Dr Rosalind Franklin

(1920 - 1958)

Above the towering slabs of dolomite, the stars
Appeared and threw the mountain folds to solid black
Which matched in dullness all her Paris coals and chars.
Some while before, just as Earth's sun had lit each track,
Her X -ray sun had teased those crystal structures out
And opened nature's secret enclaves one more crack;
Now Rosalind resolved more secrets yet to rout.
She loved to climb these hills, and measured each slight edge
For firmness; then, well roped, she'd tackle nab or snout
And climb with certain feet and reach the top -most ledge
To see the shadow of her frame flung far below.
Her pocket held a letter - a driving paper wedge -
Fermenting in her mind as yeast in rising dough
And tempting Rosalind to leave her Paris home.
Her climbing and her memories made her young face glow
With pleasure at the feat she had achieved. A tome
Of learned papers had built her reputation;
She'd fought without diplomacy's false honey -comb,
Giving her a naive love of confrontation:
Fighting with defiance her father's prejudice,
Making science her purpose with determination
By doing one thing well; eschewing that fools' office,
Marriage; her child must be the truth she would expose.
She'd cycled through blitz air -raids with no cowardice,
While facing high -incendiaries among the streets and rows
Of London homes, supporting Jewish refugees.
Returning now, with fluent French and stylish clothes,
Devoting all her gifts to find the golden keys
Which might unlock the very structure of the gene,
She left for London; and began to work with ease,
Building a camera to display with marvellous mien
The drawn -out fibres of pure DNA. One thought
Became her task and purpose: to explore what none had seen.
Then she, who with Meccano had simple models wrought,
Disdaining dolls, created now a new design,
Controlling X -ray beams with her rare skill, now brought
To focus on one form of life she could confine.
About this time in Cambridge by strange coincidence
Chance drew two men together as though by design
And they too asked themselves how nature might condense
A thousand varied life forms to a common thread.
They lacked data themselves, so looked o'er Franklin's fence
To build a trivet which to her design was wed.
Scorning their nugatory efforts as a blight,
She left to take more pictures that would fill her head
With wonder as each new emergent shape took flight.
She sat before her dappled films so silently -
Like one in temple prayer, wearing a robe of white;
True science held for her a mystic vibrancy:
She worshipped truth and felt her pictures ought to speak,
Contemptuously dismissing those who'd disagree
As over anxious Zealots whose minds were somewhat weak.

Chargaff - now Avery's acolyte - had found how bases paired
And bore his votive knowledge to the Cambridge clique,
Sarcastically deriding these two men who dared
Upon the backs of others race to heady fame.
Dare I relate, propitious fate let more yet be shared?
For Pauling's son next sought their room, and with him came
News of his famous father's tries on DNA,
Which spurred this tireless pair to try and match his game.
In London, Rosalind turned to her films to pray,
Exposing for long hours to radiation her physique
(Encumbrances like leaden aprons she thought fey);
Then slowly brought to light more plates with such technique,
She fired the best shots seen across the waiting world,
Plotting atoms' places with precision so unique
The very strands of life were to her call unfurled.
But unbeknown to Rosalind two turned to look
Till, like fresh converts to new faith, they whirled
Illumined by a lambent nun's inspiring book.
Then yet again that power, which drives celerity,
Sent one last link to forge the chain which our world shook:
One vital man who had that rare sagacity,
Divining tautomeric shapes for every base;
He shared their room until, with true audacity,
The puzzle's parts now fell into their final place.
Their model has transformed our view of all we are;
Dividing endlessly since life began its race,
And driving evolution from those shifts which mar
The order of the bases by chance mutations:
Increased complexity through vast millennia,
Till those subtle strands were formed whose designations
Were Watson and his soul mate Crick, whose names adorn
The double helix. Thus by their chance nutations,
They took that pilgrimage which brought a winter's dawn
On Stockholm soil, to greet the gentle Swedish king
And claim a Nobel honour for new knowledge born.
Humility and self -effacement never bring
Mankind to bridge new chasms on the endless plain;
Boldness to step along an unlit way and string
The labyrinth for meeker men to jump the slain
Should earn its just reward. But strange indeed the thought
That she who held a lamp to light the paths they gain
Then died of hidden cancer, from her own lamp caught.
The same low sun now glinted red on Cambridge snow,
Where generations found great truths like wires stretched taut,
Till heaven's beacons shone through silent air below
And slipped past darkened windows of the seminars
To set their model sparkling with a ghostly glow -
Built like a spiral stairway to the calling stars.

References

Rosalind Franklin
BBC-RADIO (1987) The Dark Lady of DNA
The discovery of DNA by Crick and Watson is a story of collaboration, opportunity and bad luck.

Crick: “She was a much better experimentalist than either Jim or I would ever have been, and she was thorough and painstaking, she knew what she was doing, and she didn't suffer fools gladly. If she thought they were making a mess of things she didn't say so, she looked as if she was going to say so”.
“...No, I don't think we could [have built the model without her data]”.
Klug: (based on a detailed analysis of her notebooks) “[her scientific ability was] first class - she certainly ranks with people who've made great discoveries, and she would have made it too. I've no doubt that if Watson and Crick hadn't intervened, she would have got out the structure”.
Gosling [paraphrasing Randall from memory]: “You will solve the structure of DNA from these spotty photographs”.
“Maurice [Wilkins] was in the States when she came- they might have got off to a better start if he'd been present”.
Wilkins: “I was on a holiday with my German girlfriend in Wales”. - he goes on to blame Randall for sowing the seeds of discontent in his letter of appointment to Franklin, which Wilkins did not know of until he read it in Olby's book (q.v.)
“Franklin had got her micro-camera, and using the micro-focus generator they immediately got vastly improved results and they showed that the DNA molecule makes a transition...Franklin established that there were two forms of DNA which she christened 'A' and 'B'”.
Klug: “There was no doubt that the 'B' form was helical. She discovered the 'B' form by doing carefully controlled experiments; she was a professional and knew what to do”.
Crick: “She was very brusque and thought that we were a couple of amateurs who didn't know what we were talking about. We saw Maurice, and he would tell us things...”
Gosling (referring to the black edged card she sent announcing the death of DNA-helix): “she enjoyed the cut and thrust of debate, and would play the devil's advocate. Maurice wanted to talk to people and had his old friend Crick sitting in the lab at the Cavendish, and trying to solve large-molecule structures”.
“...she didn't resign. She was asked to leave King's by Professor Randall”.
Interviewer: “Because of your close friendship with Crick, you could be perceived as passing information from Franklin to Crick”.
Wilkins: “Oh yes - they got lots of hints and bits of information. There was certainly a feeling in our laboratory that I was foolish, that I was going up there and talking with them a lot...it was quite unbusiness-like really for me to go up there and talk with them about interesting new results, stimulate their interest, and then feel irritated that they were spurred on to build more models. I was causing confusion, and I think that I was at fault there; on the other hand it was very understandable that I would want to go and talk with them because I was isolated in our laboratory... I didn't know anyone else to talk to - certainly not of the calibre of Watson and Crick -and I enjoyed going up there and having stimulating discussions with them”.
The MRC visited King's on 1st December 1952, and were given copies containing details of Franklin's data. Max Perutz of Crick and Watson's laboratory was a member of that committee.
On 26th January 1953, Franklin handed over to Wilkins her superb plate of the 'B' form, photo 51.
On 30th January, Watson visited King's; Wilkins showed him Franklin's photo of the 'B' form.
Wilkins: “He said this was like a bombshell to him. I don't think I would have shown it to him if I'd known it was going to be a bombshell!”
The photograph's impact on Watson was monumental. He now knew DNA was helical; he returned to Cambridge with Franklin's data, and they returned to model making. They asked for and got Perutz's report, with her detailed summery.
Crick: “Of course she recognised immediately that it fitted in with all her data, so her response was that this was probably the correct model. All the information we had was in the public domain, except that one photograph; all the rest of it was in her MRC report”.
Wilkins: “I think you're a couple of rogues...”
Exchange of ideas is common as science progresses. In the case of Rosalind Franklin, it was always her information that helped others, never the other way round. Klug, quoting Franklin: “They expected me to take the pictures, and them to take the credit”.
By March 1953, she had already prepared a manuscript on the 'B' form showing it was helical, 2-chains running in different directions (from the 'A' form analysis), with all the dimensions, and

phosphate groups on the outside. It still remains a puzzle why her work, which was so important, has received so little recognition and reward.
Wilkins: “she had a very hard and difficult time in our laboratory”.
Rosalind Franklin never showed any bitterness and was openly delighted that the structure had been discovered. She died of cancer in 1958 at the age of 37. In 1962, Watson, Crick and Wilkins received the Nobel Prize for their discovery of the structure of DNA.
Carlisle, C.H. Serving My Time In Crystallography: 1938-1978
(Unpublished MSS of Carlisle's 40 years in crystallography, including the time he worked with R. Franklin.) [Birkbeck College]
(p.35-42) “I would like to make a comment or two about Rosalind, for whom I had a great respect. I already had some ideas about her capabilities before she joined us. I first saw her in action at a crystallography meeting at the Royal Institution just after the war, where in a very adept and peremptory manner she pointed out the errors in someone's working with the intensity measurements of X-ray powder diagrams. There was no answer to her comments. Rosalind had the characteristic of being forthright when she knew she was on firm ground, and this sometimes gained her enemies.
“With her past experience, can one blame Rosalind for wanting to interpret her own X-ray data? Of course, the situation was not made any easier by Watson who, himself not a crystallographer, could not appreciate the workings of a disciplined mind like Rosalind's trying to interpret physical results in an objective manner.
“I am convinced from Rosalind's excellent X-ray studies on both the A and B forms of DNA that she was not in the least 'anti-helical' at that time as suggested by Watson in "The Double Helix". Rosalind was more concerned with extracting positive arguments from her X-ray data. This has been excellently confirmed by Aaron Klug [Nature].
“...the draft of a letter which Rosalind was preparing to send to Nature describing what she knew about the B-form of DNA ... contains all the essentials that appeared in her letter accompanying the other two. Doubtless, she was slowly but steadily, through her own efforts, approaching a complete solution which was to include model-building.
“I can only describe the work carried out [on TMV and the spherical plant viruses] by Rosalind...as nothing less than brilliant.
Franklin, Muriel Rosalind - A privately printed memorial to Rosalind by her mother. (St Paul’s Girls School Library).
Glynn, Mrs Jennifer. Personal Interview, Cambridge, 14 October 1988
Rosalind Franklin's sister: photographs of Rosalind climbing in the Alps, and roped climbers ascending a technically difficult overhang. Jennifer grew up in the shadow of Rosalind, following her through St Paul's Girls School, and Cambridge (where she read history).
Judson, Horace Freeland (1978) The Eighth Day of Creation
(p.70) Linus Pauling was born to exemplify the advice of Sir Peter Medawar: "Humility is not a state of mind conductive to the advancement of learning." Pauling is one of three people who have received two Nobel Prizes (Marie Curie and John Bardeen are the other two): for chemistry in 1954 and the prize for peace in 1962.
(p.94) Chargaff wrote: “Avery gave us the first text of a new language. I resolved to search for this text”.
(p.96) - his dissatisfaction for the Watson and Crick style of science: “that such pygmies threw such giant shadows only shows how late in the day it has become”.
(p.97) Kierkegaard: "Knowledge is a passion, for the compulsion to know is a mania: it produces a character out of balance. It is not true that the scientist goes after truth. It goes after him."
(p.101) The conflict between Maurice Wilkins and Rosalind Franklin ranks as one of the great personal quarrels in the history of science. Wilkins: "Basically, I don't think the problem of DNA was so difficult...it really was easy to solve. Rosalind Franklin was wrong headed."
(p.120) Franklin's colloquium notes, Nov 1951: "The results suggest a helical structure...and having the phosphate groups near the outside." She added that the unit cell could be indexed as monoclinic, face-centred. She added measurements- three dimensions and an angle- to support the description.
(p.138) Rosalind Franklin was the only person in the world, that spring (1952), working steadily at the problem of DNA.

(p.166) Crick's insight began with an extraordinary coincidence. Crystallographers distinguish 230 different space groups. The principle experimental subject of Crick's dissertation (X-ray diffraction of oxygenated haemoglobin) was of exactly the same space group as DNA.
(p.170) When Watson showed Donohue the hydrogen bonds he had worked out, Donohue said, "But those are the wrong forms." Watson was astonished, but he listened, because he knew that Donohue was a physical chemist and crystallographer who had worked for years with Pauling on the structure of small molecules. They now had everything in mind that they needed for the structure.
That morning, Watson and Crick knew the entire structure: it had emerged from the shadow of billions of years, absolute and simple, and was seen and understood for the first time.
Pauling, L. Vitamin C, the Common Cold and the Flu.
Sayre, Anne (1975) Rosalind Franklin and DNA [Norton, New York]
(p.43) Her father suggested voluntary work (as suitable for a woman). Rosalind resisted strongly, with defiance. She was 'unencouraged' which called for considerable will and stubbornness. She set out to prove herself, and when this is allied to great sincerity, ability and inflexible will, the combination can be formidable.
(p.47) She had the innocence of rationality - an unconquorable conviction that reason dominates; that sane people preferred to act [by] logic. Science is a rational business; sound arguments prevail, and the reasonableness of it suited Rosalind perfectly. She had a natural affinity for objective proof and evidence. The slow process of leading recalcitrant thinkers to better thoughts by artful persuasion seemed to her a waste of time. ...most people, even a little experience invites cynicism...Rosalind never lost it [her youthful innocent belief].
(p.52) ...the splitting of women's thoughts by the confusion of roles- 'woman' or 'intellectual' - but not both. [Rosalind] refused to let the woman through.
(p.95) In those days King's was not distinguished for the welcome that it offered to women... King's was founded as a theological school... as the Church of England does not admit women to its ministry, it was naturally a male institution.
Watson, James D. (1981) The Double Helix - Ed. Gunther Stent
(p.14-15) Maurice [Wilkins], a beginner in X-ray diffraction work, wanted some professional help and hoped that Rosy, a trained crystallographer, could speed up his research. Rosy, however, did not see the situation this way. She claimed that she had been given DNA for her own problem and would not think of herself as Maurice's assistant...there was no denying she had a good brain...The thought could not be avoided that the best home for a feminist was in another person's lab.
Sooner or later Linus [Pauling] was bound to try for the most important of all scientific prizes. Our first principles told us that Pauling could not be the greatest of all chemists without realizing that DNA was the most golden of all molecules.
(p.56) [on the first model] after tea, a shape began to emerge... three chains twisted about each other… The next step would be to check it with Rosy's quantitative measurements.
(p.59) As Francis prattled on, she displayed increasing irritation. Inspection of the model itself increased her disdain. Rosy curtly pointed out that magnesium ions would be surrounded by tight shells of water molecules and so were unlikely to be the kingpins of a tight structure. Most annoyingly, her objections were not mere perversity: at this stage the embarrassing fact came out that my recollection of the water content of Rosy's DNA samples could not be right. The awkward truth became apparent that the correct DNA model must contain at least ten times more water than was found in our model... her future course of action would be unaffected by a fifty mile excursion into adolescent blather...Rosy's triumph all too soon filtered up the stairs to Bragg.
(p.78)...Chargaff himself would soon be in Cambridge for an evening...Chargaff, as one of the world's experts on DNA, was at first not amused by dark horses trying to win the race...but regardless of what went through his sarcastic mind, someone had to explain his results.
(p.86)...her X-ray pictures were getting prettier and prettier...she thought there was evidence that the sugar-phosphate backbone was on the outside of the molecule.
(p.91)...we were sharing an office with Peter Pauling...a letter [from his father] was the long-feared news that Linus now had a structure for DNA....the possibility of Linus being wrong - he had never seen Rosy's pictures.
(p.96) I was more aware of her data than she realised.
(p.98) since the middle of the summer Rosy had had evidence for a new three-dimensional form of DNA. It occurred when the DNA molecules were surrounded by a large amount of water. When I

asked what the pattern was like, Maurice went into the adjacent room to pick up a print of the new form she called the 'B' structure. The instant I saw the picture my mouth fell open...the pattern was unbelievably simpler than those obtained previously. Moreover, the black cross of reflections which dominated the picture could arise only from a helical structure. Mere inspection of its picture gave several of the vital helical parameters....this presumed that Rosy had hit it right in wanting the bases in the centre and the backbone outside...Maurice told me he was now quite convinced she was correct.

(p.105) there was no longer any fear that it would be incompatable with the experimental data. By then it had been checked out with Rosy's precise measurements. Rosy, of course, did not directly give us her data. For that matter, no one at King's realised they were in our hands. We came upon them because of Max's membership on a committee appointed to look into the research activities of Randall's lab. The report was not confidential.

(p.112) for six months Jerry Donohue occupied a desk in our office. Next to Linus himself, Jerry knew more about hydrogen bonds than anyone else in the world. For many years he had worked at Cal Tech [with Linus Pauling] on the crystal structure of small molecules. He protested that the tautomeric forms I had copied were incorrectly assigned.

Epilogue.

(p.132) The X-ray work [Rosalind Franklin] did at King's is increasingly regarded as superb. The sorting out of the A and B forms, by itself, would have made her reputation; even better was her 1952 demonstration, using Patterson superposition methods, that the phosphate groups must be on the outside of the DNA molecule. We both came to appreciate her personal honesty and generosity, realising years too late the struggles that the intelligent woman faces to be accepted by a scientific world which often regards women as mere diversions. Rosalind's exemplary courage and integrity were apparent to all when, knowing she was mortally ill, she did not complain but continued working on a high level until a few weeks before her death.

Crick, Francis (1981) Life Itself

He describes the idea that there might have been time for life to evolve twice in the history of the universe - therefore 'directed panspermia' is a possibility. I am convinced this is nonsense.

a) The times scales are too uncertain to make more than wild guesses about the time for evolution to occur, even on the known earth.

b) The most favourable timescale proposed by Crick suggests that two evolutionary periods are a possibility; but clearly one is more likely, as one is known to have occurred and fits more comfortably into the known time span.

c) Again, if the time for evolution (ie from primaeval soup to intelligent life forms = tEV) was much less than the age of the universe (tEV << tU) then evolution might have occurred independently many times, and 'directed panspermia' could be considered. But it seems more likely that tEV~tU, and this suggests that on any planetary system, evolution could occur only once, and probably has occurred only once (though possibly on many planets simultaneously) in the lifetime of any individual solar system.

d) To suggest 'directed panspermia' as a mechanism for life on earth is merely to redirect the problem of the origin of life to somewhere else.

e) The power of evolution, and the progressive increase in complexity of the controlling DNA that is seen in evolving and more complex life forms is sufficient in my view to allow a backward extrapolation beyond the earliest and most primitive cell types to account for the emergence of life from a primitive chemical broth in its own right, and within the time-scale of the earth.

f) As an extension to this, and considering it from the other side so to speak, we know that increasingly complex organic molecules including amino acids do form from mixtures of simpler organic molecules subject to UV light and electrical discharges. Formaldehyde and other organic molecules have even been detected in interstellar space from their emission spectra.

In conclusion, I believe that the balance of probability is such that life did arise spontaneously on earth just once, from primitive organic precursors, and has continued to gain in complexity in the millennia over which evolution has operated. Life has probably arisen simultaneously and independently, and with a comparable time scale, on other planets throughout the galaxy many times.