Lesson 7.1: Double Helix / Life Story Script

**Opening Scene & Part 1. One of the believers**

By the early 1950’s, the greatest unsolved mystery in science was the secret of life itself – the process by which all living things have reproduced themselves, generation upon generation, since the very beginning of life on earth. Although the mystery had a name, the gene, no one knew what it was or how it worked.

**Opening scene**


*James Watson* (JW): How’d you like your only brother to be famous?
*Elizabeth Watson* (EW): Famous for what?
JW: Does it matter?
EW: OK.
JW: Then you have to be nice to Maurice Wilkins.
EW: Who’s Maurice Wilkins?
JW: Funny hat, white arms. Guy with the glasses. Got him? Hmm?
EW: Hmm.
JW: English. Working on DNA.
EW: So I’m nice to Maurice Wilkins. Then what?
JW: He gets to like you. He gets to like me. I get to work on DNA. I get to be famous. I'll hang out with all his rich friends. You marry one of them.
EW: I can't wait.
JW: Listen. You look like Mom, kind of. Your children, right, are gonna look like you. Has to be something that knows, something that doesn't die when you die, your piece of immortality, right? It has to be in every living cell. It has to be proteins, or it has to be nucleic acids. I say it's the acids. I say it's the DNA.
EW: Well, how come no one else knows this if it's so important?
JW: No one knows anything. This is off the map. Somebody has to guess right. Chapter one, page one. Once upon a time, life reproduced life. How? The secret of creation, worth a Nobel Prize. Hmm?
EW: OK, Jim. I'll go and be nice to Maurice Wilkins.

**Part 1. One of the believers**

[Naples 1951. Lecture Hall, Maurice Wilkins lecturing]

*Maurice Wilkins* (MW): It wasn't at all suitable at the time these experiments were carried out, good enough for single crystals but not really for DNA fibers. Our work on DNA began with our discovery of a way to draw out thin fibers in which the molecules are lined up parallel. This X-ray diffraction photograph was taken using bundles of DNA fibers from materials supplied by a Professor Signer of Bern [Switzerland]. As you can see, it is a crystalline pattern, which would suggest that genetic material has a precise structural regularity, which would suggest that it is not an impossible task to determine the structure of the gene itself.

[Roman ruins from opening scene]

EW: Jim's got this idea that there's money in genes.
MW: Money?
MW: Ah.
EW: How much can you see without your glasses?
MW: Practically nothing. It's better that way sometimes. What is your brother's field?
EW: I'm afraid I have no idea.
JW: Bacteriophages. Right now I'm with Kalckar at Copenhagen. Jim Watson. But I'm kind of interested in genes, Dr. Wilkins. What you said in the conference talk, that kind of excited me. I'd really like to – I mean, that's where the action is… going to be, no question.
MW: I don't fully understand. Are you doing work?
JW: Not work exactly. A few ideas. I'm one of the believers. Blessed are they who believe before there was any evidence, right?
MW: Evidence for what?
JW: That DNA holds the genetic secret.
MW: Ah.
EW: What Jim's trying to say is that he'd like to come and work with you.
MW: Ah. I can't really say. That sort of thing is up to the director at the lab.
EW: It was very nice meeting you, Dr. Wilkins. [grabs Watson's arm and pulls him as she walks away]
JW: What was that all about?
EW: Forget it, Jim. You don't want to know.
JW: I have to get away from Copenhagen. Kalckar's boring my smock off.
EW: Isn't there some other place you can go to be famous?
**Lesson 7.1: Double Helix / Life Story Script**

**Part 2. La religieuse (the nun)**

Background song

<table>
<thead>
<tr>
<th>French Song</th>
<th>English Translation</th>
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<td><em>Et je m’en vais clopin-clopat</em>&lt;br&gt;<em>Dans le soleil et dans le vent,</em>&lt;br&gt;<em>De temps en temps le cœur chancelle</em>&lt;br&gt;<em>Y a des souv'nirs qui s’amonncellent</em></td>
<td>And I go hobbling along&lt;br&gt;In the sun and in the wind&lt;br&gt;From time to time, my heart wavers&lt;br&gt;Memories pile up.</td>
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[Rosalind Franklin in lab with Vittorio Luzzati, looking out window.]

**Rosalind Franklin** (RF): Maurice Wilkins. [with French accent:] *Maurice Wilkins.* *Je suis sur que je l'aimerais plus s'il etait francais.* I'm sure I'd like him much more if he were French.

**Vittorio Luzzati** (VL): *Tu as fait son connaisance?* Have you met him yet?

**RF:** *Non, pas encore.* No, not yet.

**VL:** *Ce sera pas comme travailler avec toi, Vittorio.* It won't be like working with you, Vittorio.

**RF:** *Pourquoi vais-je quitter Paris?* Why am I leaving Paris?

**VL:** (humorously) *Ma chere Rosalind, il faudra que tu renonces aux jouissances.* My dear Rosalind, you need to renounce all thoughts of pleasure.

**RF:** *Nous sommes les religieux de la science.* We are the monks of science.

**RF:** *Et les religieuses?* And the nuns?

[Noisy Café scene. Violin music.]

**RF:** You know what I'm going to miss most in London? Sweets. Imagine a city without sweets. [England was still rationing sugar (and other things) after WWII as an austerity measure to pay off its war debts]

**Man at same table:** ...but death is glorious. If there are enough people watching...

**RF:** "The charm of fame is so great that we like every object to which it is attached, even death."

**Man:** Oh, Voltaire said that?

**RF:** Pascal.

**VL:** The worst you can say about the English is that they don't laugh. Telling jokes, yes, of course.

**RF:** What nonsense, Vittorio. I'm English. I laugh.

**VL:** True, the English do laugh, in their own way. Look. [mimics laughter with shoulders moving up and down]

[Aboard a train in England. Ominous music. Franklin is aware of men looking at her. She is clearly uncomfortable.]

[Franklin under an umbrella in the rain. A rowdy group of young men force her to stop. King's College. She is anxious.]

[Franklin in Dr. J.T. Randall's office]

**RF:** [to receptionist] I have an appointment with Professor Randall. Dr. Rosalind Franklin.

**J.T. Randall** (JTR): Not like Paris, I imagine, Miss Franklin.

**RF:** No, Professor Randall. Not like Paris.

**JTR:** I think you'll find we're much more informal here. I'm giving you a research student, Raymond Gosling. He's been working with Maurice Wilkins up to now.
RF: What will Maurice Wilkins be doing?
JTR: Oh, Maurice has plenty of irons in the fire. You can sort that out between you when he gets back. No hard-and-fast lines at King's, Miss Franklin.
Part 3. The bright hope

[Cambridge. Watson being show around campus by Max Perutz]

JW: Do people live here? I mean, mere mortals?

Max Perutz (MP): Indeed, they do. Some of them, I regret to say, very mere, indeed.

JW: You people are being very good to me.

MP: You come recommended by Salvador Luria and Max Delbruck. Such references we take seriously. Also, forgive me, but you are paid for by an American grant. To us, you are free.

[Girl on bicycle rings bell to pass]

JW: [staring at girl] That's right. I'm free.

[Office of Sir William Lawrence Bragg]

W. Lawrence Bragg (WLB): [smoking pipe] I'm told you're a bird-watcher. [Note: bird is/was British slang for girl].

JW: Yes, sir. When I was young, I was aiming to be curator of birds at the Museum of Natural History.

WLB: When you were young? How old are you now?

JW: 23.

WLB: And a PhD to your name? Perutz, we must introduce this young man to Crick.

JW: Who's Crick?

WLB: Crick is the bright hope of the Cavendish. A bright hope shared by us all is that – how shall I put it? He'll fulfill his early promise before it gets late. Welcome to the Cavendish, Dr. Watson. I know it doesn't look very likely, but I, too, was young once. [extends his hand to Watson – they shake hands]

[Crick's office]

John Kendrew (JK): Francis, this is Jim Watson, the bacteriophage man. We thought we'd give him the desk in here with you.

Francis Crick (FC): Ah, the boy wonder.

JW: And the bright hope?

JK: Bragg, he's rather hoping Watson's precocious achievements might shame you into action. Knock on my door if you need me, next room along.

JW: Thank you.

FC: You've entered the land of irony, Jim Watson. Right, I know back where you come from, the director of the lab would bang on the table and say, "Shape up or ship out" or "Haul your ass" or something vivid and descriptive like that. Here, it's "How's the Great Work coming along, Crick?" "Am I to hear you're being considered for a Nobel, Crick?" And it puts iron into Bragg's soul to know that I'm 35 and don't yet have a PhD.

JW: I wouldn't be too happy about it if it was me.

FC: Well, I mustn't overstate my case. I don't claim to be happy about it, but what's a fellow to do? I'm sure oxygenated hemoglobin has its due place in the scheme of things, but it can hardly be said to be fun. I mean, what's the point of science if it isn't fun?

JW: So, what's fun?

FC: Oh, the big questions. The bigger, the better. What is man? What is life? How do we come to be the way we are?

JW: Big questions, all right.

FC: Yeah, big questions get big answers. We can blow ourselves up, but we still don't know how
we reproduce ourselves.

**JW:** You're interested in genes?

**FC:** Certainly. [He finishes clearing out a desk for Watson] All yours.

**JW:** Where would you look for a gene, if you were looking?

**FC:** Excuse me [Puts away some notebooks]. My hunch is the nucleic acid. I mean, you ask me what's fun; right now, I'd say DNA.

**JW:** Me too. I'm sorry, is it Francis?

**FC:** Yeah.

**JW:** Jim.

**FC:** Hello.

**JW:** Hello.

[ They shake hands ]

[King's College. Wilkins walking down hallway.
Franklin's lab. Franklin working with Raymond Gosling on setting up equipment.
Wilkins enters without knocking.]

**MW:** Getting under way then.

**Raymond Gosling (RG):** Hello Maurice.

**RF:** It will be a little while yet.

**MW:** Oh, there's no rush. [pause] Let me know when you get going.

**RF:** Why?

**MW:** Well, we like to keep in touch. [pause, Franklin looks away]. Just as you wish. Keep me posted [Franklin tilts her head suddenly, displeased]. Oh, see you in Finch's later, Raymond?

**RG:** [noticing Franklin's reactions] Will do, Maurice.

[Franklin, displeased, powers up equipment.]

[Finch's Pub at King's.]

**MW:** I can't make her out. Can you make her out?

**RG:** She knows what she's doing.

**MW:** Well, she must do, or Randall wouldn't have hired her. No, I mean as a person.

**William (Bill) Seeds (WS):** You mean, as a woman.

**MW:** After all, Raymond and I did start this work on DNA. She seems to think that what she does is none of my business.

**RG:** I think the way she sees it, she's been taken on to set up an X-ray diffraction unit to work on DNA. And as far as that goes, she's in charge.

**MW:** Is that what Randall told her?

**RG:** I don't know. Ask her. Sort it out.

**WS:** Man to man. (laughs)

[Walking to a pub at Cambridge]

**FC:** There are two facts you should know about our esteemed director, Sir Lawrence Bragg. I appoint myself your native guide, you understand. The first is that he's the youngest person ever to win a Nobel Prize.

**JW:** How young was he?

**FC:** 25. Come here [they enter the pub]. The second fact is that everybody thinks the great work was done by his father. Bragg was just too damn young to be winning Nobel Prizes.

**JK:** What's it to be, Jim?
JW: Francis and I have already fixed that. We're going after DNA.
FC: He'll have a beer, John. Me too.
MP: The structure of DNA – that's the work of a lifetime.
FC: Max has been puzzling over the structure of hemoglobin for – what is it, Max, 15 years? Come on, Jim.
JK: Max?
MP: I think just an orange squash. Thank you, John.
JW: I don't see why DNA should take a lifetime. Maurice Wilkins says it has a crystalline structure.
FC: You know Maurice?
JW: Kind of. We were at this conference at Naples.
FC: Oh, I've known Maurice since the war.
JW: That's how we do it. [pointing at a picture of Linus Pauling] Here.
FC: Ah, the mighty Linus Pauling.
JW: He didn't take a lifetime. One brilliant guess and zappo, he discovers the α-helix.
JK: One brilliant guess, plus a lifetime's knowledge. Plus, he's a genius.
FC: Bragg was hopping mad over missing that. Hopping. Cheers.
JW: That's how we get DNA. We build a model.
MP: Then I think you should consider obtaining some data first. No bricks without straw.
FC: Maurice Wilkins has data on DNA.
JW: Does he build models?
FC: Oh, not Maurice's style. Too showy.
JW: Then he won't mind if we have a go, will he?
FC: We're having a go, are we?
JW: Why not?
FC: Why not?
JW: Just don't anybody tell Pauling.
Part 4. Gossip

[Franklin and Wilkins seated on a bench alongside a street eating lunch.]
MW: How long were you in Paris?
RF: 4 years.
MW: [kindly] I expect you miss it.
RF: Yes. You've lived abroad, have you?
MW: America.
RF: Do you miss it?
MW: It was a strange time… the war. Some things didn't work out for me. Then you come home and…

[Crick and Watson walking]
FC: I don't know about you, but from my point of view, the less data, the better. My point is that a wrong fact looks as hard as a right fact.
JW: So we do it without evidence. That's right.
FC: We listen, but we don't obey. You know, like rumors, gossip. There might be something in it; there might not.
JW: What gossip do you listen to on DNA?
FC: Well, there's Astbury's work at Leeds. He suggested a structure for DNA.
JW: Ugly.
FC: You don't like ugly?
JW: It doesn't deserve to be true. Truth is pretty.

[Crick brings Watson home. The song I'm gonna wash that man right out of my hair from the film South Pacific playing on phonograph]
FC: Odile?
Odile Crick (OC): Yes.
OC: Hello, Jim Watson. [on seeing him] What happened to your hair?
FC: Oh, all Americans are bald. It goes with conquering the world. You can't dominate and have long hair. Jim, this is Odile.
JW: It's not the style here, I guess, huh?
FC: Can you feed him? [she nods] I told you so. Come on in.
JW: So, what? Do I look strange or…
OC: Just different. Nothing wrong with that.
JW: I think where all the trouble is it grows real slow, and I can't wait that long.
OC: Wait for what?
JW: Well, uh – I have to get a girl.
OC: Ah, yes.
JW: You did these paintings [of nudes]?
OC: That's right.
JW: Know any girls?
OC: Some.
FC: Au pairs. Cambridge is full of them.
JW: What?
FC: Foreign girls, come here to learn English. Live with a family, look after the children.
JW: Nothing to do with science?
FC: Nothing at all.
JW: I don't want a scientist. I want a girl.

[Wilkins in men's lounge. Talking about Franklin.]
Bruce Fraser (BF): Is she married?
RG: I don't think so.
BF: Boyfriend?
RG: I don't know.
BF: 10-to-1 there's no boyfriend.
MW: She is attractive… in a way.
BF: Doesn't want to be. She's not trying.
WS: Your type, is she, Maurice?
MW: My type?
WS: Frightens you, doesn't she? Mind you, some men like it that way. The kiss of the whip.
[Laughs]
BF: No. No, but you get girls like that. They don't want to be treated like girls.
MW: Well, what do they want?
RG: I think Rosalind would like to be treated like – well, like a woman.
WS: Maurice, go and make eyes at her.
MW: What do you mean, Raymond?
RG: Oh, I don't know. Give her flowers.
MW: Flowers? Well, I want to work with her. I don't want to marry her.
BF: Is she coming to the party?
RG: I told her about it, and she asked me what sort of party it was.
WS: Just a party.
RG: That's what I told her.
WS: Ah, but if she comes, Maurice, oh, if she comes, bring a smile to those rosy lips, the rosy lips of Rosie Franklin.

[Rosalind applying lipstick. Talking with Freda Ticehurst.]
Freda Ticehurst (FT): You know, I never want to go to parties. Then when I'm there, I'm glad I went. The men are so different. You wouldn't believe it. Talk about wandering hands.
RF: I don't think it's quite my…
FT: Sometimes you have to make an effort, don't you? I mean, a girl has to show willing.
[Franklin puts away her lipstick with a click.]
JW: I buy helix.
FC: If it's a helix, how many chains?
JW: It has to be more than one. The density measurements tell us that.
FC: Yeah, but two, three… four?
JW: How do the pieces fit together? Phosphates on the inside, bases on the inside?
FC: What's the glue? I mean, why doesn't it fall apart?
JW: So what's the score?
JW: At least we know it's got a regular structure, if Maurice Wilkins is right.
FC: Oh, you can trust Maurice. He's new to biochemistry, hasn't got attached to the old ideas.
JW: What's Maurice Wilkins' background?
FC: Oh, he was in the Manhattan Project [America's war-time project to build the atomic bomb].
A lot of that crowd got out of physics after the war, from the science of death to the science of life.
JW: Is he good?
FC: Oh, he's good. He's done some of the best work on DNA in the last couple of years.
JW: Is he fast?
FC: Oh, not fast. Steady.
JW: In this race, steady loses too many runners.
FC: Well, Maurice doesn't see it as a race, more a brotherhood of science.
JW: Great.
FC: Well, even so, we should tell them at King's what we're doing.
JW: I wonder where they live.
FC: Oh, the foreign girls? Well, with the families that employ them or in boarding houses.
JW: Boarding houses, that sounds promising.
Lesson 7.1: Double Helix / Life Story Script

Part 5. Goal-oriented

[Franklin in lab preparing wet DNA sample. Close-ups on face, eyes, observing.]

NOTE: DNA samples are actually hard to wet. In actuality, Franklin used gas bubbling through salt solutions to hydrate her DNA samples.]

RF: Do you know what I like about our kind of work? You can be happy, or unhappy, it makes no difference. It doesn't matter whether you like what you find, or hate it. You look at it and say, "So that's how it is." [smiles] It doesn't sound [like] much when I say it.

RG: It sounds like it's much to you.

RF: Sometimes I feel like an archaeologist, breaking into a sealed tomb. I don't want to touch anything. I just want to look.

[Dark room. Freda Ticehurst develops Franklin's x-ray photograph.]

FT: Da-da-dum. There we are.

[Franklin looks.]

[MW: These are very good, Raymond. Very good. I'm impressed with the amount of detail you're getting. What's the humidity range?]

RG: 70 to 80% for the crystalline state. She's using concentrated salt solutions to control the humidity. The different forms are showing up much more clearly.

[Franklin enters in background] She's calling them A and B forms.

MW: Look at that Raymond. Wouldn't you say that was a helix? I said all along it would turn out to have a helical structure.

RF: I wonder why we bother to do experiments. [Clearly upset.]

MW: What? Rosalind. I must congratulate you. What you have here is – surely it could be helical, couldn't it?

RF: So what do you conclude from that? Because it's possible, it must exist?

MW: Well, I was just – I'm just throwing out ideas.

RF: Guesses.

MW: Well, informed guesses, I hope.

RF: Look, you may be guessing right, and you may not. We won't know until we've done the work. When we've done the work, we won't need the guesses because we'll know the answer. So what's the point of the guesses? Being able to say later you were right all along?

MW: No, I didn't think that at all.

RF: I really would appreciate it if you'd restrict your guesses to your own experimental work.

MW: Very well, I'll be on my way, Raymond.

RF: Raymond, I am not Maurice Wilkins' research assistant. If there's anything he wants to know about our work, please tell him to ask me.

[Wilkins in Randall's office.]

MW: Well I know I wasn't here when she came. But my understanding was that she was taken on to work in my unit. I mean to say, in all fairness, DNA is my province.

JTR: Yes, Maurice, Yes. But also in a way, no. Rosalind Franklin is a specialist. She may well come up with results of value to us all. I want you to find a way of working with her, Maurice.

MW: Well… Yes, of course. But how?
JTR: Be flexible.
MW: Flexible.
JTR: You know me. I don't like formal structures, hierarchies, lines of demarcation. I like flow. Don't be the seawall, Maurice; be the sea. Ebb and flow.

[Wilkins fencing. Enjoying himself.]

JW: Excuse me. Hello. Do you speak English?
Woman: Well, I speak a little.
JW: Do you? I'm American, and my sister is coming to visit me here in Cambridge. Do you know of a suitable boarding house for young women?
Woman: Well, I know only the house where I rest. [the French word for stay is rester]
JW: Where do you rest? [she writes the address for him] Oh.

[Watson and Crick's office]
JW: Number 8 Scroope Terrace.
FC: I didn't know your sister was visiting here.
JW: She will one day. It's run by a Frenchwoman named Mrs. Camille Prior.
FC: Oh, Pop. I know Pop Prior. Everyone knows Pop.
JW: Pop?
FC: Yeah, she's always been called Pop. Of course. Why didn't I think of it? She goes about in a sort of a haze of French girls, ever changing and ever the same, like underwear. I must say, you're very determined, Jim.
JW: Goal-oriented.
FC: Well, if you haven't found the girl of your dreams by Sunday, come to lunch. Maurice Wilkins will be there.
JW: Bearing copies of all his latest work?
FC: Piano, Jim [piano is a musical term meaning softly, quietly]. Softly, softly, catchy monkey. [means: take the slow and patient approach]

[Watson outside Pop Prior's boarding house, Number 8 Scroope Terrace. Rings doorbell.]
JW: Allo.
Pop Prior: Oui?
JW: Do you give French lessons?
Part 6. Buried treasure

[Crick's apartment]
OC: Here she is. Here's our little princess. [Odile hands their daughter to Wilkins.]
MW: Hello, princess.
OC: There, you sit with Maurice.
FC: What's this princess business?
OC: Well, when Prince Charles is 25, she'll be 22, so I thought they could be married.
MW: Gonna marry Prince Charles.
OC: Hello, Jim.
FC: Hi, Jim. This is Maurice. Jim Watson.
JW: Hi, we met at Naples.
MW: Did we?
FC: Sit down. Sit down. Maurice has a cuckoo in his nest. He's been telling me all about it.
MW: Well, in all fairness to Rosalind, she is doing what she was asked to do. We just don't seem
to have got off on the right foot. Maybe I'm just bad with women. I don't know.
OC: Well, Gabrielle's a woman. She's happy with you.
MW: But she is rather small, isn't she, for a woman?

[after lunch]
MW: You know how I work Francis. Anyone can come to my lab any time they'd like. Science
is a communal activity. I have always said that. Now, I gave Rosie the best DNA, I gave her the
best X-ray apparatus, and in return, she tells me nothing. Is that the way science should be done?
JW: Well, she's gonna have to tell somebody some day, this Rosie.
MW: You mustn't call her Rosie. That's just a private joke. She wouldn't like it at all. [pause]
Did I call her Rosie?.... Rosalind.
JW: Well, Rosalind's gonna have to tell somebody someday.
MW: Yes, next Wednesday.
JW: Next Wednesday?
MW: We're holding a small colloquium at King's, a report on progress and so on.
FC: Sounds interesting, Maurice.
MW: I doubt it. I've got nothing new to offer.
JW: Is it open to outsiders, by any chance?
MW: Yes, of course.
JW: Really? I'd be kind of interested.
MW: Are you working on DNA?
JW: Not what you'd call working, no experimental work. I like to keep up. I guess everybody
dreams of being the one who finds the buried treasure.
MW: What buried treasure?
JW: The secret of the gene.
MW: I'd never really thought of it that way.
FC: Jim and I are playing around with a few structural theories for DNA. You don't mind, do
you, Maurice?
MW: Should I? [smiles]

[ Watson walking down hallway at King's. Enters Common Room (men's exclusive lounge) ]
Man in chair: Can I help?
JW: Yeah, I'm looking for Rosalind Franklin.
Man: Oh, you won't find her here. This is men only.
JW: Why?
Man: I'm sorry.
JW: Why is it men only? ... What do you do here? What, is there a toilet or …
WS: You'll most likely find Miss Franklin in her room in the basement. [points down]
JW: Thank you.
WS: Was that him, do you think?
Man: Who?
WS: A tall dark stranger. Rosie finds romance. [laughs]

[Franklin walking down hallway in basement. Sees Watson standing at end of hallway. Unlocks her door and walks in. Then sticks her head back out.]
RF: Did you want me?
JW: Dr. Franklin?
RF: Yes.
JW: Jim Watson. I'm a friend of Maurice Wilkins. I'm working with John Kendrew at the Cavendish.
RF: Yes? [putting on her lab coat]
JW: Maurice says you've been doing some good work.
RF: Yes?
JW: I guess that's it. Um….
RF: I'll get on with my work then.
[Franklin closes door. Watson walks away.]

[Lecture hall]
RF: Our best crystalline fiber diagram has been obtained in a humidity range of 70-80%. At higher humidities, during a change crystalline to wet, a considerable increase in the length of the fibers occurs. In effect, this wet state is a different form, which I call the B form. This [slide of x-ray photograph – Gosling at slide projector] is the A form, the drier crystalline state. It yields by far the more detailed diagram and therefore can supply us with a greater amount of [she sees Watson, pauses] … of information. Astbury's density measurement, together with our own water content measurements indicate 24 nucleotides per primitive unit cell and 8 molecules of water associated with each asymmetric unit. The 27-angstrom layer line spacing is very strong, as you can see. [Watson stares at her chest] The results so far suggest a closely packed structure containing 2, 3 or 4 coaxial nucleic acid chains per unit.

[Watson through market street with Wilkins]
MW: What do you make of her?
JW: She knows her stuff.
MW: It doesn't seem to have got her much further than Raymond and I got. I didn't hear anything very startling, did you?
JW: She sure isn't in a hurry to commit herself – 2-chain or 3-chain or 4-chain.
MW: Raymond Gosling says he watches her sometimes when she's working. And she's so still, he says, it's like someone praying. He thinks she's beautiful. Do you think she's beautiful?
JW: Mm, not my type.
MW: What is your type?
JW: Large breasts.
MW: Oh. You're very honest.
JW: Honest Jim.

[Watson and Wilkins in restaurant]
MW: Did I tell you I got a letter from Linus Pauling? He wants copies of our DNA photos. He said we have the best data. [Watson stops chewing, hanging on every word] I wrote back saying we were still evaluating them. Rosie would never agree anyway.

[Watson and Crick walking on train platform]
JW: I nearly had a heart attack.
FC: So Pauling's getting interested in DNA.
JW: It was only a matter of time.
FC: Well, he still hasn't seen the King's results yet. We could still beat him to it.
JW: Maurice has no idea what he's sitting on. This Rosie of his is digging up gold.
FC: Enough gold for a model?

[Watson and Crick on train]
JW: 27-angstrom layer line spacing, 2, 3 or 4 chains, 24 nucleotides per unit cell.
FC: Any other dimensions?
JW: Not that I remember.
FC: Didn't you take notes?
JW: No.
FC: God. Did she talk about the structure of the molecule? Did it look like a helix?
JW: What would a helix look like?
FC: The reflections form a cross.
JW: No.
FC: So a helix still unproven. We still don't know how many chains. We don't know how the parts fit together. Did she mention water?
JW: Yes, 8 molecules of water per unit cell.
FC: 8 per cell? That's practically nothing. That's very interesting. If there's no water, virtually no water, there are far fewer ways the molecules can pack together, which gives us a chance.
JW: If we knew what stops the whole thing from falling apart…
FC: Yes…
JW: Electrostatic attraction? It's obvious, but so what? It's the strongest glue we've got.
FC: What, phosphates bonding to phosphates?
JW: Yes, sure.
FC: Phosphates are negatively charged. They'd repel each other.
JW: Oh, oh.
FC: Unless…
JW: What?
FC: Well, Jim, you could be right. I mean, if it's this dry, maybe it bonds like an inorganic crystal. To tell you the truth, I'm a bit hazy on inorganic ions.
JW: That's Linus Pauling's field, but he's published.

[Watson and Crick in library]
FC: The Nature of the Chemical Bond by Linus Pauling.
JW: Got it.

[Watsons and Crick's office. Building model]
FC: [fumbling with test tube clamps and steel parts] We have to improvise with these.
[Bragg looks in from doorway.]

[Bragg at top of staircase]
WLB: Can someone tell me what Crick and Watson are up to?
MP: They're building a model of DNA.
WLB: How do they know anything about DNA?
JK: I think it's one of Crick's hunches.
WLB: I don't like it. Crick should be getting on with his thesis.
JK: No harm in letting them have a go, though maybe we should tell Randall's crowd what's going on.
WLB: No question about that. I want everything open and above board. We play with a straight bat at the Cavendish. Give Maurice Wilkins a ring, will you Kendrew?
JK: Yes, of course.

[Franklin in dark room with Freda Ticehurst. Wilkins enters and interrupts. Franklin appears peeved and half-ignores him.]
MW: Ah, Rosalind?
RF: Yes, Maurice. Bring this up a little, Freda, can you? As much definition as you can give me.
MW: I've had a phone call from Kendrew at the Cavendish. It seems Watson and Crick are building a model of DNA.
RF: A model? Based on what? How can they build a model?
MW: Apparently they can.
RF: Oh, here too. Can you do anything with that? I know there's not a lot to go on.
FT: Yes, I'm sure I can do something.
MW: Bruce and Bill and I are going to Cambridge to see it when it is done. Do you and Raymond want to come?
[Franklin sighs]

[Train from London to Cambridge. Seed's smoking annoys Franklin.]

[Watson and Crick's office, observing model]
FC: We didn't have time to get the proper parts made by the machine shop. We cannibalized protein models.
RF: Where's the water?
FC: The water? Well, we were working to 8 molecules of water per unit cell. I understood those were your figures.
RF: No, 8 molecules of water per nucleotide. With 24 nucleotides per unit cell, that's 192 molecules of water. And you have 8 ... Even on its own terms, this model makes no sense. You have phosphate, sodium, phosphate bonds. Well, charged sodium ions attract water. It could never be this dry.
JW: So we got it 2,400% wrong. Anybody can make a mistake.
[Train back to London. King's scientists are smug.]
**WS:** Mother of God, but I enjoyed that. The look on Crick's face.

[Franklin looking out window, pleased with herself]
**MW:** It won't do him any good with Bragg.
**WS:** Ah, serves him right. Cocky bugger.

[Bragg with Watson and Crick, standing with their hands behind their backs as if being disciplined.]
**WLB:** I don't mind wild ideas, I don't mind trying and failing, but science is like a sport, you see. You have to play by the rules of the game. Perhaps that sounds old-fashioned to you. I wouldn't know. I've never gone fishing in other people's ponds, and I don't like being made to look as if I'm starting now. Crick, please go back to hemoglobin. Please finish your thesis. Watson, you have to satisfy your fellowship trustees, not me, but I would like to think that by the time you leave here, the Cavendish will have reason to be proud of you.

[Watson and Crick in restaurant, later, chuckling]

[Train station in Paris]
**RF:** It's as if I'm surrounded by children, Vittorio. Adolescents. They all want to have the theories without doing the work. I miss Paris.
**VL:** You could come back.
**RF:** That would be too much like running away.
**VL:** I know. You're the kind that stays and fights.
**RF:** I don't want to fight, Vittorio. I just want to work.
**VL:** How is the work?
**RF:** I'll see it through. I just wish there was someone I could talk to about it.
**VL:** You can talk to me. You know that.

[Botanical Gardens / Park]
**RF:** The A-form gives far more detail than we've ever had before, but all Maurice can see is that the B-form shows some signs of being helical. It's an obsession, this helix. There's nothing that says helix in the A-form. Absolutely nothing.
**VL:** Have you thought of trying a Patterson calculation? I know it's a long job, but it could settle the matter.
**RF:** Yes, I've thought of it. I don't mind the hard work. You know that. I just wish… I just wish there was someone like you to talk to.
**VL:** What are you going on about? What about the famous English pubs? Don't you all go down to the pub at the end of the day?
**RF:** Pubs are for men.
**VL:** What a country.
**RF:** They're making me hard, Vittorio. That's what's so cruel. In the end, you become the kind of person people expect you to be.

**[Paris-press headline reads: Le Roi est mort. The King is dead.]**
Part 7. It's not fair

[Spring 1952. Cambridge courtyard.]

**JW:** I'm telling you this thing is gonna take off.
**JK:** You know the arrangement, Jim. DNA belongs to Randall.
**FC:** Problems don't belong to people.
**JK:** I just don't see how you can go on with it.
**JW:** There's always Tobacco Mosaic Virus. I could look at the nucleic acids in TMV. It's not DNA, but it's the nearest I'll get. I might even learn some X-ray diffraction technique.
**JK:** You want to learn X-ray diffraction photography?
**JW:** Sure, why not?
**JK:** You mean do it, with your own hands?
**JW:** It wouldn't hurt to pick up the basics, and Francis can explain his helical diffraction theory to me.
**JK:** Ah, now that was good work. That's helped you with Bragg, Francis.
**FC:** Well, the helical diffraction theory came out of the excitement over DNA. That's what science is like. It's not all cold reason. There has to be excitement. It's like love. You can't be told, "Love this woman. Don't love that woman." You follow your heart.
**JK:** Even if she's another man's wife?

[Watson walking down hallway with a canister. Bragg and Perutz stare at him.]

**JW:** Something wrong?
**WLB:** Is Watson actually working? In a lab?

[Freda Ticehurst with flask of boiling liquid walks into darkroom]

**RF:** My Uncle Hugh attacked Churchill with a dog whip.
**FT:** Our Churchill? Winston?
**RF:** [nods] Mm.
**FT:** Why ever would he do a thing like that?
**RF:** Churchill was against votes for women.
**FT:** I never knew that. I voted for him this time.
**RF:** Oh, it was a long time ago: 1910.
**FT:** So, it's in your blood, then?
**RF:** What is?
**FT:** Being fierce.
**RF:** Am I fierce?
**FT:** You can be.
**RF:** I don't mean to be. I really don't.
**FT:** You [meaning Franklin] have to be careful with the men. I've noticed that.
**RF:** Yes, I've noticed that.
**FT:** Would you like to be married?
**RF:** Sometimes.
**FT:** I was engaged. He didn't make it through the war.
**RF:** There'll be others, Freda. You're not fierce.
**FT:** Have you ever been asked? [Franklin shakes her head no]. Plenty of time.
**RF:** No, I'd rather do one thing well than two things badly.
Lesson 7.1: Double Helix / Life Story Script

[Pop Prior's boarding house]
**JW:** Le roi est mort (The King is dead). **Merci** (Thanks). Le roi… uh. You know, with the…
George… six. Um, un, deux, trois… Six?
**Woman:** Ah, oui. Six.
**JW:** Mort…
**Woman:** Six more?
**JW:** No, no. Mort. You know. **Qu'est-ce que c'est** (what's this)?
**Pop Prior:** Qu'est-ce que c'est, Jim?
**JW:** I'm telling her the king is dead.
**Pop Prior:** Oh, that was our topic 3 Thursdays ago, Jim. This Thursday, my girls have prepared conversation on Mr. Butler's budget.
**JW:** Great.
**Woman:** Do you eat bread? Now it more by one penny and half. Do you drink tea? I think it is, for one pound, eight more pennies and half.

[Street]
**JW:** It's not natural. It's not fair. I'm being deprived.
**FC:** You mean missing DNA.
**JW:** Missing L-O-V-E.
**FC:** You're in too much of a hurry, Jim. Girls over here need time.
**JW:** Yeah, time. Everything has to be given time. You give your time, and you know what you get? Old.

[Crick and Watson's office]
**JW:** Francis, come and see what I've got. I took that [X-ray photograph] with a vertical axis. It's a helix, right?
**FC:** It could be. Get me a sharper pattern, and I'll tell you.
**JW:** Tell me now.
**FC:** You want the benefit of my years of toil involving the helical diffraction theory?
**JW:** You did it all in one afternoon. You got a headache. You went home, got bored, and worked the whole thing out.
**FC:** Not so loud. My lifetime's achievement. Now… with a helical structure, the X-rays diffract like this. Like a cross. Further out, the reflections come back again, forming a sort of an open diamond. Now, what tells you it's a helix is what's here in the middle, which is nothing. With other structures, you get spots. With a helix, it's black.
**JW:** How do you read the dimensions of the helix from the pattern?
**FC:** Well, this… tells you the pitch [the height along the vertical axis for one strand to make a complete revolution]. Count the layer lines… to here and you've got the repeat. That's what we need, Jim, one of these on DNA.

[Franklin's lab]
**RG:** Number 51. It's very good.
**RF:** Yes, it is good.
**RG:** That's the best we've got yet of the B form.
**RF:** Yes. One thing at a time, Raymond. The A form gives us far the most details, so first we do the Patterson on the A from. We'll get to the B form all in good time. There's no hurry. [Gosling looks unconvinced, Franklin enters data onto a calculating machine]
[Watson, Odile and Crick walking in street]
**FC:** Want to hear the news, Jim? Well, there's good, and there's bad.
**JW:** Bad first.
**FC:** Linus Pauling has been invited to London for the Royal Society meeting.
**JW:** No!
**FC:** He's written to Maurice.
**JW:** No! Oh, holy cow.
**FC:** Brotherhood of science, remember? You show me yours, I'll show you mine.
**JW:** If Linus sees just one of those X-ray pictures –
**FC:** Ah-ah, now for the good news. The state department has withdrawn his passport. [laughs] He can't come.
**JW:** They did that? What?
**FC:** Yeah. Well, you know Linus has been sounding off about the atom bomb. Apparently, to your average American, that means he's in the pay of the KGB.
**JW:** Holy cow. God bless America.

[Costume party, lots of flirting]

**Rosemary Clooney Song:**
*Come on-a my house, my house.*
*I'm gonna give-a you candy.*
*Come on-a my house, my house.*
*I'm gonna give-a you apple-a plum and apricot-a too, eh.*
*Come on-a my house, my house-a, come on.*
*Come on-a my house, my house-a, come on.*
*Come on-a my house, my house.*
*I'm gonna give-a you figs and dates and grapes and cakes, eh.*

**FC:** I say, Jim, you do look the part [as a vicar].

**John Griffith (JG):** I heard you've been told to lay off DNA.
**FC:** No harm in pushing a few ideas around.

**Song:** *Come on-a my house, my house.*
*I'm gonna give-a you everything.*

**Woman:** Excuse me. Will you settle a bet for us?
**JW:** Yes, sure.
**Woman:** Are you a real vicar?
**JW:** Am I… no.
**Woman:** Oh, sugar! [she walks away]
**JW:** Sorry about that.

**FC:** John, the point is, the genetic information has to be carried by varying the order of the 4 bases, adenine, thymine, guanine, cytosine, right?
**JG:** Right.
**FC:** So I was thinking, what if it's the bases that hold the chains together, adenine to adenine – ah, excuse me – guanine to guanine. They could come in any order, any amount of variation.
JG: What's the glue? Hydrogen bonds?
FC: No, I was thinking the electrical charges. Your field, the sort of thing you could work out, how the pairs could bond.
JG: Hmm, interesting problem.
Part 8. Little problems

[Franklin and Wilkins, clearly uncomfortable, in Randall's office]
JTR: I don't like to give orders. I like solutions to evolve. Everyone's different, different ways of working. No harm in that.
MW: I appreciate that, J.T. I have no objection to the way Rosalind is working, but what I had not anticipated was that Rosalind's work would – well, how should I say – would have such an effect on my own work.
JTR: I don't read you, Maurice. What effect has it had on your own work?
MW: Well, to put it bluntly, you could say as far as DNA goes, in one sense, I've not done any work at all since Rosalind…
RF: Are you saying…
MW: Of course, there is the plant cell division work –
RF: Are you saying this is because of me?
MW: Up to a point.
RF: I was brought in here to do X-ray crystallography on DNA. That's what I'm doing. I really don't see why it should limit your work.
MW: I appreciate that Rosalind has the right technical background for the work on the crystalline –
JTR: What exactly is it you're concentrating on at present, Miss Franklin?
RF: The Patterson projection of the A form.
JTR: And the B form?
RF: We've put it aside.
MW: If I may suggest –
RF: For the present.
MW: If I may suggest, if Rosalind continues to work with the Signer DNA on the A form, then perhaps I could see what I could do with the B form. I could try the sample that we got from New York.
JTR: Independent work, you mean? Yes, I like it. Separate approaches keep us all on our toes, hmm? Does that present you with any undue difficulties, Miss Franklin? [Franklin shakes her head no] Good. That's settled then. There's always a way around these little problems in the end.

[Lounge at Cambridge]
JG: Oh, Francis, I had a go at your base pairs.
FC: Oh, you don't waste much time, I must say.
JG: Nothing solid, just a first look.
FC: Any conclusions?
JG: It's not like attracts like, the way you were thinking. It looks more like adenine attracts thymine, guanine attracts cytosine.
FC: Well, that could work. They don't have to be the same so long as they carry the pattern for each other. A always makes B. B always makes A. Negatives to positives. Yes, it's perfectly OK. That could do the trick.
JG: What trick?
FC: Replication. The passing on of the genetic message. What the birds and the bees do, remember?

[Watson and Crick's office]
Lesson 7.1: Double Helix / Life Story Script

JW: Adenine to thymine, guanine to cytosine. That sounds kind of familiar. Sorry, Francis, I've read so many goddamned papers on DNA, I can't remember which is which.
FC: That way the attraction between the bases holds the structure together and gives us a method for gene replication.
JW: Erwin Chargaff. That's who it was. Chargaff figured out the ratios of the bases.
FC: John. You know Erwin Chargaff, don't you?
JK: Are you two still on DNA?
FC: Well, Jim thinks that Chargaff has figures on base ratios.
JK: I wouldn't be surprised. Chargaff regards himself as Mr. Nucleic Acids. You know he's going to be over here soon? Want to meet him?
FC: Can you fix it?
JK: Just don't tell Bragg it was me, all right?

[Wilkins looking at a mostly dark X-ray photograph]
RG: There's not much you can do with that.
MW: No, there isn't, is there? I'm afraid the new DNA is not what I hoped it would be.
RG: Rosalind's taken some good B form patterns, really very good.
MW: [bitterly] She's got the good DNA, hasn't she? How am I supposed to work without any decent samples? And what does she do with the B form? Nothing. Just on and on and on with the endless Patterson.
RG: Sorry about this, Maurice.
MW: Oh, it's not your fault.
RG: If it's any consolation, Rosalind's not finding the going easy either.
MW: Well, I can't feel sorry for her, Raymond.
RG: What I mean is, she might leave.
MW: She told you that?
RG: No, it's just a feeling I get.
MW: What went wrong, Raymond?
[Raymond shrugs, I don't know]
MW: Well, let me know if anything... changes.

[Franklin in lab entering numbers into a calculator]
RG: Do you think it will turn out to be a helix?
RF: Not you too, Raymond [groans]. You read detective stories?
RG: Yes.
RF: Well, you don't read the ending first to see who did it. It spoils the book. Satisfaction doesn't come from knowing the solution. It comes from knowing why it's the solution.

[Banquet Dinner with Chargaff]
Erwin Chargaff (EC): Linus Pauling has an exaggerated notion of the role of the scientist. I am not defending the State Department act. It's an absurdity. But if you fellows are saved the spectacle of Linus Pauling preaching peace on earth, you should be duly grateful.
JK: Is Linus Pauling working on DNA now?
EC: Not that I am aware of. Not what I would call working. He may throw out a theory or two on the subject. It has become the regular campus sport. Whenever students gather, first they solve the problems of world disarmament. Then they discover the structure of DNA.
JK: A couple of our men have been taking a look at DNA.
EC: You surprise me.
EC: Where in the States?
JW: Chicago.
EC: Ah, Chicago. Windy, I hear.

[Later, over tea]
FC: Well, the idea we've been playing with is that the structure is held together by attraction between the bases. I thought at first it would be like pairing with like, but one of our colleagues has done some calculations on the electrostatic charges, and it looks as though it could be purines pairing with pyrimidine – adenine to guanine, thymine to –
EC: Adenine and guanine are both purines.
FC: Well, adenine and thymine, and the principle's the same.
EC: It intrigues me that you gentlemen think that you can establish a structure for DNA when you don't trouble yourselves about the differences between the bases. There are four of them, of course. I grant that's a lot to hold in the mind all at once.
JW: Dr. Chargaff, I've read one of your papers. Don't your results show a consistent ratio between the bases in all the types of DNA you examined?
EC: Yes.
JW: Don't your results point to a pairing of pyrimidines and purines?
EC: No. I shall say this slowly, because it involves some long words. My results show a rough equivalence between adenine and thymine, and between guanine and cytosine. It took me two years just to discover the technique that produced those results, which we call paper chromatography, by the way. So I wish you well on your hobby.

[Crick searching for John Griffith. Opens door to find him with a woman.]
FC: Listen, John… [realizes he's barged in, closes door] Listen, John. I need your help. You know those calculations you did for me? I forgot to make a note of the order of the bases.
JG: For God's sake, Francis!
FC: Just give them to me one more time, will you?
JG: Adenine to thymine. Guanine to cytosine.
FC: Ah… Thanks, old man.

[Watson and Crick's office]
FC: What's the use of getting a structure for the gene if it doesn't tell us how genes reproduce? I mean, that's the beauty of pairing the bases.
JW: Easy, Francis. Getting a few figures to fit is dangerous. Never trust evidence, remember?
FC: Now, I'm not saying the bases have to work in pairs. I'm just saying that if I was DNA, that's the way I'd do it.
JW: If you were DNA, your bases would all be different sizes, and they'd come in all different sequences. If you're gonna fit together in pairs, they've got to be made of bubblegum.
FC: Oh, true, true, there is that little problem.
MP: [entering room] Gentlemen, I give myself the pleasure of being the first to tell the news. Pauling is coming to work at the Cavendish.
FC: What?
MP: I believe he's to be given a desk in this very room.
FC: Linus Pauling coming to the Cavendish?
Lesson 7.1: Double Helix / Life Story Script

**MP:** Linus Pauling? No, no, I don't believe I said Linus Pauling, did I? It's his son, Peter. I understand he's a research student.

**JW:** Peter Pauling. That's great. Peter Pauling's OK. I've met Peter Pauling.

**FC:** Max, you did that on purpose.

**MP:** My report was accurate, Francis. It was just not complete, but you see, you had a preexisting theory –

**FC:** Oh, spare me, Max.

**JW:** The news is good. Peter will tell us what his old man's up to.

[Franklin's lab]

**RF:** Raymond? Here. Look. Do you see the left and right quadrants? [on an X-ray photograph]

Different intensities.

**RG:** In the A form.

**RF:** One thing's clear. If it's not symmetrical, it's not a helix.

**RG:** Maurice will be sad to hear that.

**RF:** Maurice thinks I don't share enough with him, doesn't he?

**RG:** Sometimes.

**RF:** It's not because I want it all for myself. I just like to know what I'm talking about, which means getting the work done first. But if Maurice wants to share … let's share.

[Gym at Cambridge.

Crick reads newspaper while waiting for Wilkins to finish fencing.]

*Daily Express* headline reads: *Knighthood for Bomb Scientist*

**Leo:** Parry 1-2.

**MW:** Hay!

**Leo:** Good. And again.

**MW:** Hay!

**Leo:** Good, excellent, Maurice. Lunge, Good. Advance now. Good. Salute. And rest. Well done, Maurice.

**MW:** Thank you, Leo. Thank you.

**FC:** A curious sport: stab, stab, stab, but no penetration.

**MW:** Harder than it looks.

**FC:** Apparently. Have you seen this? Bill Penney's been knighted. Just think: if you'd stayed in the bomb business, you'd be Sir Maurice today, honored by a grateful nation.

**MW:** At least I wouldn't have to work with Rosie.

**FC:** Is it that bad?

**MW:** I'll show you something she's just sent me.

[Street. Rain. Under umbrella.]

**FC:** "It is with great regret that we have to announce the death of DNA helix (crystalline). A memorial service will be held. It is hoped that Dr. Wilkins will speak in memory of the late helix." This from Rosie?

**MW:** Yes.

**FC:** Well, at least she's got a sense of humor.

**MW:** It's not a joke. She says her Patterson calculations show an asymmetrical structure.

**FC:** That's impossible.

**MW:** Why?
FC: It's ugly.
MW: Well, who says DNA is beautiful?
FC: Yeah, there's another reason. If DNA isn't helical, we haven't got a hope in hell of working it out.
MW: I thought Bragg had taken you off DNA.
FC: Well, you know how it is, Maurice. Jim and I can't help kicking ideas around.
MW: Well, I envy you that. Rosie and I … There is a rumor she might leave.
FC: Where would she go?
MW: To Birkbeck, maybe.
FC: What would happen to her DNA work if she left?
MW: I suppose I'd inherit it.
FC: Well, you don't sound very pleased about it.
MW: This business with Rosie has killed it for me. That death notice – she's right. Like someone I once knew has died.

[Peter Pauling arrives, opens door to lab]
Peter Pauling (PP): Hi, I'm Peter Pauling. Anybody know what's to be done with me?
Part 9. Little boys

[Pub]

JW: Just don't think of it as beer.
PP: Oh, I've drunk bitter before.
JW: What do you think?
PP: It's good. Could be cooler.
JW: Well, people here don't have refrigerators.
PP: Where do they keep the milk?
JW: On the doorstep. You look around, milk on all the doorsteps.
FC: How's Linus, Peter?
PP: Oh, what do you want to know about the old phony?
FC: What's he working on at present?
PP: Mm, Dad works on everything at once. It depends on what excites him.
JW: Is he doing anything on DNA?
PP: I guess so.
FC: Along with everything else, or a big push?
PP: Oh, I don't know. A little push, maybe. Round about when I left, he was getting pretty interested in genes. Why? Is that what you guys are working on?
[FC nods]
PP: Oh. [pulls a rat turd from his bag of potato chips] Hey, what's this?

[Franklin greets Vittorio at train station disembarking. They enter Franklin's lab.]
RF: Voila, my little kingdom.
VL: It's not bad. Ah, the famous Patterson. How's it going?
RF: Slowly.

[They walk the hallways. She shows him the Common Room, opens door]
RF: Here, take a look.
VL: Good morning.
RF: Reserved for men. Women are not allowed.
VL: What? What kind of crazy…?
RF: I just wanted you to see for yourself, Vittorio. Sometimes I think it's all in my head.
VL: So, you've really decided to leave?
RF: Yes.
VL: What about your DNA work? Are you going to finish it?
RF: It never gets finished. You know that… [jokingly] Actually, we're making the ultimate map of the universe.

[Park]
RF: Maurice will be glad to see me gone. Then once more, DNA will belong just to him.
VL: Will you hand over your work to him?
RF: Yes, of course.
VL: Maybe he'll finish it.
RF: Is it really so important who finishes the puzzle? We all stand on each others' shoulders.
VL: That's true. But suppose someone else came up with the answer. How would you feel about
that?
RF: I don't know.

[Raymond knocks on Wilkins' door]
RG: Maurice. [enters, places notebooks and X-ray photographs on his desk]

[Train station]
JW: Hi, kid.
EW: Jim, what happened to your hair?
JW: Oh, I don't want to hear it. I'm very sensitive about my personal appearance. I fixed you up a room in town. Nice place. You'll love it.
EW: What's with this brotherly concern, Jim?
JW: How's your French?

[Pop Prior's boarding house]
JW: Jouez-vous tennis?
Woman: Tennis?
PP: Hey, you want to see Jim jump?
EW: That, I would like.
PP: Tell him my father's built a model.
EW: That'll make him jump?
PP: Yeah, just try it.
EW: Jim.
JW: Oui? Sorry.
EW: This young man says that his father's built a model.
JW: What?!!

[Street at Cambridge]
FC: What?
JW: Maurice never sent him any prints, did he?
FC: No, no, I'm sure he didn't.
JW: So he's working blind.
FC: Yeah, as far as we know.
JW: Except if anyone can see in the dark, it's Linus Pauling.
FC: I know, it makes me weep and tear my hair out. There's Maurice and Rosie with all those beautiful photographs, and Maurice is sulking, and Rosie's doing a Patterson projection. It's like asking a team of monkeys to type out Shakespeare. It'll take centuries.
JW: Isn't there some way we can see their stuff?
FC: Well, Maurice will show us if Rosie leaves, maybe.
JW: We're just gonna have to get Peter Pauling to write to Linus, "Dear Dad, Please delay breakthrough of the century by a couple of months. You're famous already. And give the little guys a break."

[Franklin in Randall's office]
JTR: You've done the MRC report, of course.
RF: Of course.
JTR: I can't say I'm happy about how this has worked out, but if it's what you want.
RF: About my work on DNA, I would like to be able to see it through.
JTR: Go as far with it as you can, by all mean.
RF: So there'd be no objection to my retaining an interest in the subject after I've left King's?
JTR: Ah, I see what you mean: the same work going on here and at Birkbeck. I don't need to tell you how things are, Miss Franklin. Nonscientists think of science as universal, celestial even. Science is terrestrial, territorial, political. Would it be fair on Maurice?

[January 1953. Wilkins' office. Wilkins sees Photograph 51]

[Lounge at Cambridge]
PP: Sorry, boys. Can't head the old man off at the pass. He's been and gone – the structure for DNA. Oh, I don't suppose you two guys would be interested in taking a look? [gives Crick and Watson a copy of the manuscript]
JW: He's got 3 chains. Nucleotides spaced at 3.4 angstroms. Phosphates in the center. He left the hydrogens on. Why would he do that?
FC: He's trying to hydrogen-bond the phosphates.
JW: Wouldn't the phosphates be ionized?
FC: Yes, they would.
JW: So they'd repel each other.
FC: Yes, at neutral pH, they would.
JW: This thing could never hold together.
FC: Never. It would blow itself apart.
JW: He's screwed up, hasn't he?

[Crick and Watson clink glasses in a toast]
FC: To Linus Pauling.
JW: Linus… A humiliated Linus is a dangerous Linus.
FC: The Linus cheated of his prey.
JW: Francis. We just ran out of time. In the words of Isaac Newton, "If the apple won't fall, let's go shake the tree."
FC: Newton said that?

[Watson walks down hallway at King's. Tries Franklin's door. Locked. Opens door to X-ray Room. Franklin is working at bench. Watson barges in.]
JW: Linus Pauling's structure for DNA. Look at this. We knew this would happen. We knew Linus would get onto DNA. Look at that. Hydrogens. Hydrogens! [shakes head back and forth] Look at that. Look at that. Look at that.
RF: It doesn't make sense.
JW: That's right. It doesn't.
RF: Well, what data has he been working with?
JW: Pre-war Astbury and Bell, lousy data. This is the point. He'll go at it all the harder now. He'll get it. I'm telling you, that's the kind of guy he is.
RF: Well, so?
JW: So, we have to pool our resources. We have to move fast.
RF: And what resources do you have to pool?
JW: You know how it goes. All those hours, all those experiments, you can get too close to it.
RF: Oh, you think you can do better?


Lesson 7.1: Double Helix / Life Story Script

**JW**: A fresh eye. [he reaches to grab her papers, she stops him]
**RF**: You think this is some sort of game, don't you?
**JW**: What do you mean?
**RF**: You think this is a playground, and I've got the ball. "Go and tell the teacher, that bad girl won't let us play with her ball." But there is no teacher. This isn't a game. Little boys. [starts to yell] You're all just little boys! Go and play with your little boys. I am not a little boy. I don't like your game, and I won't play. [backs him out of the room and slams the door on him]

**JW**: Oh, wow.
**MW**: Hello, Jim.
**JW**: What did I say?
**MW**: Oh, that's our Rosie.
**JW**: That's not a woman; that's a Sherman tank.
[Franklin sobs in lab]

**JW**: Well, I had no idea. What is it that gets into her?
**MW**: I don't know. I wish I knew.
**JW**: How long before she leaves?
**MW**: Oh, a few more weeks.
**JW**: Maurice, we don't have that kind of time. Look. Pauling is going after DNA. This is his first shot and he's missed. Look. Look, look. So he's going to be coming back. He'll rupture himself to protect his reputation, Maurice.
**MW**: Well, this doesn't make sense.
**JW**: Somebody has to do something.
**MW**: Somebody has to do what?
**JW**: Crack DNA soon.
**MW**: Somebody? What exactly is it you want, Jim?
**JW**: I want us – any of us, all of us – to keep ahead of Pauling. Tell me you're onto it, Maurice. That's OK, but you have to move fast.
**MW**: I can't do anything until Rosie leaves. When we have all the data together, then we can do it properly. Also, I have not had a close look yet at her evidence against the helix.
**JW**: Hey, hey, of course it's a helix. Even Linus has a helix.
**MW**: Oh, yes. It's a helix. Look at this. One of Rosie's best. [takes out Photograph 51] Now that is a helix. There's no two ways about it. [he hands the photo to Watson]
**JW**: How long have you had this?
**MW**: A few days.
**JW**: Maurice, you have to get moving.
**MW**: I have been patient so far. I can be patient a little longer.
**JW**: But Maurice...
**MW**: No, Jim. She'll be gone soon. Then it's all hands to the pumps.

[Watson on train back to Cambridge sketches a copy of photograph 51]

**JW**: I couldn't believe my eyes. It was just sitting there, yelling out information like a speak-your-weight machine.
**FC**: All right, Jim. Just be very calm. Tell me only what you're sure you saw.
**JW**: A double diamond pattern, empty in the middle. Helix, no doubt about that. There was a big
reflection just here.

**FC:** Tenth layer line?
**JW:** Definitely the tenth.
**FC:** That would give us a pitch of about 34 angstroms. Just tell me one more time you're sure about this.
**JW:** I'm sure. What do you say?

[Pertuz in Bragg's office]
**MP:** You know the situation at King's. Nothing will happen there until Rosalind Franklin leaves.
[Bragg nods] Crick and Watson tell me they have a new approach. They want to try again.
**WLB:** Do you believe them, Perutz?
**MP:** Perhaps I think more highly of Crick than you. His helical diffraction paper was very fine.
**WLB:** I grant you that.
**MP:** And then there's the matter of Linus Pauling.
**WLB:** I suppose I find it hard to believe that Crick and Watson can succeed when Pauling has failed. Though I can't pretend I would not be very agreeable were they to do so. They want to build another model, I suppose.
**MP:** They want permission to instruct the machine shop to make the proper parts. They didn't have the proper parts last time.
**WLB:** All right, Perutz. Tell them to go ahead, but no public showings until our people have checked it.

[Street]
**JW:** We had 3 chains last time. It's two!
**FC:** No, you just said two's prettier.
**JW:** Two's natural – two eyes, two hands, two breasts.
**FC:** No, 3 wise men, 3 dimensions, 3 musketeers.
**JW:** Two's company, three's a crowd…
Part 10. She hasn't seen it


[Watson and Crick's office. Building model.]
JW: The phosphates are still too close. They'll push each other apart.
FC: Well, maybe the phosphates shouldn't be on the inside. Why not try them on the outside?
JW: That would be too easy.
FC: Then why not do it?
JW: Francis, if we put the backbones on the outside, how do we make the bases fit together on the inside? How are we ever gonna do that?
FC: I don't know. We'll take care of the bases later. Just try it. That is the whole idea of building models.
JW: Fine.

[Franklin writes: "Phosphate groups on the outside"]

[Walking on campus]
MW: She leaves on March the 13th.
FC: What's she doing until then?
MW: Writing up her work. She's done most of it for the MRC report.
MW: Not that you two rogues paid the slightest attention.
FC: Oh, be fair, Maurice. We only make guesses. It's the kind of thing you can't help puzzling away at.
MW: I know, Francis. I don't mean to sound grouchy. You know how I dislike the dog-in-the-manger attitude. That's how Rosie is. I come through the door, she fights me.
FC: No, you're right, Maurice. There has to be a free flow of ideas.
MW: Which is just what we haven't got.
FC: But it's not your fault, Maurice. You've never had a dog-in-the-manger attitude towards DNA.
MW: No, I haven't, have I?
FC: Now, you wouldn't mind if Jim and I had a go at another model, would you?
MW: Another model?
JW: We thought we'd slip one in before Linus makes his comeback.
FC: You never know – I mean, get a few more free ideas to throw into the pool.
MW: Does Bragg know?
FC: Bragg doesn't mind. He doesn't take our DNA enthusiasm very seriously, to be honest, not after last time. But, of course, if you mind, Maurice…
MW: No, I don't really mind. How can I?

[Watson and Crick reading Franklin and Gosling's MRC paper: X-Ray Studies of Calf-Thymus D.N.A.]
JW: Ooh, she's good.
FC: She's very good.
**Lesson 7.1: Double Helix / Life Story Script**

_JW:_ She's got the phosphates on the outside. She's got all the dimensions of the unit cell. Look at this. Jesus, Francis, if we'd had this before –

.FC: Shut up. Shut up, shut up. It's right here, Jim, but she hasn't seen it [space group C2].

_JW:_ What?

.FC: Well, the space group C2. It's just like hemoglobin. God forgive me for cursing my thesis all these months.

_JW:_ What does C2 mean?

.FC: It's a dyad, the fibers symmetrical end over end.

_JW:_ A dyad – two chains?

.FC: Yes, 2 chains but running in opposite directions, so the structure's symmetrical end over end. Ah! That's where we've been going wrong. One comes up. One goes down. We've only been building half the structure. If both chains run in the same direction, the structure's repeating itself by the time we get to here. Whereas if the chains run in opposite directions, we have to take a complete turn of both chains to get to the point where the structure's repeating itself. Gah! We'll have to double all the angles. I'll do it. I'll build it. Then you'll see.

_JW:_ And you really think she hasn't spotted this, Rosie?

.FC: Not yet.

[Watson playing tennis with his sister at a feverish pace.]
[Chink building model.]
[Franklin writing up her notes.]

.FC: So this chain runs up, and this one runs down.

_JW:_ OK.

.FC: So we have a helix.

_JW:_ We have two chains.

.FC: We have the dimensions.

_JW:_ We have the phosphates on the outside.

.FC: Which leaves the bases…

_JW:_ Which have to fit on the inside…

.FC: Which they don't.

_JW:_ Yet.
Part 11. Pairing the bases

[Watson with Crick trying to figure out how the bases fit inside the double helix.
Close-up of enol form of uric acid; to its left is the keto form.]
JW: 4 bases, all different shapes, free to come in any order to carry the genetic information.
FC: It's like filling a Christmas stocking. It's gonna be bulgy.
JW: Can't be bulgy. Got to be pretty.
FC: Remember Chargaff's ratios [writes A-T and G-C]. Complementary pairing?
JW: Still doesn't make them fit. Irregular pieces, a variable order, an irregular structure. This thing's either a monster of complexity or it's so simple we're missing it.

[Close-up of research papers on Franklin's desk while she's working. Camera pans from sketch of double-helix to photograph 51 to her writing the words "double helix"].

[Watson and Crick's lab]
PP: Go wild, Jim. Have as many as you want.
JW: What?
PP: Sweet rationing's ended. Greed is back.
JW: This is driving me crazy. There's got to be a way to fit these things together, only there isn't.
Jerry Donahue (JD): [looking at double helical model, leans over Watson to look at his drawings] Hey, you've got the enol form.
JW: So?
PP: So you know, this is Jerry's field, Jim: tautomeric forms. You should listen to him.
JW: I'm listening.
JD: You've got the enol form from Davidson?
JW: All the textbooks.
JD: They're all wrong. Take it from me. It's one of those guesses that's been repeated so often it's got the status of fact.
JW: Wait a minute, you're telling me I should try the keto form?
JD: I'm 100% sure of it. Try it like that (moves a hydrogen from an OH group to its neighbor, making it an electronegative oxygen]. See what you get.

[Watson cuts/pastes cardboard models of the bases]

[Wilkins crafts letter to Francis Crick, starts with "Thank you". Mails letter on street.]

[Watson trying various configurations of base pairings. Discovers that A-T and G-C base pairs are the same sizes and occupy the same space. Crick and Watson go running through the street to pub to announce: "We've done it."]

[Franklin finishes summary of her work, sighs]

[Crick and Watson in pub celebrating. "The secret of life"]
Part 12. It's beautiful

[Camera shows completed model of DNA]
FC: That's it, isn't it?
JW: That's it. That surely is it.
FC: I feel like Pygmalion. You build something beautiful and it comes to life. All we wanted was the body and we've got the soul. That's how it is, Jim. Isn't that how it is?
JW: That's how it is.
FC: The secret of life itself. Peel the chains apart, and each chain reproduces the other. One becomes two, two becomes one, generation on generation, all the way from Adam and Eve to you and me. It never dies, Jim. It never dies. One simple shape: the womb of humanity, endlessly, effortlessly fertile, dividing, reforming itself from the beginning to the end of the world. It's the closest we'll ever get to immortality, Jim.
JW: I knew it would be pretty.
FC: [reads letter just delivered] "Dear Francis, I think you'll be interested to know that our dark lady leaves us next week. At last, the decks are clear, and we can put all hands to the pumps. Maurice."
JW: Rosie.

[Franklin's lab is empty, dark. Ominous music]

[Crack explains model to faculty at the Cavendish. Perutz sheds tears.]

[Evening. Franklin walks down alley, leaving King's College for good. Again, she encounters some pranksters, but instead of being intimidated, she walks right through them.]

[Morning. Watson standing on a bridge with Elizabeth Watson, leaning on the railing]
BW: You're very quiet, Jim.
JW: Am I?
BW: Isn't this the big time. That's what you keep telling me.
JW: When you want something, you want it so bad it hurts, and then you get it…

[Maurice looking at model]
MW: It's beautiful, Francis. Very… simple, very true.
FC: It's yours, too, Maurice, if you want it. You began it all. You…
MW: No. This beautiful model… not mine. We'll publish separately for the record. This is all yours. You see, I didn't know you… I just didn't know, did I?

[Watson dictating paper to Elizabeth Watson typing]
JW: We have been stimulated by a knowledge…
BW: I don't see why this can't wait till Monday.
JW: …of the unpublished experimental results and ideas…
BW: Why me?
JW: 'Cause you can type.
BW: … results and ideas …
JW: …of Dr. M.H.F. Wilkins and Dr. R.E. Franklin.
[Franklin looking at model. Bragg enters]

WLB: Dr. Franklin, is it?
RF: Yes.
WLB: It looks as if they've got it right.
RF: [looks at Bragg and smiles] Yes.
WLB: I've given my life to crystallography. I never thought I'd live to see this.
RF: It's your work too.
WLB: And yours.
RF: And mine.
WLB: I know how you must feel. I'm sorry.
RF: I might have seen it, but I didn't. I see it now.
WLB: This race, this winning and losing, it's not the way I was taught to do science.
RF: It doesn't matter. This… is what matters. Life is the shape it is for a purpose. When you see how things really are, all the hurt and the waste falls away. What's left is the beauty.

**Epilogue**

In 1958, five years after the discovery of the structure of DNA, Rosalind Franklin died of cancer.

In 1962, the Nobel Prize was awarded jointly to Francis Crick, James Watson and Maurice Wilkins. The rules of the Nobel Foundation do not allow prizes to be awarded posthumously.