chamber filled with boron trifluoride.

The amplitude of the deflection were visually observed by means of a cathode ray oscillograph. Recently a loop oscillograph has been constructed for a more systematic investigation of the problem.

Artificial Radioactivity.

30. *A note on the reactions and exchange of active iodine in inorganic systems.* By S. D. CHATTERJEE and P. R. RAY. (Jour. Ind. Chem. Soc., XVII, No. 8, 1940).

It has been found that exchange reactions do occur between co-valently and co-ordinately bound iodine atoms within one and the same complex zone. Our results therefore show that there is no essential difference between normal co-valency and co-ordinate co-valency.

31. *Radio-active organic bromo-compounds.* By S. D. CHATTERJEE and D. K. BANERJEE. (Jour. Ind. Chem. Soc., Vol. XVII, No. 12, 1940).

A number of radio-active organic bromo-compounds have been synthesised, radio-active bromine having been introduced into both aliphatic and aromatic molecules. A new method for making radio-active alkyl bromides has been developed.

32. *Nuclear Isomerism of Br^{80} .* By N. K. SAHA.

The genealogical relation between the two isomers of Br^{80} , that is, Br^{80} (4.2 hrs.) $\rightarrow$ Br^{80} (18 min) + soft γ -rays, has been chemically established by Sergi and others. It is the object of the present investigation to prove or otherwise the truth of this relation by purely physical methods of radio-active measurements.

First the β -ray spectra of the two isomers are carefully separated by taking advantage of their widely different rates of decay. The absorbability of Br^{80} (4.2 hrs.) β -rays in Al-foils is first measured, and then allowing for this the absorbability of the 18 min. Br^{80} β -rays alone is obtained by observing the absorbability of the two kinds of β -rays together. Each set of absorption data gives us the upper limit of the β -ray spectra of the two isomers separately. Preliminary calculations show that the two upper limits are identical within the limits of experimental error.

This shows that the two isomers of Br^{80} differ most probably in a metastable state whose energy difference from the ground state is less than the experimental error.

In the second part of this problem, now in contemplation, the excitation ratio of the two isomers as a function of the exciting neutron-energy will be studied. If Sergi's hypothesis be correct, the ratio Br^{80} (4.2 hr.) : Br^{80} (18 min.) should increase with the increase of neutron energy.

A proportional amplifier has been constructed for use in allied problems according to a modified Greinecker-circuit.

33. *Radio-active $_{11}\text{Na}^{22}$ from Fluorine Bombarded by Polonium α particles.*

By N. K. Saha (to appear shortly in Vol. XIV of the Trans. Bose Inst.).

(i) A Polonium source of α -particles has been prepared from some spent radon tubes by the method of purely chemical deposition with chemical purification.

(ii) Radio-active $_{11}\text{Na}^{22}$ has been produced by irradiating a Fluorspar crystal by means of the Po- α particles. The half-life of the activity of Na^{22} has been measured by a point-counter with proper precautions for checking the constancy of its counting property over the long period of measurements. The half-life comes out to be 2.8 ± 0.5 years.

(iii) The maximum energy of the positrons emitted from Na^{22} has been determined by measuring their absorbability in thin foils of Al. The maximum energy comes out to be 0.61 ± 0.03 MeV. A plot of the Sargent curve for Na^{22} shows that this nucleus falls approximately on the third Sargent curve indicating a spin change $\delta i = 2$ in the nuclear transition $_{11}\text{Na}^{22} \rightarrow _{10}\text{Ne}^{22}$.

The importance of this finding in relation to the probability of capture of a K-electron in Na^{22} is discussed.

(iv) A lower limit of Na^{22} is found from the known maximum kinetic energy of the emitted positron. The value obtained is $\text{Na}^{22} = 22.00$.

(v) The absolute positron yield of Na^{22} is calculated and its significance in relation to the branched relations $\text{F}^{19} (\alpha, p) \text{Ne}^{22}$ and $\text{F}^{19} (\alpha, n) \text{Na}^{22}$ is discussed.

34. *On the stability of neighbouring Isobars.* By N. K. SAHA and R. C. MAJUMDAR.

The stability of the nuclei $_{1}\text{H}^3$ and $_{2}\text{He}^3$ has been subject of many interesting discussions in recent years. In this paper the general criterion for the stability of two neighbouring isobars are discussed. It is found that in

the extreme cases when the binding energies are either very large or very small compared to the neutron-proton mass difference the stability may be decided by the usual criterion namely the nucleus having the smaller mass and the greater binding energy is more stable. But when this difference becomes nearly equal, difficulty arises and at present nothing can be said definitely about their relative stability. ${}_1\text{H}^3$ and ${}_2\text{He}^3$ falls in this marginal case.

Quantum Theory.

35. On the interaction of electron with the electromagnetic field. By S. GUPTA and R. C. MAJUMDAR.

In this paper the longitudinal part of the electromagnetic field is quantised and the interaction of the electron with this quantised longitudinal field is investigated. The interaction matrix is deduced, from which it follows that the interaction between the two electrons is coulombian. The self energy of the electron is found to be independent of Planck's constant showing its classical origin. The self energy of the electron with the quantised part of the transverse electromagnetic field is also worked out. This is proportional to Planck's constant and is therefore a typical quantum mechanical effect. The self energies are found to diverge linearly.

36. *The interaction matrices in mesotron theory.* By R. C. MAJUMDAR.

The study of the passage of mesotron through matter has become of great importance in the cosmic ray investigation. The two fundamental processes are involved in this study, namely, the interaction of mesotrons with the electro-magnetic field which is responsible for the emission or absorption of photon by the mesotron and the interaction of mesotrons with the nuclear field giving rise to emission or absorption of mesotrons by neutron-proton. It is now known that the cross-sections involving the different processes such as "Bremstrahlung", scattering etc. come out to be proportional to the square of energy of the incident mesotrons. To reconcile this scattering of mesotrons with the observations on cosmic rays it has been found necessary to assume that the nuclear particle, neutron and proton is capable of existing in different states e , $-e$, $2e$, $-2e$ etc. But no attempt has been made as yet towards the improvement of the interaction of mesotron with electromagnetic field where also one meets with the similar difficulties. To elucidate this we shall calculate in this paper in a general way the interaction matrices of the different processes involving the interaction of mesotron with electromagnetic as well as nuclear field. The application of these results to cosmic ray problems shall be made in a subsequent paper.

Astrophysics.

37. *On the theory of stellar structure.* By BIBHA MAJUMDAR.

The recent theory of Bethe on the production of energy in stars has got a very significant consequence in the future development of stellar physics. In the present paper the theorem of Vogt and Russell is reformulated in the light of Bethe's investigation and the general formulæ for the physical characteristic properties of stars such as effective temperature, luminosity, radius etc. are obtained by the method of homologous transformations. The bearing of the present investigation on the theory of stellar evolution is also discussed in this connection.

38. *On the polytropic index and convection in stellar interior.* By BIBHA MAJUMDAR.

The dependence of the rate of generation of energy on the temperature as given by Bethe's formula shows the possibility of a convection current to be set up in stellar interior. The present investigation deals with the derivation of a general formula for the Polytropic index (n), assuming a general law for the dependence of the opacity co-efficient and the rate of energy generation on the temperature and density. The results of the investigation is shown in a graph where the physical conditions under which the radiative equilibrium goes over to that of an adiabatic equilibrium is clearly shown.

Ultra sonics.

39. The paper on the dispersion of supersonic waves in water has been completed and sent for publication in Vol. XIV of the Trans. Bose Institute. By A. K. DUTTA and B. B. GHOSH.
40. The velocities of supersonic waves in strong electrolytes has been measured by A. K. DUTTA and B. B. GHOSH, and their compressibilities have been calculated. The measured compressibilities indicate very different types of structures in the case of different electrolytes.
41. With a view to obtain a correct picture of different electrolytic solutions, a comprehensive programme of investigation has been undertaken by A. K. DUTTA to correlate the data on the viscosities, the densities, the heats of solution, the X-ray diffraction, the Raman and Infrared spectra and the compressibilities of electrolyte measured in this laboratory. Good progress has already been made in obtaining valuable informations from the viscosity, the density, the X-rays and the compressibility data. It is expected that some interesting conclusions will be obtained. The dispersion of supersonic waves in aqueous solution of MgSO_4 has been measured by B. B. Ghosh and some interesting results have been obtained.

On account of the high-frequency quartz plate being damaged last December, the investigation could not be extended to other electrolytic solutions. Attempts are being however made to get a similar plate cut in the Institute Workshop.

In February last, the Board of Scientific and Industrial Research of the Government of India, have sanctioned a grant to the Bose Institute to carry out a scheme of research on the construction of a powerful ultrasonic generator. Mr. B. B. Ghose has been appointed a whole-time worker under this scheme. It is proposed to build up an oscillating circuit of frequency range 3 to 9×10^5 cycles per second and of energy output between 2-3 kilowatts. In view of the present war conditions, most of the component parts are being made in the workshop including demountable metal oscillator valves, condensers both fixed with mica insulation and variable ones with oil insulation, inductances and both high frequency and filter chokes. Arrangements are being made for the preparation of suitable quartz oscillator plates.

42. *Propagation of ultra sonic waves in liquid mixtures.* By RAM PARSHAD.

Work was begun in the investigation of the propagation of ultrasonic waves in liquid mixtures. Velocities of the waves were found at different percentage composition and the compressibilities calculated.

Some new and interesting results were obtained. Some maxima and minima of velocities and compressibilities were found. For the first time it is believed that the theory of molecular field as developed by Debye, Keesom, London and others were applied in order to interpret the results. The method developed will be a useful tool in the understanding the nature of the liquid state.

Part I. Mixture of Alcohol and Water.

(paper sent for publication to the Ind. Jour. of Physics).

The mixtures of methyl, ethyl and propyl alcohols in water showed maxima of velocities and minima of compressibilities. A theory is given showing how the molecular field depends on the nature of the molecules, their associations, and how these molecular fields affect the compressibility. It is shown that when alcohols and water are mixed, the associations of both the components are destroyed and random orientation ensues.

An energy equation first given by Butler for hydration of alcohols, has been used and quantitative determination made of the percentages at which minima of compressibilities occur.

The case of propyl alcohol shows that new factors pertaining to aggregation of molecules are introduced as the chain length of the alcohol molecule becomes appreciable.

Part II. Ether-Benzene and Alcohol-Benzene.

(ready for publication).

The experimental results found in the above mixtures and those found by some other investigators in similar mixtures (benzene-carbon tetrachloride, butyl alcohol-heptane) are given a qualitative interpretation.

Part III. Ether and Acetone in Chloroform.

The results obtained are of great interest. Ether and acetone have been found to form abnormal solutions in chloroform; as found in other lines of investigation, these are found to behave similarly in all the properties so far listed. In our own experiments however they behave just in the opposite way. The question whether ether and acetone form hydrogen bonds or dipole associations with chloroform has not been definitely decided so far. The results obtained by us seem to indicate that the formation of both dipole associations and hydrogen-bonds are possible but in acetone chloroform the latter is preponderating, while in ether chloroform it is the former. Thus compressibility determination appear to give us a tool capable of distinguishing between hydrogen bonds and dipole associations.

Further investigations have been carried on with solutions chloroform in alcohol, benzene, and carbon tetrachloride, and of benzene in alcohol and chloroform. These will be reported later.

D. *Department of Anthropology*—Report of work done by S. S. Sarkar.

Papers.

During the year under review the following papers were published:—

1. Blood Groups of the Angami Nagas, *Nature*, 145, 1940.
2. A Nicobarese betel-nut crusher, *Man*, 42, 1940.
3. On the Osteology of the Maler, *Trans. Bose Res. Inst.* XIV, (will be soon published).

The following papers are in the course of publication:—

1. Analysis of Indian blood group data with special reference to the Oraons.
2. Aims and Objects of Eugenic Researches in Bengal.
3. Co-ordination of the Anthropological and Archaeological studies in India.

Papers 2 and 3 have been very kindly permitted by the Director to be published in the Bulletin of the Indian Eugenics Society and the "Festschrift" to Rai Bahadur Sarat Chandra Roy, respectively.

Researches.

43. In January and February, 1941, a demographic survey of the Males of the Rajmahal Hills in the village of Bathbhangra was carried out in collaboration with the last Census operations. The family size, fecundity of women, sex-ratio, etc. have been investigated. The paper will be ready in about 2 months time.
44. Twin investigations are progressing satisfactorily. Six pairs of twins were brought in the laboratory for detailed investigations. The Calcutta Medical School offered opportunities of examining 3 pairs of twins. The Deaf and Dumb School and the Pediatrics Clinic of the All India Institute of Hygiene and Public Health supplied 1 pair of twin each, who were brought in this laboratory for thorough investigations. Since December, 1940, questionnaires have been circulated to twin addresses in different parts of India, some of which are yielding valuable data. In all, data have been obtained for 37 pairs of twins and one triplet.

Lectures.

In the year under review a course of lectures, both theoretical and practical, on twin studies with special reference to human heredity was given by Mr. S. Sarkar to the D. P. H. students of the All India Institute of Hygiene and Public Health. The practicals were done in the Institute Laboratory whereas the theoreticals were taken in the Hygiene Institute. They were given on the following dates:

July, 10th and 11th, 1940;
December, 5th, 16th and 19th, 1940.

E. Department of Zoology.

The following investigations have been carried out by Mr. G. C. Bhattacharya.

45. *The migratory habits of the Hibicus caterpillars* (published in the Journ. Bom. Nat. Hist. Soc., Vol. XLII, No. 1, Dec. 1940).

The instinct of migratory movement, heedless of the goal, evinced by the larvæ of the moth, *Crocallis sp.*, which occupies a very backward position in the process of biological evolution is very striking and thought provoking.

The moth, *Crocallis sp.* lays her eggs on *Hibiscus Rosasinensis* and some other plants. Hatching out of the eggs the caterpillars scrape off all the chlorophyll bodies of leaves; scarcity of food compels them to migrate to a new place for food and shelter. If any circular path intercepts their progress they continue their march incessantly round and round until death overtakes them.

46. A paper dealing with the peculiar habits of *Heteropoda venatoria* such as preying, cocooning, fighting and aeronautic habits of their young ones has been prepared for the press.

A short note entitled "Heteropoda venatoria preying on a pipistrelle bat" has been published in the "Current Science" Vol. 10 No. 8. 1941.

47. Investigations are still being continued for determination of the causes of polymorphism in ants, *Ecophylla smaragdina*, Faba, and the appearance of males and females in their colony in a particular season of the year, i.e., March to May. So far it has been observed that the workers come out of workers partheno-genetically and the ovarioles of some of the workers are found to be laden with eggs throughout the year. It has also been noticed that the males appear from partheno-genetic eggs laid by the females. The question of the appearance of females during the summer months only has not yet been definitely solved. One thing, however, has been observed that the egg may remain dormant for 5 to 6 months in winter, though in summer they are hatched within a fortnight or so. It seems plausible then that the females are reproduced from the fertilized eggs of the queen of the previous year. But we have to wait till further corroborative results are obtained.

48. Since the drowning experiments of the previous year with the *Kai* and *Singi* fishes were performed it appeared probable that there must be some similarity in function of the breathing contrivance between these fishes and the aquatic insects, such as water scorpion (*Nepa cinerca*), water-bug (*Ranatra elongata*), water boatman (*Notonecta maculata*) and the larvæ of *Æschma cyanea*, a kind of big dragon-fly. It has been observed that the fish *kai* (*anabas sp.*) can live out of water for a long time, even for months together if their bodies are kept properly moistened. The aquatic larva of *Æschma cyanea* can also be kept alive till the completion of its larval stage in a similar condition. Only the metamorphosis is hastened in the case of advanced maturity. In order to make a comparative study of the air-breathing apparatus and their

functions under different conditions of the kai fish and dragon-fly larva, experiments and observations are being undertaken. The functions and structural peculiarity of steridulating and water-pumping organs of the aquatic larva of dragon fly are also being studied.

49. About 31 different species of true ant-mimicking spiders have been collected from different parts of Bengal. After systematic studies some of them have been identified to be of new species (Journ. Bom. Nat. Hist. Soc., Vol. XXXVII, No. 4, 1935; Sci. & Cult. Vol. 1. No. 3. 1935). The rest of them are to be examined. From a long experience of the peculiarities of these ant-mimicking spiders it appeared worth while to investigate how this structural adaptation was possible for a spider which is not in any way related to the ant. We can suppose it to have been developed through the operation of natural selection but for different reasons it is not comprehensible why it should be so and no other plausible explanation has been adduced. In mimicry, however, there is a suggestion that the morphological changes in the mimic is brought about by some influence in which the mimicked has a role to play. Spiders are preyed upon by solitary wasps. To protect themselves from this danger the spiders mimic some ants which are carefully avoided by the wasps. This is a sort of protective mimicry which helps the mimic to escape the attention of the enemy. In the same way a beneficial mimicry might also be possible. 'Beneficial' in the sense that one species of insect might imitate quite a different one in order to have an easy condition of life. In view of this suggestion some experiments were undertaken with the spiders *Marpissa melanognathus* the young ones of which habitually exist by piracy on ants. This peculiar habit of the spider was observed by the author in 1934 (Journ. Bom. Nat. Hist. Soc., Vol. XXXIX, No. 1, 1936). A contrivance was made such that these spiders had to collect their food from the ants, with a view to find out whether any tendency towards structural variation or colour pattern appears in future generation under such conditions. The morphological changes were noted through two generations which is a very short period to come to any definite conclusion in this respect. Further experiments are being continued.

Kai, singhi and a kind of viviparous fish known as Goupi are still being reared in experimental tank in order to have an idea of how the eggs are inseminated or mating takes place in natural course.

F. *Report of work carried out by Dr. B. K. Bagchi, Sir J. C. Bose Research Fellow in Bio-physics of the Calcutta University.*

50. The brain potential work was continued in the Institute during the last year. Additional evidence was reported in connection with the amplitude adaptation of the brain potential in the face of repeated stimuli like calling the subject's name, thus indicating the regaining of the dynamic electrical equilibrium of the cortex. A quantitative index of the baseline shift of the brain potential in the form of microvolt seconds has been set forth. Fear, apprehension, presleep stages and psychical abnormalities have been founded to be associated with 10% to 30% base line shift index as against 0 to 10 p.c. under normal conditions. The auditory region of deaf and dumb children's brain has been observed to produce a more or less distinct type of beta rhythm (20 to 30 per second) not prevalent in their other region, nor in the region of the normal persons. Cerebral trauma has been traced, and expressed or incipient cortical abnormality pointed out through the brain potential technique.

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APPENDIX II.

List of periodicals subscribed.

1. American Journal of Botany.
2. American Journal of Physical Anthropology.
3. Annals of Botany.
4. Annals of Eugenics.
5. Biochemical Journal.
6. Biological Abstracts.
7. Botanical Gazette.
8. Botanical Review.
9. Chemical Abstracts.
10. Current Science.
11. Cytologia.
12. Genetics.
13. Hereditas.
14. Indian Farming.
15. Indian Journal of Medical Research.
16. Journal of Applied Physics.
17. Journal of Biological Chemistry.
18. Journal of Chemical Physics.
19. Journal of Heredity.
20. Journal of Neurophysiology.
21. Man.
22. Nature.
23. Naturwissenschaften.
24. New Phytologist.
25. Physical Review.
26. Plant Physiology.
27. Review of Scientific Instruments.
28. Reviews of Modern Physics.
29. Science Abstracts (A).
30. Science and Culture.
31. Zeitschrift fur Rassenkunde.

List of periodicals received on exchange.

1. Acta Physicochimica U.R.S.S.
2. Annual Report of Smithsonian Institution.

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3. Comtes Rendus (Doklady) de l'Academic des Sciences dell'URSS.
4. Indian Journal of Agricultural Science.
5. Indian Journal of Veterinary Science and Animal Husbandry.
6. Journal of Agricultural Research.
7. Journal of Franklin Institute.
8. Journal of General Physiology.
9. Journal of Indian Botanical Society.
10. Journal of Indian Chemical Society.
11. Philosophical Transactions of Royal Society of London (A).
12. Philosophical Transactions of Royal Society of London (B).
13. Proceedings of Royal Society (A).
14. Proceedings of Royal Society (B).
15. Science Reports of Tohoku Imperial University (4th Series).
16. Welsh Journal of Agricultural.

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APPENDIX III.

PHYSICS SEMINAR

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|---|----|----|-----------------------|
| 1. A nuclear chart (1 lecture) | .. | .. | Dr. S. C. Sircar. |
| 2. Properties of free electrons in graphite. | | | |
| (2 lectures) | .. | .. | Prof. K. S. Krishnan. |
| 3. Nuclear fission (1 lecture) | .. | .. | Prof. M. N. Saha. |
| 4. Electron diffraction (2 lectures) | | .. | Dr. I. Usmani. |
| 5. Specific ionisation of cosmic rays | | | |
| (3 lectures) | .. | .. | Dr. R. L. Sen Gupta. |
| 6. Cosmic rays. (3 lectures) | .. | .. | Dr. H. J. Bhabha. |
| 7. Nuclear spin (2 lectures) | .. | .. | Prof. M. N. Saha. |
| 8. Mesotron production by non-ionising parti- | | | |
| cles (1 lecture) | .. | .. | Dr. R. L. Sen Gupta. |
| 9. Diamagnetism of organic crystals | | | |
| (2 lectures) | .. | .. | Prof. K. S. Krishnan. |
| 10. X-ray emission bands of solids | | | |
| (2 lectures) | .. | .. | Prof. B. B. Ray |
| 11. Extra spots in Laue photographs | | | |
| (1 lecture) | .. | .. | Dr. S. C. Sircar. |

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MODERN INDIA PRESS, 7, Wellington Sq., Calcutta.