

To Harold Himsworth, August 24, 1956

I am writing to tell you of exciting developments in the work of our unit.

The first news is the discovery by Dr. Vernon Ingram of a definite chemical difference between the globins of sickle cell anaemia and normal haemoglobin. Ingram has devised a new and rapid method of characterising proteins in considerable detail. This consists in first digesting the protein with trypsin and then spreading out the peptides of the digest on a two-dimensional chromatogram, using electrophoresis in one direction and chromatography in the other. By applying this method to the two haemoglobins Ingram finds that all the 30 odd peptides in the digest are alike except for a single one. This peptide is uncharged in normal haemoglobin and carries a positive charge in haemoglobin S. The size of the peptide is probably of the order of 10 amino-acid residues. Ingram is now going to set about to determine the composition and sequence of the residues in the two peptides.



*Vernon Ingram in the
early 1950s*

This discovery is particularly interesting, because the change in structure from normal to sickle cell haemoglobin is thought to be due to the action of one single gene, and the action of genes is thought to consist in determining the sequence of residues in a polypeptide chain. We have long wanted to know how large a section of chain is affected by one gene and Ingram's work will enable him to find out. Moreover the many other abnormal haemoglobins offer interesting field for further study.^{32,33}

Crick is particularly interested in this work. He and Brenner, who is shortly going to join the Unit under an appointment from the Council, plan a wider programme of work both on the reproduction of genes and on their mode of action, which means in effect the biosynthesis of nucleic acid and protein.

³²See the letter of 18 June 1968.

³³Sickle cell anaemia is an inherited disease found mainly in people of African origin because it increases resistance to malaria. Its cause is a single mutation in one of the two haemoglobin chains. Vernon Ingram identified the single amino acid substitution when compared to the same peptide in normal haemoglobin. This was the first demonstration of a structural change in a protein correlated with a single mutation in a gene: this substitution greatly reduces the solubility of the haemoglobin and, as a result, deforms the red blood cells, thereby causing them to break with consequent severe anaemia in the patient. In the 1950s, African children inheriting the defective gene from both parents rarely lived for more than a few years, but with good medical care, close to 50% will now survive well into adulthood. Nevertheless, the disease is both debilitating and disfiguring.—AW

The abnormal haemoglobins offer one way of studying the action of genes. Another is the study of the tail protein of bacteriophage. This has the advantage that phage has only one chromosome consisting of a single chain of DNA, so that changes in the amino-acid composition of the tail protein caused by a certain mutation could be related to changes in the sequence of bases in the DNA chain. In this way a correlation between sequence of bases and DNA and the sequence of residues in a polypeptide chain might gradually be established.

There is also a proposal to study haemoglobin synthesis by rabbit reticulocytes. Evidence is accumulating that the "organs" which carry out protein synthesis in cells are the microsomes.³⁴ These are particles comparable in size to small viruses, which look spherical in electron micrographs and consist of 50% RNA [ribonuclease] and 50% protein. Crick suspects that they may have a regular structure like the viruses, and wants to try and verify this idea by X-ray analysis of microsome crystals. Together with Brenner he therefore wants to try and crystallise them and of course study the mechanism by which they synthesise protein.

I think that this programme looks exciting, all the more so as recent experiments carried out in America suggest not only that the Watson-Crick structure of DNA is correct, but that the mechanism of duplication which they proposed may also turn out to be right. This programme does however need additional equipment.

Returning to scientific news Kendrew and I, in collaboration with Dr. David Ingram, a physicist at Southampton University, have used electron spin resonance, a spectroscopic method of employing radar waves, to determine the orientation of the haem groups in myoglobin and haemoglobin. This still does not give us their positions which would be much more interesting, but it is at least one definite piece of structural information.

To Felix Haurowitz, September 20, 1956

We have two successes to report. 1. David Ingram and I found the orientation of the haem groups in haemoglobin by paramagnetic resonance. This is a most powerful new spectroscopic device by which one can determine the angular orientation of each of the 4 haem groups separately with an

³⁴Reticulocytes are premature red blood cells which were used for experiments on protein synthesis in the test tube. The "microsomes" described here were pellets centrifuged from cell homogenates at very high speed: They contained mainly ribosomes, later identified as the biological sites of protein synthesis.—AW

accuracy of $\pm 2^\circ$. 2. Vernon Ingram in my lab has discovered a definite chemical difference between the globins of normal and sickle cell haemoglobin. It is located in one small section of one of the polypeptide chains.

We are getting rather short of hands which is sad in view of the interesting stage of the work. We have had a great batch of American post-graduate students, but they are now leaving and at the moment we have no one to replace them with.

To Felix Haurowitz, April 19, 1957

Most exciting news: Ingram has found the nature of the chemical difference between sickle cell and normal haemoglobin. A glutamic acid residue in normal Hb is replaced by valine in sickle cell Hb. It is fascinating that the effect of a single mutation in one gene appears to be a change in just one amino-acid residue in a protein, and that this change should have such far-reaching effects on the physiological properties of the protein.

***To Vivien and Robin Perutz. Approaching
New York, April 21, 1957***

I saw the comet.³⁵ It had a striking very long tail, pointing away from the rising sun and could be seen for a long time, because we were flying away from the sun so fast. I was the only man on board who spotted it; the navigator was unable to find it, and yet it was as brilliant as Venus. The comet appeared on the star-board side, and when I looked out on the port side the moon was up and I could also see what at first looked like a strongly lit cloud of greenish colour. When I watched it for a while I noticed that some of the cloud suddenly seemed to vanish and other patches appeared as from nowhere. Then I realised that I was watching the Aurora Borealis which lights up the sky like strange curtains of cloud in the neighbourhood of the magnetic poles.

Now this was just where the aircraft was flying to. It went in a great circle from England north to the Southern tip of Greenland and then touched Labrador at Goose Bay and flew south across Canada, past the St Lawrence River and so to the United States.

One of the prettiest sights appeared right at the start when the plane rose over London and we could see the lights in Parliament and Trafalgar Square and all the lovely lighted bridges across the Thames.

³⁵This seems to be the comet Arend-Roland C/1956 R1, which was visible until July of 1957.

John Kendrew

***To Dr. G.R. Pomerat of the Rockefeller Foundation,
September 16, 1957***

Kendrew completed the first three-dimensional Fourier of myoglobin a few weeks ago and we are all very thrilled with it. It shows the position of the iron atom with the haem group together with several long stretches of rods of high electron density which clearly represent polypeptide chains. Their configuration cannot be seen directly but judging by the distances between these rods one would guess them to be α -helices. The structure of the molecule as a whole is most complex and intricate, and quite different from anything anyone had ever imagined, the haem group being attached to a kind of basket work of polypeptide chain with many different kinds of contact between protein and prosthetic group. The resolution (6 Å) is still too low to make out details but at least the shape of the molecule, general layout of the polypeptide chains and the position of the haem group are clear.

I am immensely encouraged by Kendrew's success and am redoubling my efforts to try and get a three-dimensional Fourier of haemoglobin at a comparable resolution. Kendrew meanwhile is already going ahead with plans for a second three-dimensional Fourier at twice the resolution of the present one and so far as we can see there are no fundamental obstacles in the way of this being achieved.

I am very pleased that the long-continued support of the Foundation for this research is now beginning to bear genuine fruit.

***To Steffen Peiser, undated*³⁶**

In my opinion nothing matters so much to a scientist as the interest and stimulus of his work, and I hope that you will consider your difficult choice first and foremost from that point of view, without letting yourself be swayed too much by considerations of position, finance and personal loyalties.

To Steffen Peiser, Easter Sunday, 1958

We received the news of your intention “mit einem lachenden und einem weinenden Auge” [with one smiling and one weeping eye]. We had no one else in this country to whom we felt as closely linked by family ties and bonds of affection.

To be set against all these losses are the gains in your professional life. I have often felt that your talents were not used to the full. You have an enthusiasm and energy which inspires people around you. Your meteoric rise at the NBS is a magnificent achievement and shows that your gifts are appreciated in America much more than they were here.

You were quite wrong when you wrote that we might jeer at you, as though you had become a disaster. Science is as international today as scholarship was in the Middle Ages, and a scientist must go where people will allow him to blossom out and do great things. It is true that this country had given you asylum, and that you felt you had to give your best to it in return, but I think you have repaid your debt in about 17 years of good work and should feel free from all guilt when you decided to change to a post with wider opportunities in the States.

My own position is quite different. After the repeated and spectacular successes achieved in my Research Unit, the Medical Research Council is prepared to do anything we ask for, and research workers are coming to us from many countries. It looks as though we are only at the beginning of the discovery of the molecular basis of living processes, and fascinating prospects of scientific revelation stretch out in all directions.

On April 18th I am to address the MRC on the scheme of building a Laboratory of Molecular Biology, and I think the prospects for its acceptance are good. On the other hand, the University may well put insuperable difficulties in our way, even if the MRC is prepared to build and maintain such a laboratory.

³⁶Steffen was taking a year's sabbatical in Washington at the National Bureau of Standards and had written that he was debating whether to accept a permanent post at the Bureau.

Despite these bright prospects the first 3 months of 1958 have been most worrying and difficult for us. My father's illness looked hopeless at times and I never thought that we should be able to get him on his feet again.³⁷ Then there is your mother's hostility against Gisela which always haunts her dreams both by day and night.

Finally my own work on haemoglobin (3D Fourier) went through a crisis, now happily overcome, when it looked as though we had got to a dead end. There are still great difficulties ahead, but none as intractable as that which foxed us for the best part of 4 years, until a chance observation led me to discover its cause.³⁸

To Linus Pauling, April 21, 1958

There are moves afoot to put both Crick and Kendrew up for election to the Royal Society. The arrangement is that Bragg will propose Kendrew and I shall second him, while Crick will be proposed by me and seconded by [Alexander] Todd. We wondered if you would be willing to sign either or both of these certificates?³⁹

To Nelly Peiser, May 25, 1958⁴⁰

In the lab I also had to struggle with tremendous scientific problems, which I've solved at least in part. They only concerned my own work. My labora-

³⁷He died later that year.

³⁸In *Science Is Not a Quiet Life*, Max explained that his aim was to put into practice Bijvoet's method of phase determination by double isomorphous replacement. "Bijvoet's method required a second heavy atom derivative with different heavy atom positions, but I had no idea how one could be made. I obtained a variety of mercurials from colleagues in the United States and Germany, but none of them solved my problem. Even worse, I was unable to reproduce the original crystals of the parmercuribenzoate derivative without introducing a lattice defect which ruined their isomorphism with the native crystals and made phase determination impossible. For several years I tried in vain to find the cause of this lattice defect, until one day I happened to take an X-ray diffraction picture of a crystal and was surprised that it was perfect. When I examined the tube from which I had taken it, I noticed that its stopper was leaky. It now occurred to me that evaporation from the tube might have lowered the pH and I soon confirmed this. I guessed that this must have cured the lattice defect." Later that year, Max solved the problem of finding a second heavy atom derivative: see the letter to John Edsall of 26 November 1983. Perutz M.F. 1997. *Science Is Not a Quiet Life*. World Scientific and Imperial College Press, London, p. 67.

³⁹Pauling replied "I may say that I would be delighted to sign a certificate of nomination of Kendrew and of Crick to the Royal Society. I would put them in this order—that is, Kendrew first."

⁴⁰Translated from the German.

tory as a whole is a tremendous success and our reputation with the Medical Research Council constantly rising. From the human point of view the lab also works brilliantly as we've succeeded in keeping a number of extremely gifted scientists all of the same age who work together harmoniously without jealousy or feuds. That is only possible in England where there's the most remarkable trust in the personal decency of others.

To Harold Himsworth, October 24, 1958

As regards the site, our first aim is to have a laboratory in which we can solve some of the key problems of molecular biology by the methods we have developed. Moreover, we want this laboratory to serve as a focus and model for the development of the subject in this country and overseas. If this aim cannot be realised in Cambridge we should certainly be willing to move elsewhere, and I have no hesitation in assuring you that we are all anxious for an enlarged Laboratory of Molecular Biology to be set up under the Council, even if this has to be done independently of the University.

I do not think that at this stage any of us are vitally concerned over the matter of Ph.D. students, because we have no difficulty in staffing our laboratory with post-doctoral graduates. Moreover, the number of first class B.A.s wanting to take up research in a borderline subject for their Ph.D. thesis is small. Therefore rather than abandon our proposal for a laboratory, we would abandon our right to have Ph.D. students.

However, we still retain our hope that it will in fact be possible to retain the cooperation of the University and that the University will do its best to let us have a laboratory on a central site, associated with one or more of the existing departments, and that it would be acceptable to the University as a place where Ph.D. students might be trained.

It would help me greatly if our document "The Case for a Laboratory of Molecular Biology" could be "declassified," leaving me free to send it to interested members of the University.

To Steffen Peiser, Easter Monday, 1959

You probably gathered from Gisela that the General Board of the Faculties has approved the plan to set up a Laboratory of Molecular Biology jointly with the MRC and that the University is offering us a central site for the building. If it is all right, there are only minor disagreements between the

University and the MRC to be settled. If we are lucky a Grace for the establishment of the laboratory might be passed this term.

Gisela will also have told you of the £100,000 which were left to the MRC by the widow of an Indian cotton magnate who died last year at Monte Carlo. The money was left mostly in the form of jewellery which has to be sold at Sotheby's. According to the will it is to be spent by the MRC for the support of research in the University of Cambridge. Is it not an extraordinary piece of luck that this money should have appeared at this vital moment, given under conditions which are tailor-made to our purpose? I have no notion what made the old lady or her husband, Sir Cudrow [Wadia], do it. Himsworth believes that this will cover $2/3$ of the cost and that it would not be too difficult to raise the remainder from the Treasury or elsewhere. We intend to put up a building of about 18,000 square feet with room for expansion if possible.

To Gisela Perutz, May 1 [?], 1959

Yesterday morning seems an age ago. I found the vacuum of our X-ray tubes had begun to leak and by this morning both had to be shut down. With Tony [Broad] in hospital this is a calamity. We are sad about this as our next 3D series of pictures is nearly finished and we might have got to the end in another 2-3 days. We shall consult Tony in hospital tomorrow.

This morning I found the enclosed letter from Fort [?] and decided to see Himsworth this afternoon. After nearly 2 hours with him I believe I have convinced him of the need for a speedy agreement with the University, regardless of the complications. But there is still a fearful struggle ahead, with the University Financial Board (a new difficulty), the Hospital Board and finally the Ministry of Health who own the land. [By this time the site in question must have been that adjacent to the relocated hospital on the southern edge of the city.] I told Himsworth again and again not to give up and emphasised my belief that with one more great heave the battle can be won. I am sure it can. This is chicken feed compared to the 3D Fourier of Hb.

At the RI [Royal Institution] I found the X-ray spectrometer which had broken down several weeks ago still not repaired. Here again a great push is needed to get the measurements completed.

Don't think I am depressed. These setbacks are unavoidable and part of life. In a week's time most of them may be overcome and you may find me wondering how to cross the next hurdle.

I can hardly believe what life will be like when haemoglobin is solved and the Laboratory has been built. Will I be able to resist complacency? Let us hope that we shall continue to live happily through all these difficulties. They matter little as long as there is love and affection at home.

To Gisela Perutz, May 3, 1959

As you see from the children's letters, we are all well. I enjoyed Robin's enthusiasm when I worked with him in the garden yesterday and found it a tonic after the tension of the previous day.

Yesterday morning I mobilised Mott, Todd and Noel Annan against the Financial Board and hope that they will all bear down on it next week.⁴¹ I have told Himsworth that the scheme will collapse unless we can push it through by 10 June which is the last General Board meeting, and I hope that this will induce him to deal with matters more expeditiously. If only I could move these various officials out of their offices where they write nasty letters to each other and get them to discuss matters in person, everything could be settled in one afternoon. A summit meeting is what we want.

To Harold Himsworth, May 3, 1959

[Mott and Todd] were also most indignant about the scandalous business of Taylor offering the Council a site which the University does not have, and I do not think that the last word has been said about this.

When you asked me on Friday whether Crick would agree to a laboratory on the outskirts of Cambridge, I ought to have remembered that he was actually asked that question at the hearing of the General Board Committee last November and replied that he would prefer to accept a post abroad. Moreover Kendrew is dead against the entire scheme unless the Laboratory can be part of the University. There is little doubt therefore that the whole scheme will fall through unless it is pushed through in the form now contemplated.

I am confident that it can be done, especially if we enlist Mott and Todd's very willing help to iron out difficulties rather than try and do it through the cumbersome official channels. [On 13 May, senior members of the proposed laboratory agreed to a hospital site with the proviso that the agreement on the general relationship with the University should remain intact.]

⁴¹The Board was making administrative difficulties which would have entailed a delay of years. Among its few members, as a representative of the colleges, was the bursar of King's College; hence the appeal to Noel Annan, its Provost. Todd was the head of the Chemistry Laboratory.

***To Dr. G.R. Pomerat of the Rockefeller Foundation,
October 1, 1959***

Kendrew, Dickerson and Strandberg have completed a three-dimensional Fourier of myoglobin at 2 Å resolution, three times better than the resolution of Kendrew's first attempt. M.G. Rossmann, Ann Cullis, Hilary Muirhead and I have a three-dimensional Fourier of haemoglobin at 6 Å resolution. The four units fit together in a most beautiful way, so that the surface contours of one part of the chains match those of the other. The model is a remarkable thing, and I shall send you some photographs when I have them ready.

What is most exciting, perhaps, about our results are their wider implications. If the myoglobin of a whale is like the haemoglobin of a horse, then the structure of these two proteins is probably much the same throughout the animal kingdom. There must be certain standard sequences of amino acids which all these proteins have in common and which determine the characteristic loops and turns of the chain. These must have developed from a common primeval gene which provided the physiological basis for the development of the higher animals, by making possible the storage and transport of oxygen.

Looked at from the point of view of protein chemistry it makes one suspect that proteins are probably grouped into broad classes, and that within each class the main structural features are similar. In other words, one will probably discover a natural history of enzymes which will give one an insight into the biochemical development of the species.

All this is for the future.

These advances owe much to the far-sighted support by the Foundation, especially during the long, lean years when the problem seemed complex almost beyond hope. Please assure the Trustees of our gratitude for their long-continued support and accept my thanks for your own kind interest.

To Dely Perutz, October 2, 1959⁴²

I am working on the construction of the haemoglobin models suitable for publication. It is really difficult to present this huge molecule effectively but I am enjoying it.

⁴²Translated from the German.

To Felix and Gina Haurowitz, December 13, 1959⁴³

I have spent some of the happiest weeks of my life this autumn working out the results of my 3D Fourier of haemoglobin. It gives a clear and most satisfying answer. There are 4 chains and each has a configuration very similar to Kendrew's whale myoglobin. They are arranged at the corners of a tetrahedron. The haems lie in pockets on the surface of the molecule as shown in the picture and are far apart from each other.

To Gisela Perutz. Near Munich, December 27, 1959

I had a stormy but comfortable passage and a good night under my cosy eiderdown. So I feel quite well and refreshed and have started to read my *Scientific Americans*. One of the books you gave me, *The Catcher in the Rye*, is very good and highly original. I much enjoyed it last night. *The Wrong Set* is the usual "people are no good" satire which we deplore in modern art. Writers must spend most of their time in the company of good-for-nothings.

The train is full of parties of schoolgirls going to Kitzbühel. I share the compartment with their dear old teachers to whom you have to say everything twice before they take it in. One never referred to her coat, but always carefully to her fur-coat. She is called Millicent and wears a dark red beret and a pink scarf tied under her chin with the fur coat. I thought V[ivien] would be all agog to hear these fascinating details.

⁴³ Glued to Max's Christmas card was a photo of his model of haemoglobin.

worked there. It expanded later into a great "Advanced Institute of Science" employing some 250 graduates on pure research. It is built and maintained entirely from the contributions of wealthy Jews abroad, mostly British and American. Every single building is designed with taste and imagination and one or two are outstanding feats of modern architecture in a tropical setting.

The only lavish villa we saw belongs to the Chairman of the Executive Council, a Mr. Weissgal. He is a colourful figure retired from New York music hall and theatrical world where he had worked as a writer, actor and producer. He is literally a man of many parts, friend of Reinhardt and Epstein and acquainted with leading Jews throughout the world and has the sole job of collecting money for the Institute. He obviously discharges his task most effectively and is justly proud of it. At his house we met a mixed company of Zionists, but it was not clear who was being milked by whom. There was a German gentile and his family who professed to philistinism and told us that he went around lecturing to German audiences about Nazi times and the achievements of Israel. In his presence it was evidently tactless to blame the Germans for everything which led people to discourse on Austria as the cradle and hotbed of Nazism. This annoyed me as I knew how many stood aloof from Nazism there, except perhaps during the period 1938–40 when it was a national power.

Jerusalem (Israeli Side) We were driven to Jerusalem in a ramshackle old Chevrolet over terrible roads, as I had to give a talk at the Hebrew University. We found the City flag-bedecked and thronged with holiday crowds and soldiers in preparation for tomorrow's independence celebrations. There were also masses of armoured cars and tanks concentrated for the great military parade to be held despite the protests of the Jordanian Government. People from all over the country were being brought into the city by coach, and parties of schoolchildren in their Saturday best were being conducted along the streets to see the army tanks (not, as one well-meaning guide tried to tell us, on natural history excursions). She was very disappointed that we would not attend tomorrow's parade. I told her that we were pacifists, to which she replied that the army's sole task was defence. In fact the Government's attitude strikes the observer as ultra-nationalist and aggressive. They would certainly try to push Israel's frontiers back to the Jordan and the Suez Canal if they got half a chance.

The Hebrew University The original buildings of the Hebrew university are now isolated on an island of Israeli territory on the Jordanian side of

Jerusalem, and are unusable except for the library. The University we saw has been built since 1948 and again entirely from gifts provided by Jews abroad. The administrative block was built by Sherman, the owner of a football pool in S. Wales, and is outsize and absurdly lavish for a university of only 3000 students, while physics is housed in shabby single storey buildings. Most of the university buildings are beautiful pieces of modern architecture.

We were received by a Dr. Frankl, a physicist applying X-ray crystallography to solid state problems, and shown around the department. They have beautiful apparatus all built by their own workshop, which is run by an elderly German mechanic and kept as clean as an operating theatre. Research is financed by grants from the U.S. Air Force on the principle of not looking a gift horse in the mouth. The Israeli Government merely provides staff salaries.

Research problems struck me as sensibly selected within the limited means available, though nothing was exciting.

Tel Aviv and Nathania By way of a *pourboire* [gratuity] each Weizmann lecturer is given a tour of the country; by a generous extension of that customary act of hospitality, all five of us were included in this tour on which we were taken by Judy Bergman in a large new American car hired for the purpose.

Tel Aviv has the looks of a shabby Balkan town with occasional attractive houses. In Nathania, on the other hand, these predominate and there are some inviting-looking hotels. As it was Independence Day the entire population was out on the Esplanade or the beach. I told myself how marvellous it was to see all these people liberated from the oppression of the ghettos in eastern Europe and holding up their heads in their own country. Yet their appalling ugliness oppressed me, and I had only the one wish to get away from them, out into the hills.

Mount Carmel: Arabs in Israel We next drove up to Mt. Carmel above Haifa only just in time to see the sun drop into the Mediterranean and settled down for the night in a picturesque hotel built by a former Arab lawyer in Haifa. It is built in the style of what I guess to be an Arab country house with rooms opening out on to loggias and a drawing room full of beautiful oriental rugs. It was run by the widow of the lawyer and his handsome well-educated daughter. She told me that her father had had the strength of mind to stay behind in Israel when the Arab press and radio advised everyone to leave. He had been arrested several times by the Haganah [Jewish paramilitary organization], but was eventually left in peace and tried to

develop this hotel on Mt. Carmel as a place where people from Haifa could go on hot summer nights. He died tragically as a result of a knife attack by an Arab servant who had gone insane, and now his widow and daughter find themselves isolated as Christian Arabs in a Jewish state. All their friends and relatives have fled and they could follow only by giving up all their possessions, as Israel will not allow any export of capital. The girl wants to go abroad to study political science thinking perhaps that this will teach her how to put the troubles of her people right.

Haifa, Nazareth and the Sea of Galilee We finally emerged from the hot and noisy town into the hills of Galilee. The ground was thick with spring flowers. Soon afterwards we arrived in Nazareth which is still a wholly Arab town. The Christian churches and convents all seem to carry on as before. We found the Church of St. Joseph supposedly built on the site of Mary's and Joseph's house closed, but a French nun whom I asked for the way to another church took us into her convent and showed us some interesting underground dwellings which fitted biblical descriptions of Mary and Joseph's house, and were in any case dwellings of that period.

Night at a Model Kibbutz We finally arrived at the Kibbutz Ayalet Hashahar, north of the Sea of Galilee where we were to spend the night in a charming guest house, built on the lines of an American motel. All the houses, furniture and fittings were done by local people in exquisite style and workmanship. The kibbutz itself was nicely laid out among attractive gardens; people lived in middle class houses with curtains, books and good furniture. However, we learnt that nevertheless it was still run on communist lines. The children slept in houses separate from their parents, and all meals were taken in a communal canteen which incidentally was an architectural masterpiece.

We heard that this particular kibbutz was exceptionally wealthy partly because its members had helped to drain a great swamp in the Jordan valley which had been turned into a fertile farm, partly as a result of German compensation to many individuals. The Israeli economy as a whole was much helped by German reparations, and people were worried how they would manage after 1962 when the reparations are due to cease.

Upper Galilee We first drove to a small remnant of the former swamp which is being kept as a bird sanctuary. Our boatman was a former businessman from Shanghai who had had to leave because of the Communists and had fled to Israel with his Chinese wife. He now works on a kibbutz.

Haifa and Home We drove into Haifa where I had to give another lecture. Meanwhile the family visited the Baha'i shrine and temple and were cheered to find a sect proclaiming that all faiths were one and all peoples one.

In the afternoon we embarked on a German-built liner of the Israel Shipping Line (given to Israel as reparation) and sailed through the night to Cyprus.



Moscow Diary, August 9–17, 1961

Our Comet⁴ left London at 3.30 and took us over the Hague, Amsterdam and the Zuidersee. I always enjoy flying over familiar places even if they look like coloured maps from 33,000 ft.

The International Airfield lies in the midst of a great forest with no sign of any big town around. The airport building is small by our standards, but lavishly decorated with marble, stucco and gilded chandeliers: this was my first meeting with Stalin Baroque. Formalities at the airport were disorganised but easy.

I found the Congress Bureau well organised and friendly. They had expected me and had everything ready for me, including an allowance of 6 roubles a day during my stay (£2.8.0).

My hotel is enormous. My room was small and dirty but was changed for a much nicer and cleaner one next day. Luxury suites have TV and piano and walls hung with oil paintings.

A pleasant young girl called Nina introduced herself to me and told me that she had been assigned to the British guests of the Soviet Academy.

At first people in the street seemed terribly drab to me. Especially women seemed worn out from cares and hard work and everybody shabbily dressed. However, there were no hungry children, no beggars, and in fact everybody looked well fed. Shops of all kinds are well stocked and though some goods are shoddy, especially paper, by no means all things are. Food is about the same price as here, clothes more expensive, optical instruments and cameras, gramophones and especially records much cheaper.

In the evening Boris Vainshtain, a Russian crystallographer who visited us here on two occasions, came to meet me at the hotel and took me out for

⁴de Havilland jet airliner.

a meal. He is a very bright, hard-working, friendly and generous man, and wants to start protein crystallography in Russia.

The University lies 10 miles from the centre of the town and is a magnificent complex of buildings dominated by a skyscraper. The lecture rooms are well lit, air-conditioned but have poor acoustics. The entire building is lavishly decorated with marble, sculptures and chandeliers. It even has decent toilets, usually a sad chapter in university buildings.

A friend told me that there was to be a press conference held by the Soviet Academy in honour of Major [Gherman] Titov, and that there would probably be an invitation for me, as a guest of the Academy. The press conference was held in the grand marble assembly hall of the university which holds over 1000 people. I was lucky to get a seat near the front. The conference was opened by the President of the Academy of Sciences, an applied mathematician who is said to have contributed to the success of the space programme. He looked intelligent, determined, tough, unyielding and humourless, and made an orthodox Communist Party speech not worth listening to, to introduce Titov. Titov himself is a fighter pilot and looks it. [He had returned from orbiting the earth, only the second person to do so, on 7 August.] A daredevil of the absolutely fearless kind, and a romantic who will climb the north face of the Eiger or perform any other great feat calling for exceptional courage, skill and endurance. He introduced his speech by saying that he had been aware during every second of his flight that the eyes of the heroic Soviet people, the glorious Communist Party and of Nikita Sergeyeovich Khrushchev were turned upon him and that he must do his duty by them. This sounded like the start of another party speech, but to my relief it was followed by a spontaneous account of his great adventure. Most fascinating to me was his account of the view from his space ship. How he could see not only continents, but rivers, fields and mountains, and how he could distinguish clouds from snow-capped mountains because the former cast shadows on the ground and the latter did not. And how beautiful it was to be flying through the night side of the earth, with the brilliantly lit stars above him and to look down to see the borderline between night and day lit up in all the colours of the rainbow at the line of sunrise. He told us that he was in complete control of the space-ship, and would turn it in any orientation and determine himself the moment of descent. The condition of weightlessness made him a little giddy at first, but after a night's rest he felt this much less. Otherwise he felt no discomfort and the air in his space capsule was excellent throughout.

Titov's story was followed by a lecture by a physiologist who told us about all the observations made on Titov both during and after the flight. So far there had been no ill-effects. There was a further talk and finally answers to press correspondents' questions. Most amusing were the questions from the *Soviet Children's Newspaper*: whether he used a knife and fork to eat, whether he stayed in his space helmet or took it off and whether he slept sitting up or lying down. The answer to the last question, amid roars of laughter, was that it's all the same when you are weightless. When asked about future passengers he admitted that an excursion into space was still a tough affair and had required months of training.

We visited the palace of former Princes Lisnitzky [?], a noble family of several hundred years' standing. The palace was built by serfs in the 18th century and contained a fabulous display of wealth in regal style, with ballroom, theatre, innumerable salons, inlaid floors and painted ceilings; the style and scale was similar, perhaps to the Palais Schwarzenburg in Vienna. The last room contains some interesting statistics drawn up by the Soviets on the accumulation of wealth by the family. The number of serfs owned by them rose steadily until it reached the number of 97,000 in 1800. The domestic staff alone numbered 1000. Just to show that people can never make ends meet, however rich they are, they exhibited graphs of the family's debts which rose to several million roubles in the 19th century.

A couple of pleasant girls came to take me to the Institute of Crystallography, an old-fashioned laboratory across the river. They do excellent work on X-ray analysis and electron diffraction, but nothing very good yet in the biological field. Russian built equipment looked excellent. They are presently moving to a new institute.

We next went to a new Institute of Biophysics at the other end of the town. This was shoddily built and looked shabby, even though it was brand new. Here I had to give a lecture on methods of protein crystallography in a badly designed colloquium room with a rough wooden blackboard and a noisy lantern. The room was lit by brass chandeliers. No fluorescent lighting anywhere in the building. The audience consisted only in part of crystallographers, and I heard afterwards that my lecture, in which I had been told to concentrate of methods rather than results, was lost on the majority of those present. Vainshtain did a brilliant job of translating it sentence by sentence and was usually able to explain my slides in Russian without my having to say anything in English. The people at this Institute seemed of mediocre calibre and I doubt that they will do anything brilliant.

We next went to visit the workshop in the Institute of Crystallography which lies in an area of research institutes run by the Academy. This shop employs 200 people: about a dozen graduate engineers and a horde of highly skilled men. To my mind this number is quite out of proportion to the work done at the Institute, but even so the workshop, run regardless of expense, seemed a symbol of the importance attached to scientific research in the Soviet Union. It also showed the abundance of skilled manpower.

[Paul] Doty and I went home early [from a dinner]. He recounted how he had reproached the Praesidium of the Academy about the failure of the Nuclear Test Talks. He told them that he had persuaded the American Government to accept all the main conditions on which the Russians had insisted earlier, and expressed his great disappointment that these conciliatory proposals had met with a flat rejection. These reproaches, however, merely met with an embarrassed silence. No explanation was given. He himself believes that the Chinese must have vetoed the nuclear test agreement, but this is just a guess. (Paul Doty is a member of Kennedy's Scientific Advisory Committee.)

After an hour or more queuing at various counters I finally boarded the Russian jet which was to fly us home. The exterior design is marvellous and its two jet engines must have a bigger thrust than their Western counterparts. The interior, however, is fitted out with brass railed luggage nets and gilded table lamps like one of those antiquated dining cars of the *Companie Int. des Wagons Lits* on the Continent of Europe.

Summing Up All my generalisations faded away as the days in Moscow passed. Life there is not as hellish as I thought at first when I saw the dreary barrack-like blocks of apartments lining the streets of Moscow's suburbs, or the drab crowd of people in the streets.

There is much to enjoy life with: woods, swimming, sports of all kinds, books, records, the arts. Material progress is terrific and every man and woman is made to be extremely proud of it.

People are not really conscious of the lack of correct news about the outside world. No foreign, non-Communist paper is obtainable anywhere in Moscow. It is clear that everybody feels himself watched and is guarded in his conversation, but they take this as part of the nature of life.

They are all convinced of the iniquity of the Capitalist system and of the superiority of theirs. They all fervently hope that there will be no war.

Foreigners who had known Russia in the thirties told me that material progress and progress in personal freedom were tremendous, and this is clearly what keeps people's enthusiasm going.

It would take a much longer stay to discover what an individual's life is really like.

For me the trip has been a great adventure, and I am very pleased to have come.

Perhaps I should still add that the Congress itself was extremely well organised in every way. This was quite a feat as it had 6000 members. My only criticism concerned a tendency to leave things to the last minute.

***To Dr. G.R. Pomerat of the Rockefeller Foundation,
July 21, 1961***

I note that the Foundation wishes to cut down their commitments in Europe, but I am glad if you think that they might nevertheless continue their association with us.

Sir Harold Himsworth is against our applying for grants from the National Science Foundation or the U.S. Public Health Service, because he believes that the British, rather than the American tax payer, should support our work. Indeed the Medical Research Council are providing us with all the staff and equipment needed for our work, so that we do not require massive support from outside.

We should like to ask the Foundation for support on a modest scale, just to do some things for which the MRC cannot pay. This is mainly payment of travelling expenses and lecturing fees to visitors from abroad, and payment of travel expenses to young research workers from our own laboratory to attend scientific congresses abroad. Sometimes we also need money to support a promising young man or girl who failed to secure a scholarship.⁵

To Nelly Peiser, April 26, 1962⁶

Many thanks for all your touching presents and your offer in addition to give me a moving-in present for the lab. Your idea of pictures of those on whose shoulders I stand, pleases me greatly. I would love to hang pictures of [Lawrence] Bragg, [Desmond] Bernal, [David] Keilin and Dorothy [Hodgkin] in my office. It is these 4, who from the first recognised the significance of my work and supported me in the period when it looked hope-

⁵Max cites two research students who won scholarships after doing excellent work in their first year.

⁶Translated from the German.

less. Keilin's name is possibly unfamiliar to you. He is now the retired professor of Biology here in Cambridge, in whose lab for many years I did the biochemical part of my work.

I only knew [Max] Von Laue fleetingly and in my active years as a scientist he was occupied with a very different branch of physics. On the other hand I would love to procure a picture of his Ph.D. student and my old friend P.P. Ewald. In fact it was Ewald's thesis that in 1912 gave Von Laue the idea that crystals could bend X-rays.

To Gisela, Vivien and Robin. Harwich July 23, 1962

As I am now v. famous I have asked Anthony Scooper, special correspondent of the *Daily Tripe*, who follows my every step, to report to you on my movements so far.

"Dressed in dapper grey suit (not new) MFP arrived at Cambridge Station with bulky, but unassuming, luggage. Prolonged search produced a long-haired young man who introduced himself as a porter (ex Eton and Trinity perhaps) and volunteered to take his luggage. Pleased by generous tip, perhaps not Eton after all.

"MFP settled in empty carriage immediately, unpacked various coloured files and proceeded to work on manuscript of world shaking discovery relating to *Secret of Life*. Looked over his shoulder to obtain news for my readers; read Hashimoto, M. See Motohashi, H. and Hashimoto, M. 1960. Cannot understand it. Must spin it out for benefit of my readers.

"On arrival at Bury St. Edmunds MFP settled on luggage trolley, still working on *Secret of Life*. Ventured a few words by offering to help with his luggage. Declined charmingly. Delightful personality.

"MFP entered boat train, baby in first compartment had one look at him and screamed. Personality must strike people in different ways. After finishing *Secret of Life* MS, MFP proceeded to dining car and ordered mixed grill with colourless liquid. Left 14 peas, explained they tasted like last year's crop. Sipped colourless, clear liquid. Explained it was neat Vodka, habit he had acquired in Moscow.⁷

"On arrival at Harwich MFP had correct passport and tickets actually ready, not absent-minded professor after all.

"Disappeared into pleasant single cabin. Offered to share same with

⁷Max's allergies meant that he had become teetotal as of course we knew.

Max with the Queen at the opening of the laboratory (© The Times)

charming Scandinavian lady who arrived at boat without reservation, but surprisingly lady declined. Shock for professor.

“Ascended on deck where he was immediately joined by three cronies from Manchester specialising in crystal gazing and bound for same destination.

“Now have to dive for bar before it closes. Look for report ‘On the Spot with MFP’ or ‘The Secret of Life’ in tomorrow’s column by Anthony Scooper.”

After this fascinating account which I trust you will enjoy I send you lots of love and kisses.

To Lawrence Bragg, November 3, 1962

As I said to Lady Bragg the other day, we owe it all to you! I never believed we would get the great Prize as quickly, and have no doubt that your enthusiasm and authority, vouching for the correctness of our results, turned the scales. As you can imagine, we are all overjoyed. I had hardly dared to hope that my long odyssey would come to such a happy ending. Many many thanks for all you have done for us!

I am very excited by the 3D Fourier of reduced human haemoglobin which Miss [Hilary] Muirhead and I have obtained. It shows that the black chains move relative to each other by 7 Å in the reaction with oxygen, while the movement of the white chains is less than 3 Å. There is also suggestive, but still shaky evidence, that the helical segment which is linked to

the haem group changes its angle of inclination, and that the dyad symmetry of the molecule is lost in the reduced form. I wish that I would not have to leave for America just now, but could continue working on these fascinating results, which show that the molecule changes its shape as it breathes.

Lady Bragg tells me that you are really getting better now. I hope that your rate of recovery from now on will be exponential and that you will soon be restored to your old health and vigour.⁸

***To Gisela, Vivien and Robin Perutz. Mid Atlantic,
November 4, 1962***

I was lucky again. Owing to adverse winds we had to refuel near Reykjavik in Iceland.

Next, we flew over Greenland, my dream for many years, and had a superb view of its spectacular mountains flanking the great icecap and of the gigantic glaciers flowing out from it, all bathed in soft sunshine with long silvery shadows cast over the ice by the craggy peaks. It was wonderful.

I noticed the picture of F, J and me⁹ in *The Sunday Times* as a woman next to me was reading it. I asked her for the paper and she gave me permission to cut the picture out; I am glad to say she never noticed it was me on the picture. In fact no one on the aircraft spotted it. No Sherlock Holmes aboard. I am glad, as I like my anonymity.

***Telegram to Gisela Perutz from Washington,
November 9, 1962***

Loving greetings from united family. Lunching with ambassador. Your haircut vindicated. Your swollen headed Max.

To Steffen Peiser, November 16, 1962

I visited the Rockefeller Foundation on Monday, and they let it transpire that they too had proposed John and me for The Prize.

⁸In an interview in 2001, with tears in his eyes, my father told of visiting Sir Lawrence in hospital and being told by a nurse that it had been touch and go; the announcement of the Prize, she said, had been the turning point in his mentor's recovery.

⁹Francis Crick and John Kendrew; Francis Crick, Jim Watson and Maurice Wilkins won the prize in Physiology or Medicine in the same year.