DNAi DVD CONTENTS

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- DNA in action ... 2
- Genetics to genomics ... 2
- Human genetics ... 3
- Ethics & implications ... 4
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THEMES

• DNA MOLECULE •

Discovery of DNA

A pre-1953 notion	_ biology prior to discovery of the double helix ... François Jacob
DNA is the genetic material	_ the experiment that identified DNA as the genetic material ... Maclyn McCarty
Chargaff's ratios	_ the DNA base ratio rules ... Erwin Chargaff
Race to discover the structure	_ the race between King's College, London, and other groups to define the structure of DNA ... Raymond Gosling
Clue: position of phosphates	_ realizing phosphates are on the outside of the structure ... Raymond Gosling
An earlier DNA model	_ Franklin's analysis of Watson and Crick's early model of DNA ... Raymond Gosling
Clue: X-ray diffraction	_ how the X-ray diffraction camera works ... Raymond Gosling
	_ the X-ray diffraction picture that revealed the helix ... Maurice Wilkins
The answer	_ working out the structure of DNA ... Jim Watson
DNA: the secret of life	_ on his and Francis Crick's gigantic breakthrough ... Jim Watson
DNA: the key to understanding	_ why the discovery of DNA's structure was so important ... Francis Crick

Structure of DNA

An elegant structure	_ the elegant simplicity of Watson and Crick's model ... Raymond Gosling
Replication models	_ the different models proposed for DNA replication ... Matthew Meselson
The correct model	_ Meselson and Franklin Stahl's experiment to determine the correct DNA replication mode ... Matthew Meselson
Replicating the helix	_ animation
Mechanism of replication	_ animation
How DNA is packaged	_ animation

Organization of DNA

Billions of bases	_ there are 2.9 billion letters in the human genome ... Mark Adams
Chromosome map	_ animation
100 km of DNA	_ the length of the human genome ... John Sulston
Walking down a chromosome	_ traveling down the genome ... Ewan Birney
Coding vs. non-coding	_ how much of the genome is active? ... Jim Kent
How much DNA codes for protein?	_ animation
An important gene cluster	_ a cluster of immunity genes on chromosome six ... Jim Kent
Bacterial vs. human genome	_ human genes are organized in patches of information ... Eric Lander

• DNA IN ACTION•

The genetic code

The digital code	_ DNA is a digital code that can be read . . . Leroy Hood
The coding problem	_ the problem posed by Watson and Crick's model . . . Sydney Brenner
DNA has four units	_ animation
Defining the gene	_ matching the gene to protein sequence . . . Sydney Brenner
3 DNA bases = 1 amino acid	_ the mathematician George Gamow's idea that three DNA bases encode one amino acid . . . Marshall Nirenberg
Code analogies	_ the idea of applying a code to DNA sequence . . . Sydney Brenner
Triplet code	_ animation
Cracking the first codon	_ deciphering the first amino acid codon . . . Marshall Nirenberg
Cracking the code	_ deciphering every triplet code . . . Marshall Nirenberg
Universal code	_ all forms of life use the same genetic instructions . . . Marshall Nirenberg

The Central Dogma & gene expression

The Central Dogma & gene expression	_ DNA makes RNA makes protein . . . Jim Watson
Protein synthesis	_ synthetic RNA stimulates protein synthesis . . . Marshall Nirenberg
The role of the ribosome	_ ribosomes recognize a triplet code . . . Marshall Nirenberg
Transcription	_ animation
Explaining the Central Dogma	_ the mechanism of protein synthesis and the virus (phage) experiment that proved it . . . Sydney Brenner
RNA splicing	_ RNA is spliced . . . Tom Cech
Processing mRNA	_ mRNA editing by the spliceosome . . . Eric Lander
Translation	_ animation
Gene regulation	_ the regulation of genes by control proteins . . . Walter Gilbert
The lac operon model	_ his model for bacterial gene regulation . . . François Jacob

Mutation & evolution

Random mutations	_ random mutations are necessary for evolution . . . Jim Kent
Sickle cell	_ animation
DNA damage	_ animation
Junk DNA & evolution	_ junk DNA may have important evolutionary functions . . . Eric Lander
Humans & chimps	_ humans and chimps share around 99% of their DNA . . . Mary-Claire King
Regulatory networks	_ the importance of regulatory systems for evolution . . . Leroy Hood
Differences & similarities	_ DNA variations result in differences between individuals . . . Robert Plomin
Evolutionary relationships	_ the conservation of life processes . . . John Sulston
Smell receptors	_ every gene has a distinctive evolutionary history . . . Eric Lander
What came first: DNA or RNA?	_ evidence that RNA evolved before DNA . . . Tom Cech

• GENETICS TO GENOMICS•

Key experiments & techniques

Polymerase chain reaction	_ discovery of the PCR technique . . . Kary Mullis
DNA variation	_ measuring DNA variation: techniques and applications . . . Mark Skolnick
DNA fingerprinting	_ using minisatellites (tandem DNA repeats) to create unique genetic profiles . . . Alec Jeffreys
First recombinant DNA	_ describing the first experiment with recombinant DNA . . . Paul Berg
Mechanism of recombination	_ animation
Microarray analysis	_ studying gene expression using microarrays . . . Pat Brown
DNA transfer: agrobacterium	_ transferring genes into plant cells using agrobacterium . . . Robert Horsch
DNA transfer: gene gun	_ inserting genes into plant cells using a gene gun . . . Robert Horsch

Key experiments & techniques (. . . continued)

Sequencing DNA	_ inside a DNA sequencing machine . . . Leroy Hood
Sequencing genomes	_ the speed of sequencing since automation . . . Mike Hunkapiller

Advances & applications

Cross-species recombination	_ first experiment to recombine DNA from different species . . . Stanley Cohen
Birth of genetic engineering	_ significance of his experiment with Stanley Cohen to clone toad DNA . . . Herbert Boyer
The impact of cloning	_ the implications of cloning mammalian genes . . . Herbert Boyer
Cloning DNA in bacteria	_ importance of being able to clone DNA using bacteria . . . Paul Berg
Risks of DNA recombination	_ potential risks associated with recombining DNA . . . Robert Pollack
Lab safety	_ demonstrating the P4 lab containment suit he developed for working with high risk substances . . . Emmett Barkley
Insulin production	_ the Genentech method of producing . . . David V. Goeddel
First transgenic crop	_ the first transgenic crop, engineered by Monsanto . . . Robert Horsch
Cotton plants	_ cotton plants engineered to be pest resistant . . . Jim Watson
GM crop concerns	_ raising concerns associated with GM crop production . . . Jim Kent

The Human Genome Project

The aim	_ the aim of the Human Genome Project . . . Jim Watson
The motivation	_ the justification for the Human Genome Project . . . Francis Collins
Public & private	_ comparing methods used by the public and private teams . . . Gene Myers
Public project sequencing	_ animation
Assembling the fragments	_ problems assembling the genome fragments . . . Jim Kent
Private project sequencing	_ animation
Reading the genome	_ interpreting the completed human genome sequence . . . Ewan Birney
The completed genome	_ the completion of the draft human genome sequence . . . William J. Clinton
Outcome of the HGP	_ a new paradigm for studying biology . . . Eric Lander
After the HGP	_ a new foundation for science . . . J. Craig Venter

Bioinformatics

An overview	_ using computers to assemble genomes and interpret data . . . Gene Myers
Solving a problem	_ developing the tools to sequence the genome . . . J. Craig Venter
Computing power	_ computational power of a processing farm . . . Ewan Birney
Analyzing your genes	_ understanding the genome will lead to medical advances . . . Leroy Hood
Proteomics	_ studying proteins to understand disease . . . Scott Patterson
Implications for the future	_ new tools for redesigning life . . . Leroy Hood

• HUMAN GENETICS •

Disease research

The challenge of gene hunting	_ the challenge of finding a disease gene . . . Francis Collins
Locating disease genes	_ locating disease genes using markers . . . David Botstein
Impact of the genome projects	_ the increased speed of gene searching . . . Ewan Birney
Animal models	_ using mouse models to study disease . . . Mario Capecchi
The DMD approach	_ gene replacement therapy in Duchenne muscular dystrophy (DMD) . . . Kay Davies
Gene expression patterns	_ gene expression patterns in diseased cells . . . Pat Brown
Gene switches	_ switching genes on and off to study disease . . . Mario Capecchi
Gene manipulation	_ using embryonic stem cells to make mouse models . . . Mario Capecchi

Disease research	(. . . continued)
Living with sickle cell	_ how sickle cell has affected her life . . . Katreece McGhee
Inheriting sickle cell	_ how she inherited sickle cell . . . Katreece McGhee
Work on cancer	
Mutations & cancer	_ cancer is caused by an accumulation of mutations . . . Bruce Ames
Tumor growth	_ animation
Cancer genes	_ describing tumor suppressors and oncogenes . . . Mike Wigler
Early cancer studies	_ studying cancer prior to understanding its mechanisms . . . Mary-Claire King
Finding cancer genes	_ searching for candidate genes in families with breast cancer . . . Mary-Claire King
Using family trees	_ identifying and tracking genetic markers using family trees . . . Barbara Weber
Identifying BRCA1	_ finding and cloning the first breast cancer gene: BRCA1 . . . Mark Skolnick
Looking for BRCA2	_ finding the second breast cancer gene: BRCA2 . . . Mark Skolnick
Limitations of testing	_ current status of testing for cancer genes . . . Mary-Claire King
Hopes for the future	_ hopes for cancer treatments . . . Mary-Claire King
Screening & treatment	
Leukemia: the Gleevec story	_ the development of Gleevec, a drug to treat leukemia . . . Brian J. Druker
How Gleevec works	_ animation
Gleevec: first trials	_ the first patient in the Gleevec trials . . . Bud and Yvonne Romine
Developing other cancer drugs	_ applying the Gleevec model to other cancers . . . Brian J. Druker
More questions than answers	_ approaching population screening with caution . . . Francis Collins
Genetic screening	_ setting up a screen for muscular dystrophy . . . Kay Davies
Offering options	_ importance of choice regarding genetic testing . . . Kay Davies
Testing for a reason	_ schizophrenia: a case for testing . . . Kay Jamison
Behavioral genetics	
Genetic pre-wiring	_ behavior can be both genetically pre-wired and learnt . . . Hubert Markl
Nature vs. nurture	_ how much of our behavior can be attributed to genes? . . . Robert Plomin
Complex behavior	_ the honeybee as a model for complex behavior . . . Hubert Markl
Twin studies	_ the genetic basis of cognitive traits . . . Robert Plomin
Prediction & prevention	_ predicting and preventing behavioral problems . . . Robert Plomin
Heritability of behaviors	_ all behavioral traits have a heritable component . . . Robert Plomin
Mental illness & creativity	_ genetic links between mental illness and creativity . . . Kay Jamison
Basis of complex disorders	_ understanding the genetic basis of complex traits . . . Robert Plomin
Human origins	
Neandertal DNA	_ comparing Neandertal and modern human mitochondrial DNA . . . Svante Pääbo
Neandertal & human ancestry	_ human origins and our common ancestry with Neandertals . . . Svante Pääbo
Counting DNA mutations	_ why the number of mutations in mitochondrial DNA is an underestimate . . . Mark Stoneking
Tracking human history	_ using the Y chromosome and other genomic regions to track human history . . . Michael F. Hammer
The evolutionary puzzle	_ genetic data must be part of a framework . . . Michael F. Hammer
The divergence of Neandertals	_ fossil evidence shows that Neandertals diverged from modern humans . . . Chris Stringer
A recent common ancestor	_ mitochondrial DNA confirms a recent common ancestor for modern humans . . . Douglas Wallace
Classification and value	_ confounding genetic classification with human worth . . . Hubert Markl

• ETHICS & IMPLICATIONS •

Eugenics

Sterilization as a welfare reform	_ sterilization in the USA: used as a welfare reform . . . Paul Lombardo
Pre-WWII German eugenics	_ eugenics in Nazi Germany . . . Jim Watson
American perspective	_ an overview of eugenics in the USA . . . Jim Watson
The Buck vs. Bell case	_ sterilization in the USA: Buck vs. Bell . . . Paul Lombardo
Reactions to imperfections	_ should we correct natural genetic imperfections? . . . Jim Watson
Who should decide?	_ making life choices and economic considerations . . . Benno Müller-Hill
Directing our evolution	_ our responsibility to direct our own evolution . . . Jim Watson
Classification and value	_ confounding genetic classification with human worth . . . Hubert Markl

Diversity & enhancement

None of us are perfect	_ human imperfections and genetic enhancement . . . Jim Watson
Vanilla children	_ for diversity and against narrowing the options . . . Kay Jamison
Designer babies	_ intervening in a child's future at a genetic or social level . . . Robert Plomin
Weeding out disease	_ predictions for gene testing . . . Bruce Ames
Harrington family	_ his relationship with his son who has Down syndrome . . . Roby Harrington
A case for testing	_ testing and managing genetic disorders . . . Kay Davies
Protecting diversity	_ manic depressives: an endangered but valued species . . . Kay Jamison
A better understanding	_ improving our species with better education . . . Hubert Markl

Ownership & access

Patenting living organisms	_ creating and owning living organisms . . . Ananda Chakrabarty
Selecting genes to patent	_ a private company's approach to patenting genes . . . Mark Adams
Patenting chaos	_ on knowing the function of a gene before you patent . . . Mary-Claire King
Commercial patents	_ on patenting genes for commercial purposes . . . Mary-Claire King
Human genome patents	_ the human genome sequence is not a basis for a patent . . . John Sulston
A free flow of information	_ making sequence public to pre-empt the patents . . . John Sulston

• REFLECTING ON SCIENCE •

A selection of views

Science & faith	_ reconciling working in science with faith in God . . . Francis Collins
Playing God	_ miracles from knowledge, not prayer . . . Jim Watson
Explaining life through science	_ reading a letter from Rosalind to her father . . . Rosalind Franklin's sister
Reading our own code	_ reflecting on our evolution . . . John Sulston
Influencing our evolution	_ eliminating faults in our genetic programming . . . Raymond Gosling
Manic depression	_ mental illness and complicated choices . . . Kay Jamison
Definitions of life	_ defining what it is to be alive . . . Tom Cech
Can genetics provide answers?	_ genetics may not provide the answers we seek . . . Benno Müller-Hill

Still to be explored

Unused tools	_ gene technology and its possible uses . . . Robert Pollack
Future of medicine	_ predictive and preventative personalized medicine . . . Leroy Hood
Manipulating living systems	_ manufacturing new proteins in living systems . . . Robert Horsch
Germline therapy	_ on needing to make germline therapy reversible . . . Mario Capecchi
Redesigning organisms	_ technological advances may allow us to redesign life . . . Leroy Hood
The future of humans	_ what will humans look like in 5,000 years? . . . Ananda Chakrabarty

ANIMATIONS

DNA molecule
- DNA has four units
- Chargaff's ratios
- Triple helix
- Base pairing
- How DNA is packaged *
- DNA unzip
- Chromosome map
- How much DNA codes for protein?

Replication
- Replicating the helix
- Mechanism of replication *

Transcription & translation
- Triplet code
- Transcription *
- mRNA splicing
- Translation *

Experiments & techniques
- Mechanism of recombination
- Microarray
- Polymerase chain reaction
- Sanger sequencing
- Public project sequencing
- Private project sequencing

Disease & mutation
- DNA damage
- Sickle cell
- Tumor growth
- How Gleevec works

(*) narration options: none, basic, and advanced.

INTERVIEWS

1)

Mark Adams
- Billions of bases
- Selecting genes to patent

Bruce Ames
- Mutations & cancer
- Weeding out disease

Emmett Barkley
- Lab safety

Paul Berg
- First recombinant DNA
- Cloning DNA in bacteria
- Cohesive ends & recombination

Ewan Birney
- Walking down a chromosome
- Reading the genome
- Computing power
- Impact of the genome projects

David Botstein
- Locating disease genes
- Cost of the Human Genome Project
- Opposition to the Human Genome Project

Herbert Boyer
- Birth of genetic engineering
- The impact of cloning
- Why study plasmids?

Sydney Brenner **
- The coding problem
- Defining the gene
- Code analogies
- Explaining the Central Dogma
- The coiled nature of DNA
- Cell organization

Pat Brown
- Microarray analysis
- Gene expression patterns

Mario Capecchi
- Animal models
- Gene switches
- Gene manipulation
- Germline therapy

2)

Tom Cech **
- RNA splicing
- What came first: DNA or RNA?
- Definitions of life

Ananda Chakrabarty
- Patenting living organisms
- The future of humans

Erwin Chargaff
- Chargaff's ratios

William J. Clinton
- The completed genome

Stanley Cohen
- Cross-species recombination

Francis Collins
- The motivation (HGP)
- The challenge of gene hunting
- More questions than answers
- Science & faith

Francis Crick **
- DNA: the key to understanding
- The fascination of science
- DNA's deceptive "simplicity"
- Understanding the brain

Kay Davies
- The DMD approach
- Genetic screening
- Offering options
- A case for testing

Brian J. Druker
- Leukemia: the Gleevec story
- Developing other cancer drugs

Rosalind Franklin's sister
- Explaining life through science

3)

Walter Gilbert **
- Gene regulation
- Experiments to find RNA
- The repressor/inducer system

David V. Goeddel
- Insulin production

Raymond Gosling
- Race to discover the structure
- Clue: position of phosphates
- An earlier DNA mode
- Clue: X-ray diffraction
- An elegant structure
- Influencing our evolution

Michael F. Hammer
- Tracking human history
- The evolutionary puzzle

Roby Harrington
- Harrington family

Leroy Hood
- The digital code
- Regulatory networks
- Sequencing DNA
- Analyzing your genes
- Implications for the future
- Future of medicine
- Redesigning organisms

Robert Horsch
- DNA transfer: agrobacterium
- DNA transfer: gene gun
- First transgenic crop
- Manipulating living systems

Mike Hunkapiller
- Sequencing genomes

François Jacob **
- A pre-1953 notion
- The lac operon model

Kay Jamison
- Testing for a reason
- Mental illness & creativity
- Vanilla children
- Protecting diversity
- Manic depression

4)

Alec Jeffreys
- DNA fingerprinting

Jim Kent
- Coding vs. non-coding
- An important gene cluster
- Random mutations
- GM crop concerns
- Assembling the fragments

Mary-Claire King
- Humans & chimps
- Early cancer studies
- Finding cancer genes
- Limitations of testing
- Hopes for the future
- Patenting chaos
- Commercial patents

Arthur Kornberg **
- Enzymes: DNA polymerase
- Studying DNA replication
- DNA synthesis

Eric Lander
- Bacterial vs. human genome
- Processing mRNA
- Junk DNA & evolution
- Smell receptors
- Outcome of the HGP

Paul Lombardo
- Sterilization as a welfare reform
- The Buck vs. Bell case

Hubert Markl
- Genetic pre-wiring
- Complex behavior
- Classification and value
- A better understanding

Maclyn McCarty
- DNA is the genetic material

Katreece McGhee
- Living with sickle cell
- Inheriting sickle cell

Matthew Meselson
- Replication models
- The correct model

5)

Benno Müller-Hill
- Who should decide?
- Can genetics provide answers?

Kary Mullis **
- Polymerase chain reaction

Gene Myers
- Public & private
- An overview (bioinformatics)

Marshall Nirenberg **
- 3 DNA bases = 1 amino acid
- Cracking the first codon
- Cracking the code
- Universal code
- Protein synthesis
- The role of the ribosome

Svante Pääbo
- Neandertal DNA
- Neandertal & human ancestry

Scott Patterson
- Proteomics

Robert Plomin
- Differences & similarities
- Nature vs. nurture
- Twin studies
- Prediction & prevention
- Heritability of behaviors
- Basis of complex disorders
- Designer babies

Robert Pollack
- Risks of DNA recombination
- Unused tools

Bud and Yvonne Romine
- Gleevec: first trials

Mark Skolnick
- DNA variation
- Identifying BRCA1
- Looking for BRCA2

6)

Mark Stoneking
- Counting DNA mutations

Chris Stringer
- The divergence of Neandertals

John Sulston **
- 100 km of DNA
- Evolutionary relationships
- Human genome patents
- A free flow of information
- Reading our own code

J. Craig Venter
- After the Human Genome Project
- Solving a problem

Douglas Wallace
A recent common ancestor

Jim Watson **
The answer
DNA: the secret of life
Cotton plants
The aim (Human Genome Project)
Need for an RNA template
Pre-WWII German eugenics
Reactions to imperfections
Directing our evolution
None of us are perfect
American perspective
Playing God

Barbara Weber
Using family trees

Mike Wigler
Cancer genes

Maurice Wilkins **
Clue: X-ray diffraction

(**) Nobel Laureate

BACKGROUND BRIEFING

Animator: Drew Berry

Making 3D animations
Working with scientists
Using 3D models
Absolute accuracy
A complex animation

_ the process of making 3D scientific animations
_ science as a creative career
_ online libraries of molecules can model interactions
_ ensuring the scientific accuracy of the models
_creating the replication animation

Teacher: Caren Gough

Teacher involvement
Using the DVD
Planning lessons
Interviews on the DVD
Ease of use

_ teacher contribution to content selection
_ planning lessons using the DVD content
_ planning lessons using the animationsc
_ scientist interviews provide a unique resource
_ on expertise required to use the DVD