**DNAi DVD and the DNAi Teacher Guide**

The DNA Interactive (DNAi) DVD carries approximately four hours of video interviews with 11 Nobel Laureates and more than 50 other scientists, clinicians, and patients. It also holds the complete set of 3-dimensional animations produced for the DNA TV series and DNAi project.

The following pages list video clips and animations from the DVD that would be appropriate to show with specific activities in the DNAi Teacher Guide. The clips and animations are listed under “themes” and “additional animations.” The “themes” listing includes relevant interviews and animations that can be accessed from the “themes” section of the DVD. The “additional animations” are best accessed from “animations” button in the DVD main menu.

You can access the DNAi Teacher Guide by registering at www.dnai.org/teacher.

**Activity 1:**

**DNAi Timeline: a scavenger hunt**

**THEMES**

• **DNA MOLECULE •**

**Discovery of DNA**
- A pre-1953 notion
- DNA is the genetic material
- Chargaff’s ratios
- The answer
- DNA: the key to understanding

**Structure of DNA**
- The correct model

• **DNA IN ACTION •**

**The genetic code**
- Defining the gene
- Cracking the first codon

**The Central Dogma and gene expression**
- Explaining the Central Dogma
- The lac operon model

• **GENETICS TO GENOMICS •**

**Key experiments and techniques**
- Polymerase chain reaction
- DNA fingerprinting
- First recombinant DNA
- Microarray analysis
Advances and 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 Human Genome Project
The completed genome
_ the completion of the draft human genome sequence . . . William J. Clinton

• HUMAN GENETICS •

Disease research
Gene manipulation
_ using embryonic stem cells to make mouse models . . . Mario Capecchi

Work on cancer
Finding cancer genes
_ searching for candidate genes in families with breast cancer . . . Mary-Claire King

Activity 2.
Finding the Structure: pieces of the puzzle

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 answer
_ the X-ray diffraction picture that revealed the helix . . . Maurice Wilkins
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

ADDITIONAL ANIMATIONS

DNA molecule
DNA has four units
Chargaff’s ratios
Triple helix
Base pairing

www.dnai.org
© Copyright 2003, Dolan DNA Learning Center, Cold Spring Harbor Laboratory. All rights reserved. Dolan DNA Learning Center
Activity 3.
(Clues to) Copying the Code: examining the evidence

THEMES

• DNA MOLECULE •

Structure of DNA
An elegant structure
Replication models
The correct model
Replicating the helix
Mechanism of replication

 ADDITIONAL ANIMATIONS

DNA molecule
DNA unzip
Replication
Replicating the helix
Mechanism and replication

Activity 4.
Reading the Code

THEMES

• DNA IN ACTION •

The genetic code
The digital code
The coding problem
DNA has four units
Defining the gene
3 DNA bases = 1 amino acid

The Central Dogma & gene expression
Need for an RNA Template
Protein synthesis
The role of the ribosome
Transcription
Explaining the Central Dogma
RNA splicing
Processing mRNA
Translation

© Copyright 2003, Dolan DNA Learning Center; Cold Spring Harbor Laboratory. All rights reserved.
ADDITIONAL ANIMATIONS

DNA molecule
  How much DNA codes for protein

Activity 5.
Controlling the Code: molecules at work

THEMES

• DNA IN ACTION •

The Central Dogma & gene expression
  Gene regulation _ every gene has a distinctive evolutionary history . . . Eric Lander
  The lac operon model _ evidence that RNA evolved before DNA . . . Tom Cech

ADDITIONAL ANIMATIONS

  Transcription and translation
    Triplet code
    Transcription
    Translation
  Transcription and translation
    How DNA is packaged

Activity 6.
Manipulation: transferring genes

THEMES

• 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
  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

**ADDITIONAL ANIMATIONS**

Experiments and techniques  
Polymerase chain reaction
Sanger sequencing

Activity 7.
**Gel Electrophoresis: sort and see the DNA**

**THEMES**

**• GENETICS TO GENOMICS •**

**Key experiments & techniques**
DNA fingerprinting  
_ using mini satellites (tandem DNA repeats) to create unique genetic profiles . . .  Alec Jeffreys

Activity 8.
**Model Organisms: the genes we share**

**THEMES**

**• DNA IN ACTION •**

**The genetic code**
Universal code  
_ all forms of life use the same genetic instructions . . .  Marshall Nirenberg

**Mutation and evolution**
Random mutations  
_ random mutations are necessary for evolution . . .  Jim Kent
Junk DNA & evolution  
_ junk DNA may have important evolutionary functions . . .  Eric Lander
Evolutionary relationships  
_ the conservation of life processes . . .  John Sulston
• GENETICS TO GENOMICS •

**Key Experiments & techniques**
Sequencing genomes  _ the speed of sequencing since automation . . . Mike Hunkapiller

• HUMAN GENETICS •

**Disease research**
The challenge of finding a disease gene . . . Francis Collins
Locating disease genes  _ locating disease genes using markers . . . David Botstein
Animal models  _ using mouse models to study disease . . . Mario Capecchi
Gene manipulation  _ using embryonic stem cells to make mouse models . . . Mario Capecchi

**Human origins**
The evolutionary puzzle  _ genetic data must be part of a framework . . . Michael F. Hammer

ADDITIONAL ANIMATIONS

**Disease and mutation**
DNA damage

Activity 9.
Sequencing

THEMES

• GENETICS TO GENOMICS •

**Key experiments and techniques**
Sequencing DNA  _ inside a DNA sequencing machine . . . Leroy Hood
Sequencing genomes  _ the speed of sequencing since automation . . . Mike Hunkapiller

**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

ADDITIONAL ANIMATIONS

**Experiments and techniques**
Mechanism and recombination
Sanger sequencing
Activity 10.
 Genome: a tour and genetic disorder brochure

**THEMES**

**• DNA MOLECULE •**

**Organization of DNA**
- Billions of bases
- Chromosome map
- 100 km of DNA
- Walking down a chromosome
- Coding vs. non-coding
- How much DNA codes for protein?
- An important gene cluster
- Bacterial vs. human genome

- there are 2.9 billion letters in the human genome . . . Mark Adams
- the length of the human genome . . . John Sulston
- traveling down the genome . . . Ewan Birney
- how much of the genome is active? . . . Jim Kent
- a cluster of immunity genes on chromosome six . . . Jim Kent
- human genes are organized in patches of information . . . Eric Lander

**• HUMAN GENETICS •**

**Disease research**
- The challenge of gene hunting
- Locating disease genes
- Impact of the genome projects
- Animal models
- The DMD approach
- Gene expression patterns
- Gene switches
- Gene manipulation
- Living with sickle cell
- Inheriting sickle cell

- the challenge of finding a disease gene . . . Francis Collins
- locating disease genes using markers . . . David Botstein
- the increased speed of gene searching . . . Ewan Birney
- using mouse models to study disease . . . Mario Capecchi
- gene replacement therapy in Duchenne muscular dystrophy (DMD) . . . Kay Davies
- gene expression patterns in diseased cells . . . Pat Brown
- switching genes on and off to study disease . . . Mario Capecchi
- using embryonic stem cells to make mouse models . . . Mario Capecchi
- how sickle cell has affected her life . . . Katreece McGhee
- how she inherited sickle cell . . . Katreece McGhee

**Work on cancer**
- Mutations & cancer
- Tumor growth
- Cancer genes
- Early cancer studies
- Finding cancer genes
- Using family trees
- Identifying BRCA1
- Looking for BRCA2
- Limitations of testing
- Hopes for the future

- cancer is caused by an accumulation of mutations . . . Bruce Ames
- describing tumor suppressors and oncogenes . . . Mike Wigler
- studying cancer prior to understanding its mechanisms . . . Mary-Claire King
- searching for candidate genes in families with breast cancer . . . Mary-Claire King
- identifying and tracking genetic markers using family trees . . . Barbara Weber
- finding and cloning the first breast cancer gene: BRCA1 . . . Mark Skolnick
- finding the second breast cancer gene: BRCA2 . . . Mark Skolnick
- current status of testing for cancer genes . . . Mary-Claire King
- hopes for cancer treatments . . . Mary-Claire King

**Screening & treatment**
- Leukemia: the Gleevec story
- How Gleevec works
- Gleevec: first trials
- Developing other cancer drugs
- More questions than answers

- the development of Gleevec, a drug to treat leukemia . . . Brian J. Druker
- the first patient in the Gleevec trials . . . Bud and Yvonne Romine
- applying the Gleevec model to other cancers . . . Brian J. Druker
- approaching population screening with caution . . . Francis Collins
Genetic screening
Offering options
Testing for a reason

ADDITIONAL ANIMATIONS

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

DNA molecule
- How DNA is packaged

Experiments and techniques
- Microarray
- Polymerase chain reaction
- Sanger sequencing

Activity 11.
Genome Mining

THEMES

• GENETICS TO GENOMICS •

The Human Genome Project
- The aim
- The motivation
- Public & private
- Public project sequencing
- Assembling the fragments
- Private project sequencing
- Reading the genome
- The completed genome
- Outcome of the HGP
- After the HGP

Bioinformatics
- An overview
- Solving a problem
- Computing power
- Analyzing your genes
- Proteomics
- Implications for the future

ADDITIONAL ANIMATIONS

Experiments and techniques
- Microarray
- Sanger sequencing

DNA molecule
- DNA unzip
- How much DNA codes for protein?
Activity 12.
Human origins: the prehistoric race

THEMES

• DNA IN ACTION •

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

• HUMAN GENETICS •

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

ADDITIONAL ANIMATIONS

Transcription and translation
  Transcription
  mRNA splicing
  Translation

Disease and mutation
  DNA damage
Activity 13.
Recovering the Romanovs

THEMES

• MUTATION & EVOLUTION •

Random mutations _ random mutations are necessary for evolution . . . Jim Kent
DNA damage _ animation
Differences & similarities _ DNA variations result in differences between individuals . . . Robert Plomin

• HUMAN ORIGINS •

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

ADDITIONAL ANIMATIONS

Experiments and techniques
- PCR
- Sanger sequencing

Activity 14.
Dealing with DNA controversy: issues, arguments, and ethics

THEMES

• 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  
Protecting diversity  
A better understanding  

Ownership & access
Patenting living organisms  
Selecting genes to patent  
Patenting chaos  
Commercial patents  
Human genome patents  
A free flow of information

A selection of views
Science & faith  
Playing God  
Explaining life through science  
Reading our own code  
Influencing our evolution  
Manic depression  
Definitions of life  
Can genetics provide answers?

Still to be explored
Unused tools  
Future of medicine  
Manipulating living systems  
Germline therapy  
Redesigned organisms  
The future of humans