

## **Introduction to this document**

*The Eighth Day of Creation* by Horace Freeland Judson is a narrative history of molecular biology. It tells the story of how scientists in the early-mid 20th century discovered the basic rules of life that we now call the Central Dogma. The book presents both an in-depth analysis of the foundational research and a look into the lives of the scientists involved. We used this book as the primary text for an advanced undergraduate seminar course at the University of Washington in Winter 2020. The course was rewarding for us and we felt our students got a unique perspective on scientific progress, so we wanted to share our syllabus (annotated with some reflections on the course) as inspiration for others to teach similar courses. We welcome any questions, comments, or contributions. If you decide to teach a course with *Eighth Day* please let us know how it goes!

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## Honors 396A/Genome 490

### Scientific Revolution and Molecular Biology: 'The Eighth Day of Creation'

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#### Course overview

The founding of molecular biology was a synthesis of ideas from physics, biology, and chemistry. The efforts of its interdisciplinary founders laid out a vision of life as composed of molecular systems orchestrated by a progression of information from DNA to RNA to protein – what we now call the central dogma. The field's early days were shaped by incredible new technologies, revolutions in logic, and unique personalities. While spectacular, this history is part of a process of scientific development that continues today in burgeoning fields. In this course, we will explore the process of scientific revolution through the history of molecular biology depicted in Horace Freeland Judson's *The Eighth Day of Creation*.

#### Schedule (Thursdays 1:30-3:20 in Foege S-040)

We will meet two hours a week for in-class discussion of concepts and materials from assigned reading excerpts from the book *The Eighth Day of Creation*. Part of this time will also be devoted to review of biological and historical topics touched on in the reading.

Weekly, students will produce a short blurb of their thoughts on the reading using a prompt from instructors. Students will receive feedback on these blurbs to use as starting material for a final major writing assignment. Note that this schedule may change. In the event of a change, we will alert you during class and update the schedule on Canvas.

#### Textbook

*The Eighth Day of Creation*, by Horace Freeland Judson

We recommend the 1st edition (Touchstone Books 1979). If you prefer to use the commemorative edition (Cold Spring Harbor Laboratory Press 2011), note that page numbers will differ.

## Schedule

**A weekly reading list is provided for both editions at the end of this document.**

### **Week 1**

Th, Jan. 9      NA      Introduction to *The Eighth Day of Creation*

### **Week 2**

Th, Jan. 16      Chapter 1      Topic: Biology before it went molecular

### **Week 3**

Th, Jan. 23      Chapter 2      Topic: Pursuing the molecular basis of the gene; first attacks on the structure

### **Week 4**

Th, Jan. 30      Chapter 3      Topic: The structure of DNA

### **Week 5**

Th, Feb. 6      Chapters 3 & 5      Topic: Difficulties posed by RNA; RNA code; The RNA Tie Club

### **Week 6**

Th, Feb. 13      Chapters 6 & 7      Topic: The Central Dogma; bacterial genetics; diauxic shift

### **Week 7**

Th, Feb. 20      Chapter 7      Topic: Gene regulation and the *lac* operon

### **Week 8**

Th, Feb. 27      Chapters 7 & 8      Topic: Solving the code and Soviet science; Nirenberg and Matthaei's system; Crick's suppressors

## **Week 9**

Th, Mar. 5      Chapters 10 & 2      Topic: Protein structure-function; Haemoglobin

## **Week 10**

Th, Mar. 12      Chapter 4 and      Topic: Rosalind Franklin and what comes/came next  
Rosalind Franklin  
essay\*

## **Week 11 (Final exam period )**

Fr, Mar. 20      **Final paper due**

\*Note: the Rosalind Franklin essay is only available in the commemorative edition. We made a PDF of this available to students.

## **Grading**

The final grade will be determined by participation, weekly writing assignments, a topic presentation, and a final writing assignment. See Rubric.pdf for details of grading expectations.

*Participation (45%):* The course is structured heavily around in-class discussion of the reading material. Attentive listening and active engagement in class discussion is worth 45% of the final grade. Each class period represents 5 points toward the participation grade over the ten week period; the single lowest participation grade will be dropped. Please discuss with the instructors if circumstances arise requiring an extended absence.

*Weekly Writing Assignments (20%):* Each week students will be given reading assignments and will be asked to write a short statement (200-400 words) based on the reading and provided writing prompts. These weekly writing assignments are due by 9:00am the day of class. Each writing assignment is worth 2.5 points; late assignments will be graded at minus 1 point each day following the deadline (starting at 9:01am).

*Topic Presentation (15%):* Starting in week 3, each class period will end with one short student presentation (5-7min each). These presentations will provide foundational information on a biological topic, discovery, or technique that will make an appearance

in the subsequent week's reading. Signups for topics and dates will take place during the first class period.

*Final Writing Assignment (20%):* Each student will write a final 4-5 page essay, drawing from the weekly assignment material and based on a final writing prompt. The final writing assignments will be due at 4:20pm March 20, 2020.

## Recommendations for future instructors

After taking some time to reflect on the course, we have some thoughts about what went well and what could be improved in future iterations. Feel free to reach out for clarification on any of the following points.

Aspects of our approach that we felt were successful:

- We opened each in-person meeting with a class effort to generate a timeline of events from the week's reading. These timelines were an extremely useful exercise, serving as 1) a review of the events in the reading for each student at the start of class, 2) an immediate insight into what stuck out to our students, and 3) a visual reference during discussion for the rest of the period.
- We additionally asked pairs of students, in class, to work through one of the benchmark experiments in that week's reading and then diagram it (question, method, results and conclusion) on the board for the class. This revisiting of the description they had read, along with the incentive to explain it to the rest of the class, seemed to help in solidifying the logic behind each individual experiment and the big picture revealed by each week's experiments in aggregate. These are tricky concepts after all, worthy of the term revolutionary! We started this approach several weeks in, which may have given the students time to build some comfort with the material and with discussing complex topics together.

There are also many things we would do differently if we were to teach this course again. We think it would improve the course to:

- Re-work the readings a bit to mix up experiments and narrative, particularly weeks 7 and 8 which students reported were "boring".
- One of the discussion topics we brought up is the idea of Judson's perspective on the events in the book. *Eighth Day* is largely composed from Judson's interviews with many characters and at times appears biased by the people he had access to. For instance, he included very little on Barbara McClintock and could not interview Rosalind Franklin. Many individual characters introduce their own biases in how they discuss people they worked with. In future iterations we would dig deeper into this aspect of the history.
- Related to the above point, we would include more multimedia and external sources. This would necessitate cutting back *The Eighth Day* page assignments even more (or increasing the course credits!), but would have helped with pacing, in addition to exposing students to alternative sources. This would have provided an opportunity to cover more deeply some of the female scientists (ex.

McClintock, Dorothy Hodgkin) and additionally allow for more modern updates since the 70s. We have included some possible resources below as a starting point.

- Have students peer review each other's writing assignments (as in the [Calderwood seminars](#)). This would have helped disseminate perspectives, and given students an opportunity to see writing styles of others.
- Change up the presentation system – one of the weaker aspects of our course structure was the weekly topic presentations. The approach is not without merit (and there were some real gems among the presentations we saw), but the exercise as outlined in our syllabus did not connect as directly to the readings as we hoped and may not have been beneficial to the students as a result. At the very least, there were instances when the topic assignment should have been more specific or different for a given week.

## Example writing prompts

Each week we provided multiple writing prompts for students to choose from. Below are examples of prompts that elicited the most responses.

(Week 3)

On page 94 Chargaff offers the comment: “to a scientist nature is a mirror that breaks every thirty years.” What did he mean by that? Would you agree? If so, would you consider that a feature or a bug of the scientific process?

(Week 5)

Page 193-194 includes discussion about competition: who Watson saw himself as competing with, opinions on who he was really competing with, and Watson’s own assertion that competition is “the dominant motive” in science. Do you agree with Watson’s statement? What role do you think competition plays in the advancement of science, and is this to science’s benefit or detriment?

(Week 7)

One of the prevailing ideas at the time was that rRNA was the messenger, and ribosomes (as made of protein+rRNA) were specific for specific gene products. Does the eventual overturning of this idea with the discovery of mRNA count as a revolution? Do any of the revelations in this section (the idea of regulation of expression, the PaJaMo experiment, etc.) count as revolutions in biology? What makes a discovery revolutionary?

(Week 8)

Barbara McClintock a) seemed to have similar ideas about gene regulation as Jacob and Monod, earlier and in a more complex system, and b) was working under conditions almost certainly biased against her (sometimes she worked without pay). Comment on this.



Two to four options for writing prompts were provided each week; students were expected to respond to one of these of their choosing. Below are paired examples of prompts given the same week, for which one (*italics*) failed to receive any responses.

(Week 4)

There were a number of wrong turns and incorrect models put forward before Watson and Crick proposed the double helix structure. Do you think the multiple incorrect models proposed are a reflection of: The hurried nature of the research (the perception of a competition)? The difficulty of the problem? The nature of all science, just most of the time the wrong models do not get as much press as these did? Other aspects of the story?

*Comment on the ways partnership, collaboration, and communication (or lack thereof) influenced the course of science when it came to understanding the structure of DNA.*

(Week 5)

Page 193-194 includes discussion about competition: whom Watson saw himself as competing with, opinions on whom he was really competing with, and Watson's own assertion that competition is "the dominant motive" in science. Do you agree with Watson's statement? What role do you think competition plays in the advancement of science, and is this to science's benefit or detriment?

*The discovery of the double-stranded helical nature of DNA is often lauded as one of the landmark discoveries in biology. Comment on the ways in which thinking about and approaching biology changed after the discovery and why this might be considered a "revolution."*

We are happy to provide additional examples of writing prompts used in our course upon request.

## Additional relevant media

We incorporated the following media into our course and felt that they complemented the book well:

We showed a Sydney Brenner interview, and there are many others that might have been appropriate (week 5)

<https://www.youtube.com/watch?v=MvJYU3c3Zco&list=PLVV0r6CmEsFyxf1sRqxZgh-06Wfw4zgPj&index=58>

We played a clip from the play *Photo 51* by Anna Ziegler (week 4) available on YouTube. <https://www.youtube.com/watch?v=KCy22tEkBFo>

We showed Crick's letter to Watson about "Honest Jim" (week 3)

<https://profiles.nlm.nih.gov/spotlight/sc/catalog/nlm:nlmuid-101584582X137-doc>

We did not include these resources, but they may be useful in providing additional context:

Information about female and POC scientists who received little if any attention in the text. This list is non-comprehensive and should be treated as a starting point for additional research.

[McClintock](#); McClintock's [Nobel Prize lecture](#)

[Dorothy Hodgkin](#)

[Nettie Stevens](#)

[Har Gobind Khorana](#)

Recent perspectives by POC in science.

[Surviving as an underrepresented minority scientist in a majority environment by Erich D. Jarvis](#)

[Diversifying the Biological Sciences: Past Efforts and Future Challenges by Tyrone B. Hayes](#)

[African Americans in evolutionary science: where we have been, and what's next Joseph L. Graves Jr.](#)

Other books that cover events depicted in *The Eighth Day of Creation*.

[\*The Gene: An Intimate History\*](#) by Siddhartha Mukherjee covers events that took place before and after *Eighth Day*, as well as discussion of the eugenics movement.

*Brave Genius: A Scientist, a Philosopher, and Their Daring Adventures from the French Resistance to the Nobel Prize* by Sean B. Carroll gives a deeper insight into Jacques Monod, as well as the time period covered by *Eighth Day*.

## Reading assignments for *The Eighth Day of Creation* 1st edition

(Commemorative edition page numbers are available in a follow-up document)

Page range is given in **bold**. Details of the starting and ending paragraphs are given.

1/16/20

**Week 2** *“...it is extremely difficult, when one has found something that makes a difference, to recapture the way one thought before.”* (25)

**27-41** - Avery

p27: “At the time, the discovery...”

p41: ends before the section *b* starts

**50-61** - Luria & Delbruck

p50: “The mass intellectual emigration from continental Europe...”

p61: discussion of paradigms with Delbruck, through paragraph that starts with “There was a long pause.”

1/23/20

**Week 3** *“There isn’t such a thing as a hard fact when you’re trying to discover something. It’s only afterwards that the facts become hard”* (114)

**94-104** - Chargaff, Wilkins, and Franklin intros

p94: “Erwin Chargaff was decisively moved by Avery’s work.”

p104: ends section break, through paragraph that starts with “Not long after that, at the turn of the year...”

**108-114** - Crick intro and Watson and Crick meet

p108: “Francis Harry Compton Crick...”

p114: through paragraph that starts, “The number of chains was a crucial question...”

**118-129** - the colloquium where Franklin speaks, and bases-on-the-outside model

p118: begins section *c*

p129: ends section break, through paragraph that starts, “Crick went back to his dissertation.”

**133-138** - A and B forms of DNA. Franklin takes picture No 51.

p133: “Franklin had the pictures she had taken the previous fall...”

p138: ends section break, through paragraph that starts, “Late one night in June...”

**141-144** - Chargaff visits Watson and Crick

p141: “At about the same time, Crick learned from Rosalind Franklin...”

p144: “Crick was excited enough to think up...”

1/30/20

**Week 4** *“...[the structure] had emerged from the shadow of billions of years, absolute and simple, and was seen and understood for the first time...”* (173)

- 147-186** - Denouement of DNA double helix  
p147: start of Chapter 3  
p186: ends section break, through paragraph that starts, "He then mentioned a plan..."
- 196-198** - Watson and Crick's 1953 paper

2/6/20

**Week 5** *"These and little more are the observations...upon which the latter-day biologist seizes: yet in the original papers they were brief, fragmentary, even elusive, for they pointed in a direction different from any the authors thought they were travelling."* (236)

- 186-195** - Chapter 3 section on Meselson and Stahl  
p186: "More was involved than simply sweeping up the marble chips..."  
p195: end of chapter 3
- 225-228** - intro to the next phase: RNA  
p225: start of Chapter 5  
p228: ends section break, through paragraph that starts, "The culmination of those years took place in two meetings..."
- 233-234** - Intro to RNA  
p233: "You see, people didn't necessarily believe in the code'..."  
p234: through paragraph that starts, "Ribonucleic acid, one recalls, differs chemically..."
- 248-282** - Gamow, RNA Tie Club, amino acids, and Benzer  
p248: "The same week in June of 1953 that Watson..."  
p282: through paragraph that starts, "To demonstrate, however, that the pairing was statistically random..."

2/13/20

**Week 6** *"...either living beings could be explained in terms which did not contradict or supersede physical laws, or else the interpretation of the whole universe had to be something different."* (353)

- 333-338** - Central Dogma  
p333: section c  
p338: ends with Crick's Central Dogma figure
- 344** - Belozerskii and Spirin on GC content (this experiment comes up a lot in Chapter 7)  
p344: "The fundamental assumption beneath all coding..."  
p344: end of page, through paragraph that starts "At the same time, the RNAs of these creatures were almost constant."
- 346-347** - Crick addresses the Belozerskii and Spirin problem  
p346: "In January of 1959..."  
p347: end of Chapter 6
- 348-384** - Monod and Jacob  
p348: start of Chapter 7  
P384: ends section break, through paragraph that starts, "By that time, Cohn said, "The term 'adaptation' was causing a lot of confusion, because people

would say, You're giving a bacterium a substance it can't metabolize; you're giving it the signal to make an enzyme it can't use; it's a very unhappy situation for the bacterium: how can you call that an adaptation?"

2/20/20

**Week 7** *"..he announced, 'You know, we have discovered the induction of the prophage!' I said, 'Oh!' putting into it all the admiration I could and thinking to myself, 'What the devil is a prophage?'"* (385)

**384-424** - Jacob, Monod, and the operator  
p384: "In September 1949..."  
p424: ends with "...would turn out not to be universal."

2/27/20

**Week 8** *"We're the only two [who] know it's a triplet code!"* (485)

**424-446** - mRNA  
p424: "The one assumption..."  
p446: - end of Chapter 7  
**460-461** - Barbara McClintock  
p460: "One classical geneticist had been attempting..."  
p461: ends section break, through paragraph that starts, "The bacterial work was done..."  
**463-469** - Lysenko and Medvedev  
p463: section *b*  
p469: ends section break, through paragraph that starts, "Engelhardt laughed gustily..."  
**470-482** - Nirenberg and Matthaei and solving the code  
p470: "Marshall Warren Nirenberg took his doctorate..."  
p482: ends second section break, through paragraph that starts, "Jacob and Gros, who read papers the same day..."  
**483-489** - Crick and demonstrating the triplet, wrap up on the code  
p483: frame shifting figure with "Base added" and "Base deleted"  
p489: end of Chapter 8 (amino acid code chart)

3/5/20

**Week 9** *"By using certain proteins not only as catalysts or transporters but as molecular receivers and transducers of chemical signals, freedom is gained from otherwise insuperable chemical constraints, allowing selection to develop and interconnect the immensely complex circuitry of living organisms."* (578)

**70-93** - Linus Pauling  
p70: start of Chapter 2  
p93: last paragraph before section *b* starts  
**568-593** - Allostery and symmetry as a basis for molecular action  
p568: start of Chapter 10

p593: ends section break, through paragraph that starts, "The flamboyance, the autocracy..."

3/12/20

**Week 10** "...in the next twenty-five years we are going to have to teach biologists another language still." (220)

**Judson's Rosalind Franklin essay**

Posted on Canvas (Franklin\_essay.pdf)

**201-222** - Chapter 4: Reflections on molecular biology

## Reading assignments for *The Eighth Day of Creation* Commemorative edition

Page range is given in bold. Details of the starting and ending paragraphs are given. **Note:** the commemorative edition page numbers are not the same as the Touchstone Books 1979 1st edition. If you are using the 1<sup>st</sup> edition see above.

Page range is given in **bold**. Details of the starting and ending paragraphs are given.

1/16/20

**Week 2** “...it is extremely difficult, when one has found something that makes a difference, to recapture the way one thought before.” (9)

**10-24** - Avery

p10: “At the time, the discovery...”

p24: ends where the section *b* starts

**31-42** - Luria & Delbruck

p31: “The mass intellectual emigration from continental Europe...”

p42: discussion of paradigms with Delbruck, and ends with paragraph “There was a long pause.”

1/23/20

**Week 3** “There isn’t such a thing as a hard fact when you’re trying to discover something. It’s only afterwards that the facts become hard” (93)

**73-83** - Chargaff, Wilkins, and Franklin intros

p73: “Erwin Chargaff was decisively moved by Avery’s work.”

p83: ends with paragraph that starts with “Not long after that, at the turn of the year...”

**86-93** - Crick intro and Watson and Crick meet

p86: “Francis Harry Compton Crick...”

p93: end with paragraph that starts “The number of chains was a crucial question...”

**97-107** - the colloquium where Franklin speaks, and bases-on-the-outside model

P97: begins section *c*

p107: ends section break, last paragraph begins “Crick went back to his dissertation.”

**111-115** - A and B forms of DNA. Franklin takes picture No 51.

p111: “Franklin had the pictures she had taken the previous fall...”

p115: ends section break, last paragraph begins “Late one night in June...”



**118-121** - Chargaff visits Watson and Crick

p118: "At about the same time, Crick learned from Rosalind Franklin..."

p121: "Crick was excited enough to think up..."

1/30/20

**Week 4** "...[the structure] had emerged from the shadow of billions of years, absolute and simple, and was seen and understood for the first time..." (149)

**125-160** - Denouement of DNA double helix

p125: start of Chapter 3

p160: ends section break, last paragraph begins "He then mentioned a plan..."

**170-173** – Watson and Crick's 1953 paper

2/6/20

**Week 5** "These and little more are the observations...upon which the latter-day biologist seizes: yet in the original papers they were brief, fragmentary, even elusive, for they pointed in a direction different from any the authors thought they were travelling." (243)

**160-173** - Chapter 3 section on Meselson and Stahl

p160: "More was involved than simply sweeping up the marble chips..."

p173: end of chapter 3

**233-236** - intro to the next phase: RNA

p233: start of Chapter 5

p236: ends section break, last paragraph begins "The culmination of those years took place in two meetings..."

**240-241** - Intro to RNA

p240: "You see, people didn't necessarily believe in the code'..."

p241: through paragraph that starts, "Ribonucleic acid, one recalls, differs chemically..."

**253-285** - Gamow, RNA Tie Club, amino acids, and Benzer

p253: "The same week in June of 1953 that Watson..."

p285: through paragraph that starts, "To demonstrate, however, that the pairing was statistically random...."

2/13/20

**Week 6** "...either living beings could be explained in terms which did not contradict or supersede physical laws, or else the interpretation of the whole universe had to be something different." (348)

**330-336** - Central Dogma

p330: section c

p336: ends with Crick's Central Dogma figure

**339-340** - Belozerskii and Spirin on GC content (this experiment comes up a lot in Chapter 7)

p339: "The fundamental assumption beneath all coding..."

p340: end of page, through paragraph that starts "At the same time, the RNAs of these creatures were almost constant."

**341-342** - Crick addresses Belozerskii and Spirin problem

p341: "In January of 1959..."

p342: end of Chapter 6

**343-374**

p343: start of Chapter 7

p374: ends section break, through paragraph that starts, "By that time, Cohn said, "The term 'adaptation' was causing a lot of confusion, because people would say, You're giving a bacterium a substance it can't metabolize; you're giving it the signal to make an enzyme it can't use; it's a very unhappy situation for the bacterium: how can you call that an adaptation?"

2/20/20

**Week 7** *"..he announced, 'You know, we have discovered the induction of the prophage!' I said, 'Oh!' putting into it all the admiration I could and thinking to myself, 'What the devil is a prophage?'" (375)*

**374-411** - Jacob, Monod, and the operator

p374: "In September 1949..."

p411: ends with "...would turn out not to be universal."

2/27/20

**Week 8** *"We're the only two [who] know it's a triplet code!" (467)*

**411-432** - mRNA

p411: "Well, we *were* unsympathetic..."

P432: end of Chapter 7

**445-446** - Barbara McClintock

p445: "One classical geneticist had been attempting..."

p446: section break, last paragraph begins "The bacterial work was done..."

**447-452**- Lysenko and Medvedev

p447: section *b*

p452: section break, last paragraph before break begins "Engelhardt laughed gustily..."

**453-465**- Nirenberg and Matthaei and solving the code

p453: "Marshall Warren Nirenberg took his doctorate..."

p465: ends second section break, through paragraph that starts, "Jacob and Gros, who read papers the same day..."

**465-471**- Crick and demonstrating the triplet, wrap up on the code

p465: after the break with paragraph that starts "When Crick arrived home..."

p471: end of Chapter 8 (amino acid code chart)

3/5/20

**Week 9** *"By using certain proteins not only as catalysts or transporters but as molecular receivers and transducers of chemical signals, freedom is gained from otherwise insuperable chemical constraints, allowing selection to develop and interconnect the immensely complex circuitry of living organisms."* (554)

**51-72** - Linus Pauling

p51: start of Chapter 2

p72: last paragraph before section *b* starts

**545-568** - Allostery and symmetry as a basis for molecular action

p545: start of Chapter 10

p568: end with paragraph, through paragraph that starts, "The flamboyance, the autocracy..."

3/12/20

**Week 10** *"...in the next twenty-five years we are going to have to teach biologists another language still."* (195)

**Judson's Rosalind Franklin essay**

Posted on Canvas (Franklin\_essay.pdf)

**177-197** - Chapter 4: Reflections on molecular biology

## Condensed reading list (select discoveries and personal accounts)

Recommended list of discoveries and personal reflections described in *The Eighth Day of Creation* that may be useful for supplementing high school and early undergraduate biology education.

Category	Event	Page # (1st edition)**	Page # (Commemorative edition)	Conclusion or Relevance
Key Experiment	Salvador Luria & Max Delbrück perform the Fluctuation Test (1943)	50-53, 55-57	32-34, 36-38	Mutations are spontaneous.
Key Experiment	Alfred Hershey & Martha Chase further demonstrate DNA is the heritable material (1952)	130-131	108-109	DNA is the heritable material.
Key Experiment	Francis Crick, Rosalind Franklin, James Watson, and Maurice Wilkins show the structure of DNA (1953)	102-104, 108-114, 135-136, 153-154, 156-161, 164-166, 171-175*	80-83, 86-93, 112-114, 131-132, 133-138, 141-142, 147-150	DNA is a double helix.
Key Experiment	Matt Meselson & Franklin Stahl reveal semiconservative DNA replication (1957)	187-192	162-166	DNA replication follows a semiconservative model.
Key Experiment	Marshall Nirenberg & Johann Matthaei demonstrate a	470-472, 476-478, 480-482	453-455, 459-461, 463-464	The first specific mRNA codon was identified for an amino acid.

	solution to the coding problem (1961)			
Key Theoretical Advance	Francis Crick proposes the central dogma (1957)	333-338	330-335	The central dogma describes the flow of information in a cell.
Science as an Experience	Author extracts DNA from bacteria with Sidney Altman	30-33	14-16	What does working at the bench feel like?
Science as an Experience & Key Experiment	Oswald Avery describes his results showing that DNA is the heritable material (1944)	34-41	17-24	DNA is the heritable material. What does making a revolutionary discovery feel like?
Science as an Experience	François Jacob lobbies to join André Lwoff's lab and work on prophage (1950)	384-385	374-375	What does starting from scratch in a lab feel like?

\*Most of pg 94-198 is devoted to this discovery. The provided page numbers represent an abridged selection of some notable events within this period.

\*\*Many of the recommended sections do not start and end precisely at page breaks. Below are quotes from the first edition of *The Eighth Day of Creation* (Judson 1979) indicating our recommendations for starting and ending points for the sections:

### 1st Edition Page Numbers (Detailed)

**Salvador Luria & Max Delbrück** (1943) perform the Fluctuation Test:

p50-53 – Delbrück's background and how he met Luria

p50: *"The most important immigrant to biology..."*

p53: *"And he did, and we did."*

p55-57 – How does bacterial resistance arise?

p55: *“The most fundamental line of research...”*

p57: *“..the nucleic acid of the virus head flows into the cell.”*

**Alfred Hershey & Martha Chase** (1952) further demonstrate that DNA is the transforming principle:

p130-131 – Hershey-Chase description

p130: *“Hershey has since urged...”*

p131: *“...by Hotchkiss in Avery’s lab.”*

**James Watson, Francis Crick, Rosalind Franklin** (1953) discover the double helix structure of DNA:

p102-104 – Rosalind Franklin introduction

p102: *“When Rosalind Franklin died in 1958, she left her...”*

p104: *““And that’s what Rosalind from then on tried to do.””*

p108-114 – Francis Crick introduction, Watson and Crick meet

p108: *“Francis Harry Compton Crick...”*

p114: *“...but Watson and Crick had none of these. Rosalind Franklin had them.”*

p135-136 – Franklin takes photo 51 of DNA

p135: *“During the course of that same day...”*

p136: *“...before going around to visit King’s College London.”*

p153-154 – Franklin’s report and news about Linus Pauling’s attempted model for DNA

p153: *“By the end of November...”*

p154: *“...a copy of his father’s manuscript.”*

p156-161 – Pauling’s incorrect model for DNA and Watson and Franklin’s confrontation

p156: *“To read a paper by a great scientist that’s all wrong is an odd exercise.”*

p161: *“...still on the inside.”*

p164-166 – Franklin’s report and the ethics of how it got to Watson and Crick, Crick realizes the reverse parallel structure of DNA

p164: *“At some point, Crick learned – probably from Wilkins – about the report...”*

p166: *“...one chain must run up and the other down.”*

p171-175 – Conclusion of the structure of DNA

p171: *“On Monday, February 23...”*

p175: *“The structure of DNA is flawlessly beautiful.”*

**Matt Meselson & Franklin Stahl** (1957) show the semiconservative nature of replication of DNA:

p187-192 - Meselson and Stahl

p187: *“The second kind of confirmation needed was biological.”*

p192: *“...locked them into an upstairs room with two sleeping bags and a typewriter until they wrote the paper.”*

**Marshall Nirenberg & Johann Matthaei** (1961) solve the coding problem (which RNA sequence codes for which amino acids?):

p470-472 - Nirenberg and Matthaei introduction

p470: *“Marshall Warren Nirenberg took his doctorate...”*

p472: *“They kept them all in a freezer.”*

p476-478 – Matthaei’s experiment to solve the genetic code

p476: *“By Monday afternoon, 22 May 1961, Matthaei had worked his way down...”*

p478: *“Matthaei had identified the first word of the genetic code – that poly-U translates to poly-phe.”*

p480-482 – Nirenberg presents the results to the world (twice)

p480: *“Marshall was not on the grapevines...”*

p482: *“...to get back to the lab.”*

**Francis Crick** (1957) proposes the Central Dogma:

p333-338 – Crick and the central dogma

p333: *“In September of 1957, Crick addressed the Symposium of the Society for Experimental Biology.”*

p338: Crick’s diagram of the central dogma

**Horace Freeland Judson** learns from Sidney Altman how to extract DNA:

p30-33 - detailed description of science journalist Horace Judson learning to extract DNA

p30: *“On the point of picking up Avery’s paper...”*

p33: *“...charge of individual molecules.”*

**Oswald Avery** (1944) demonstrates rigorously that DNA is the substance responsible for encoding genetic information:

p34-41 - explains his experiments (34-38), conclusions (39), and reception (40). Francis Crick reflects on the contrast between Avery’s cautious approach to science and the boldness of other famous scientists (41).

p34: *“Avery was by training a physician...”*

p41: *“When we started we were living in the woods and now here we are in the middle of a city.”*

**François Jacob** (1950) lobbies to join André Lwoff’s lab and work on prophage:

p384-385 - Jacob

p384: *“In September 1949, François Jacob came to Lwoff...”*

p385: *“...mechanism that went unglimped by anyone for another three years at least.”*



## Commemorative Edition Page Numbers (Detailed)

**Salvador Luria & Max Delbrück** (1943) perform the Fluctuation Test:

p32-34 – Delbrück’s background and how he met Luria

p32: *“The most important immigrant to biology...”*

p34: *“And he did, and we did.”*

p36-38 – How does bacterial resistance arise?

P36: *“The most fundamental line of research...”*

P38: *“..the nucleic acid of the virus head flows into the cell.”*

**Alfred Hershey & Martha Chase** (1952) further demonstrate that DNA is the transforming principle:

p108-109 – Hershey-Chase description

p108: *“Hershey has since urged...”*

p109: *“...by Hotchkiss in Avery’s lab.”*

**James Watson, Francis Crick, Rosalind Franklin** (1953) discover the double helix structure of DNA:

p80-83 – Rosalind Franklin introduction

p80: *“When Rosalind Franklin died in 1958, she left her...”*

p83: *“And that’s what Rosalind from then on tried to do.”*

p86-93 – Francis Crick introduction, Watson and Crick meet

p86: *“Francis Harry Compton Crick...”*

p93: *“...but Watson and Crick had none of these. Rosalind Franklin had them.”*

p112-114 – Franklin takes photo 51 of DNA

p112: *“During the course of that same day...”*

p114: *“...before going around to visit King’s College London.”*

p131-132 – Franklin’s report and news about Linus Pauling’s attempted model for DNA

p131: *“At the end of November...”*

p132: *“...a copy of his father’s manuscript.”*

p133-138 – Pauling’s incorrect model for DNA and Watson and Franklin’s confrontation

p133: *“To read a paper by a great scientist that’s all wrong is an odd exercise.”*

p138: *“...still on the inside.”*

p141-142 – Franklin’s report and the ethics of how it got to Watson and Crick, Crick realizes the reverse parallel structure of DNA

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p150: *“The structure of DNA is flawlessly beautiful.”*

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