2013

Use Howard Hughes Medical Institute Resources to Teach:

Gene Regulation

Prepared by:

Ann Brokaw

AP Biology/Biology Teacher
Rocky River High School
Rocky River, Ohio

Last updated: January, 2013

Use Howard Hughes Medical Institute Resources to Teach: *Gene Regulation*

Table of Contents

From the Author

With the pace of current research, the biological sciences change incredibly fast, particularly in the fields of molecular genetics, specifically gene expression and gene regulation. Therefore, as a veteran biology teacher, I am constantly looking for resources that include up-to-date research, prompt students to process material, help reinforce textbook material, and stimulate discussions and explorations of current biological topics. For these reasons, I routinely use HHMI's BioInteractive website and Holiday Lectures on Science DVDs in my classroom to highlight and strengthen my day-to-day coverage of material.

These resources are accurate, user-friendly, free of charge, and easily accessible; all key elements for successful classroom implementation. They have greatly enhanced my teaching methods in the classroom, my students' ability to understand the material, and our shared knowledge about current findings in Biology. The video clips, animations, and lecture chapters enhance formal classroom lecture material increasing student understanding and assisting student visualization of the subject matter, particularly at the molecular level, where many students struggle. Furthermore, the interactive click-and-learns, virtual museum, and classroom activities are used to introduce or complement curricular objectives. Finally, the virtual lab series is an excellent set of computer laboratory simulations.

This curriculum guide assists in filtering through the vast available resources and organizes the material according to topics related to molecular genetics, specifically the regulation of gene expression. Please do not hesitate to contact me with any questions or suggestions.

Most sincerely:

Ann Brokaw
Rocky River High School
Rocky River, Ohio
abrokaw44@gmail.com

Introduction

The amount of resources accessible to teachers from various organizations and the internet can be overwhelming. Furthermore, finding the time to process these resources and develop them into solid classroom-ready activities and lessons is difficult. This guide provides teacher-ready curriculum ideas utilizing Howard Hughes Medical Institute (HHMI) resources, including the BioInteractive website features and the Holiday Lectures on Science DVDs, to enhance classroom instruction of molecular genetics, specifically related to gene expression.

This curriculum guide organizes HHMI resources in the following categories: gene regulation mechanisms, examples, human diseases, and RNA interference. The resources include animations, video clips, interactive click-and-learn activities, virtual labs, and lectures specific to the topic. The following is a brief overview of the material covered in each part.

Gene Regulation Mechanisms

The resources included here demonstrate mechanisms associated with the regulation of gene expression. These regulatory resources pertain to gene switches, cytoplasmic signaling factors, transcription factors, and the role of p53. This section is the "how to" section, while the next section provided numerous examples.

Gene Regulation Examples

This vast list of resources includes a multitude of gene expression regulation examples. These examples include such things as: quorum sensing in bacteria, cell differentiation during neuron development, long-term memory processes, stem cell differentiation, toolkit genes, genes for obesity, circadian rhythm genes, and sex determination genes. Spend some time in this section. There are several great examples of regulatory processes here that will help illustrate the importance of controlling gene expression.

Gene Regulation and Human Disease

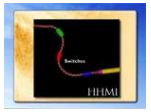
Several human diseases are associated with faulty gene expression regulation. Several examples, such as Type II Diabetes, Rett Syndrome, Cancer, Muscular Dystrophy, among others, are presented here.

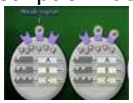
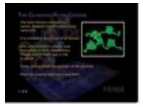
RNA Interference (RNAi)

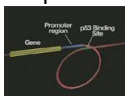
RNA Interference is one of the most significant discoveries of our time. In this section, learn how RNAi was discovered, how it works, and the important role it plays in regulating gene expression.

Gene Regulation Mechanisms

This table includes HHMI animations, video clips, interactives, and lecture material pertaining to DNA Structure and Function.
All of these resources can be accessed via www.BioInteractive.org and via Holiday Lectures on Science DVDs.
If you have downloaded this document from BioInteractive.org, simply click on the thumb print photo or lecture title to open the resource.

Holiday Lecture	BioInteractive Topic	Resource Type	Resource	Resource Summary
Evolution: Constant Change and Common Threads (2005)	Evolution	Interactive Click and Learn	Genetic Switches  *Resource title on DVD:* Gene Switches	Learn about how gene switches can control expression of genes in different tissues. (2 slides)
Evolution: Constant Change and Common Threads (2005)	Evolution	Animation	Gene Switch 	Regulatory "switches" are found upstream from a gene. Regulatory molecules bind to the switches and recruit RNA polymerase to bind to the gene's promoter region, increasing the transcription of the gene into messenger RNA. (1 min. 14 sec.)
Evolution: Constant Change and Common Threads (2005)	Evolution	Classroom Activity	Gene Switches 	Conceptually, how genetic switches function and their role in the process of evolution can be difficult for students to visualize. *Gene Switches—A Model* attempts to make this concept more understandable through the use of clips from the HHMI DVD *Evolution: Constant Change and Common Threads* and the construction of a model. This activity can be done as a demonstration, a student inquiry activity, or a combination of the two.
Evolution: Constant Change and Common Threads (2005)	Evolution	Lecture	Lecture 4: From Butterflies to Humans, Ch. 19–22	Genes are reused in different ways via genetic switches. (21:23–25:41) *These chapters discuss the significance of genetic switches and the role of evolution in the gain and loss of control.*

Holiday Lecture	BioInteractive Topic	Resource Type	Resource	Resource Summary
Potent Biology: Stem Cells, Cloning, and Regeneration (2006)	Stem Cells	Animation	Cytoplasmic Factors 	Cytoplasmic factors play a significant part in determining how a cell develops. This segment discusses their importance in turning the appropriate genes on and off for proper development. (56 sec.)
Potent Biology: Stem Cells, Cloning, and Regeneration (2006)	Stem Cells	Lecture	Lecture 1: Understanding Embryonic Stem Cells, Ch. 17–18	Cytoplasmic factors affect cell fate. (24:22–27:34) *These chapters illustrate how cell-to-cell interaction affects cell fate.*
Making Your Mind: Molecules, Motion, and Memory (2008)	Neuroscience	Animation	Signal Molecules Trigger Transcription Factors 	Varying concentrations of a signaling molecule activate different transcription factors and determine cell fate. (2 min. 4 sec.)
Making Your Mind: Molecules, Motion, and Memory (2008)	Neuroscience	Lecture	Lecture 2: Building Brains: The Molecular Logic of Neural Circuits, Ch. 21	Q&A: Do signal molecules have to be present throughout cell life? (31:38–32:50)
Making Your Mind: Molecules, Motion, and Memory (2008)	Neuroscience	Lecture	Lecture 2: Building Brains: The Molecular Logic of Neural Circuits, Ch. 22	Q&A: Can cell type be changed after initial signaling? (32:50–34:00)
Making Your Mind: Molecules, Motion, and Memory (2008)	Neuroscience	Lecture	Lecture 2: Building Brains: The Molecular Logic of Neural Circuits, Ch. 23	Q&A: How do cells secrete the correct amount of signal? (34:00–34:59)
Learning from Patients: The Science of Medicine (2003)	Cancer	Interactive Click and Learn	The p53 Gene and Cancer  *Resource title on DVD:* p53: The Guardian of the Genome	One of the most important molecules relating to cancer is called p53. It has been called the guardian of the genome. Learn about what p53 does, and how interfering with its function can lead to cancer. (8 slides)

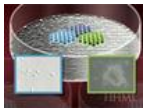
Holiday Lecture	BioInteractive Topic	Resource Type	Resource	Resource Summary
Learning from Patients: The Science of Medicine (2003)	Cancer	Animation	p53 	A 3-D animation showing the molecule p53 binding to DNA and initiating the transcription of mRNA. (25 sec.)
Scanning Life's Matrix: Genes, Proteins, and Small Molecules (2002)	Genomics and Chemical Genetics	Lecture	Lecture 1: Reading Genes and Genomes, Ch. 33	Q&A: What is currently being done to figure out noncoding DNA? (51:06–52:39)
Scanning Life's Matrix: Genes, Proteins, and Small Molecules (2002)	Genomics and Chemical Genetics	Lecture	Lecture 2: Probing Genes and Genomes, Ch. 4–8	If you want to understand life's processes, perturb them. (4:49–11:40) *This segment illustrates research methods to study proteins, genetics, and gene regulation.*

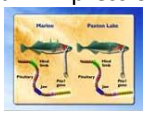
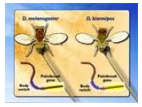
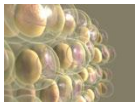
Gene Regulation Examples

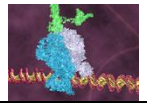
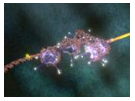
This table includes HHMI animations, video clips, interactives, and lecture material pertaining to DNA Structure and Function.
All of these resources can be accessed via www.BioInteractive.org and via Holiday Lectures on Science DVDs.
If you have downloaded this document from BioInteractive.org, simply click on the thumb print photo or lecture title to open the resource.

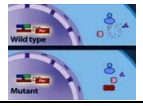
Holiday Lecture	BioInteractive Topic	Resource Type	Resource	Resource Summary
Exploring Biodiversity: The Search for New Medicines (2009)	Biodiversity	Interactive Click and Learn	Bacterial Quorum Sensing  *Resource title on DVD:* Quorum Sensing in *Vibrio harveyi*	Understand how quorum sensing works by reasoning through experiments involving genetically engineered bioluminescent bacteria. (13 slides)
Exploring Biodiversity: The Search for New Medicines (2009)	Biodiversity	Lecture	Lecture 2: Shedding Light on an Invisible World, Ch. 29	Quorum sensing and autoinducers. (32:28–34:01)
Exploring Biodiversity: The Search for New Medicines (2009)	Biodiversity	Lecture	Lecture 2: Shedding Light on an Invisible World, Ch. 32	Quorum sensing activates a large network of genes. (36:31–37:51)

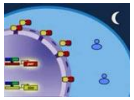
Holiday Lecture	BioInteractive Topic	Resource Type	Resource	Resource Summary
Exploring Biodiversity: The Search for New Medicines (2009)	Biodiversity	Lecture	Lecture 2: Shedding Light on an Invisible World, Ch. 34–40	Quorum sensing allows bacteria to act collectively. (38:44–50:59) *This segment explains the roles of kinases and phosphatases in the molecular pathway, as they are utilized by bacteria to act as a group. An animation is also included.*
Exploring Biodiversity: The Search for New Medicines (2009)	Biodiversity	Animation	*Lux* Operon Controls Light Production 	A single transcription factor controls this operon, which contains five genes necessary to produce bioluminescence. (2 min. 26 sec.)
Exploring Biodiversity: The Search for New Medicines (2009)	Biodiversity	Lecture	Lecture 4: Eavesdropping on Tiny Conspiracies, Ch. 11–15	The *Lux* signaling cascade in low cell density. (12:41–21:01) *This material discusses the specifics of the molecular cascade involved in quorum sensing and the role of RNA interference during the process.*
Exploring Biodiversity: The Search for New Medicines (2009)	Biodiversity	Animation	The Molecular Cascade in Bacterial Quorum Sensing 	Quorum sensing regulates gene expression by a protein phosphorylation cascade that controls transcription. (3 min. 20 sec.)
Exploring Biodiversity: The Search for New Medicines (2009)	Biodiversity	Lecture	Lecture 4: Eavesdropping on Tiny Conspiracies, Ch. 17–19	Two parallel QS (quorum sensing) circuits. (22:40–25:32) *These chapters discuss the differences between a bacterium communicating with "self" and "non-self" and the role of gene expression in those processes.*
Exploring Biodiversity: The Search for New Medicines (2009)	Biodiversity	Lecture	Lecture 4: Eavesdropping on Tiny Conspiracies, Ch. 21	Can QS (quorum sensing) be used to treat bacterial infections? (26:31–28:15)
Making Your Mind: Molecules, Motion, and Memory (2008)	Neuroscience	Animation	Signal Molecules Trigger Transcription Factors 	Varying concentrations of a signaling molecule activate different transcription factors and determine cell fate. (2 min. 4 sec.)

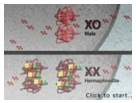
Holiday Lecture	BioInteractive Topic	Resource Type	Resource	Resource Summary
Making Your Mind: Molecules, Motion, and Memory (2008)	Neuroscience	Lecture	Lecture 2: Building Brains: The Molecular Logic of Neural Circuits, Ch. 10–14	How do neurons differentiate during development? (13:06–22:55) *Included here is a discussion of the development of the human brain during embryonic development and the role of gene expression in that process.*
Making Your Mind: Molecules, Motion, and Memory (2008)	Neuroscience	Lecture	Lecture 2: Building Brains: The Molecular Logic of Neural Circuits, Ch. 15–20	Studying simple motor circuits in the spinal cord. (22:55–31:38) *This lecture teaches the role of the* Sonic Hedgehog *protein as a signaling molecule during embryonic development.*
Making Your Mind: Molecules, Motion, and Memory (2008)	Neuroscience	Animation	Molecular Activity in *Aplysia* Long-Term Memory 	Long-term memory requires the activation of CREB, turning on specific genes that support new synaptic growth. (1 min. 39 sec.)
Making Your Mind: Molecules, Motion, and Memory (2008)	Neuroscience	Lecture	Lecture 4: Memories Are Made of This, Ch. 17–18	Gene expression, long-term memory, and autism. (24:06–27:31) *These chapters use an animation to demonstrate the gene expression problem associated with long term memory problems and the link to autism.*
Making Your Mind: Molecules, Motion, and Memory (2008)	Neuroscience	Lecture	Lecture 4: Memories Are Made of This, Ch. 28–30	PKA-deficient mutant mice have a reduction in late LTP. (39:46–42:37) *This segment explains how protein kinase mutant mice have poor memory because of changes in gene expression.*
Potent Biology: Stem Cells, Cloning, and Regeneration (2006)	Stem Cells	Animation	Creating Embryonic Stem Cell Lines 	The inner cell mass (ICM) cells of blastocyst-stage early human embryos can be removed and cultured. These cells can be grown in the lab indefinitely. Various growth factors cause these cells to develop into a variety of differentiated cells, such as muscle or nerve cells. (1 min. 37 sec.)
Potent Biology: Stem Cells, Cloning, and Regeneration (2006)	Stem Cells	Lecture	Lecture 1: Understanding Embryonic Stem Cells, Ch. 13–15	Progressive development creates specialized cells. (18:33–23:43) *These chapters discuss how genes are turned on and off as cells differentiate during development.*
Potent Biology: Stem Cells, Cloning, and Regeneration (2006)	Stem Cells	Lecture	Lecture 1: Understanding Embryonic Stem Cells, Ch. 17–18	Cytoplasmic factors affect cell fate. (24:22–27:34) *The chapters illustrate how cell-to-cell interaction affects cell fate.*

Holiday Lecture	BioInteractive Topic	Resource Type	Resource	Resource Summary
Potent Biology: Stem Cells, Cloning, and Regeneration (2006)	Stem Cells	Lecture	Lecture 1: Understanding Embryonic Stem Cells, Ch. 22	Q&A: Can you change gene expression to change cell types? (30:27–31:05)
Potent Biology: Stem Cells, Cloning, and Regeneration (2006)	Stem Cells	Lecture	Lecture 1: Understanding Embryonic Stem Cells, Ch. 23	Q&A: Can cells be changed in vitro with chemical factors? (31:05–32:23)
Evolution: Constant Change and Common Threads (2005)	Evolution	Animation	*Pitx 1* Expression 	In the stickleback fish, pelvic-fin reduction resulted from changes in the regulatory switch elements of the *Pitx1* gene. In the marine ancestor, the *Pitx1* gene is activated in the pelvic-fin region during development to generate the fin. In the pelvic-reduced stickleback, the regulatory switch that normally turns on the *Pitx1* gene is either missing or nonfunctional. (54 sec.)
Evolution: Constant Change and Common Threads (2005)	Evolution	Lecture	Lecture 3: Fossils, Genes, and Embryos, Ch. 32–39	*Pax6* is a toolkit gene that turns other genes on and off. (41:23–48:39) *This lecture covers material pertaining to the* Pax6 *and* Pitx *genes and how they function during gene expression.*
Evolution: Constant Change and Common Threads (2005)	Evolution	Animation	Paintbrush Gene 	In two related *Drosophila* species, a so-called paintbrush gene is activated to "paint" the pigment on the body. In one species, an extra switch activates the gene, resulting in spotted wings. (49 sec.)
Science of Fat (2004)	Obesity	Animation	PPAR-gamma Activation in the Fat Cell 	The PPAR-gamma receptor activates certain genes in a fat cell, resulting in the storage of fat and changes in hormone levels. (2 min. 48 sec.)
Science of Fat (2004)	Obesity	Lecture	Lecture 3: Balancing the Fat Equation, Ch. 6–10	Two types of hormone action: At the membrane and at the nucleus. (8:36–18:48) *This segment includes information regarding how endocrine hormone signals get received and the role of nuclear-based receptors in gene expression regulation.*

Holiday Lecture	BioInteractive Topic	Resource Type	Resource	Resource Summary
Science of Fat (2004)	Obesity	Animation	PPAR-delta Activation in the Muscle Cell 	The PPAR-delta receptor activates certain genes in a muscle cell, resulting in the burning of fat. (1 min. 44 sec.)
Science of Fat (2004)	Obesity	Lecture	Lecture 3: Balancing the Fat Equation, Ch. 19–24	Can we use PPAR-delta to increase metabolism? (33:32–45:46) *This segment discusses two types of muscle fibers and illustrates the role of PPAR-delta in muscle twitching in mice.*
Science of Fat (2004)	Obesity	Video	Mouse Activity 	Dr. Evans compares the activity of a normal mouse to one with a mutation in a key gene controlling obesity. (29 sec.)
Science of Fat (2004)	Obesity	Video	Marathon Mice: PPAR 	Dr. Ronald Evans discusses the so-called "marathon" mouse, with a mutation in the *PPAR delta* gene, and its performance on a treadmill relative to a normal mouse. (52 sec.)
Learning from Patients: The Science of Medicine (2003)	Neuroscience	Lecture	Lecture 3: A Healthy Nervous System: A Delicate Balance, Ch. 31	Using chaperones to counteract protein accumulation. (46:31–48:46)
Learning from Patients: The Science of Medicine (2003)	Neuroscience	Lecture	Lecture 3: A Healthy Nervous System: A Delicate Balance, Ch. 35	Q&A: Why do cells degrade proteins? (53:33–54:25)
Learning from Patients: The Science of Medicine (2003)	Neuroscience	Animation	MECP2 	This animation shows how the protein MECP2, in conjunction with another protein complex, can act as an "on-off" switch for gene expression. (43 sec.)
Learning from Patients: The Science of Medicine (2003)	Neuroscience	Lecture	Lecture 4: The Strength of Families: Solving Rett Syndrome, Ch. 25–27	What does methyl-CpG (MECP2) binding protein do? (27:46–32:14) *This portion of the lecture discusses how MECP2 regulates gene expression.*

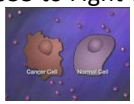
Holiday Lecture	BioInteractive Topic	Resource Type	Resource	Resource Summary
Learning from Patients: The Science of Medicine (2003)	Neuroscience	Lecture	Lecture 4: The Strength of Families: Solving Rett Syndrome, Ch. 30	MECP2 gene is expressed during neuronal maturation. (37:14–41:08)
Learning from Patients: The Science of Medicine (2003)	Neuroscience	Lecture	Lecture 4: The Strength of Families: Solving Rett Syndrome, Ch. 36	Q&A: Why is MECP2 not needed until neurons are fully mature? (51:08–52:35)
Learning from Patients: The Science of Medicine (2003)	Neuroscience	Video	Rett Syndrome 	Dr. Zoghbi introduces the topic of Rett syndrome by showing how development usually progresses in a young girl. She then shows an excerpt from *Silent Angels*, introduced by Julia Roberts, which shows how Rett syndrome affects development. (2 min. 51 sec.)
Learning from Patients: The Science of Medicine (2003)	Neuroscience	Lecture	Lecture 4: The Strength of Families: Solving Rett Syndrome, Ch. 39	Q&A: How is Rett syndrome turning some genes off? (55:25–56:32)
Clockwork Genes: Discoveries in Biological Time (2000)	Biological Clocks	Animation	The *Drosophila* Molecular Clock Model 	Watch these animations display the dynamic orchestration of the molecular events of the *Drosophila* biological clock. (7 min. 34 sec.) *Also included here is a detailed explanation of this molecular process, including negative feedback, activation, and degradation of the components. (Click on the animation link, then before clicking on the MOV or WMV, scroll down to the information.)*
Clockwork Genes: Discoveries in Biological Time (2000)	Biological Clocks	Lecture	Lecture 2: Unwinding Clock Genetics, Ch. 25–32	Beginning of the molecular era: Cloning of the *period* gene (34:29–47:10) *This segment illustrates the molecular clock genetic regulatory pathways of the fruit fly.*
Clockwork Genes: Discoveries in Biological Time (2000)	Biological Clocks	Lecture	Lecture 2: Unwinding Clock Genetics, Ch. 37	Q&A: What kind of protein is PER and what does it do? (52:32–53:16)
Clockwork Genes: Discoveries in Biological Time (2000)	Biological Clocks	Lecture	Lecture 2: Unwinding Clock Genetics, Ch. 17	Q&A: Are there fundamental differences between diurnal and nocturnal animals? (25:15–26:32)
Clockwork Genes: Discoveries in Biological Time (2000)	Biological Clocks	Lecture	Lecture 3: PERfect TIMing, Ch. 8–13	Currently known *Drosophila* clock genes. (12:24–22:06) *This lecture explains the PER and TIM genes and their role in the circadian rhythm of the fruit fly.*
Clockwork Genes: Discoveries in Biological Time (2000)	Biological Clocks	Lecture	Lecture 3: PERfect TIMing, Ch. 20	The role of the kinase Doubletime (DBT). (31:02–32:48)

Holiday Lecture	BioInteractive Topic	Resource Type	Resource	Resource Summary
Clockwork Genes: Discoveries in Biological Time (2000)	Biological Clocks	Lecture	Lecture 3: PERfect TIMing, Ch. 30	Summary of the *Drosophila* clock system. (50:53–53:09)
Clockwork Genes: Discoveries in Biological Time (2000)	Biological Clocks	Animation	The Mammalian Molecular Clock Model 	This animation shows the molecular interactions involved in the negative feedback loop responsible for circadian rhythms in mammals. (3 min. 40 sec.) *Also included here is a detailed explanation of this molecular process, including negative feedback, activation of the process, and the specific genes involved. (Click on the animation link, then before clicking on the MOV or WMV, scroll down to the information.)*
Clockwork Genes: Discoveries in Biological Time (2000)	Biological Clocks	Lecture	Lecture 4: The Mammalian Timekeeper, Ch. 21–23	Nine different proteins related to circadian clock genes. (30:50–35:10) *These 3 chapters cover material related to the mammalian clock genes and their role in gene expression.*
Clockwork Genes: Discoveries in Biological Time (2000)	Biological Clocks	Lecture	Lecture 4: The Mammalian Timekeeper, Ch. 24–30	*Tau* mutant in the golden hamster. (35:10–45:31) *This section discusses the discovery of the* tau *mutant and the role it plays in the clock molecular pathway. Also included is a summary of the mammalian and fruit fly clocks.*
Clockwork Genes: Discoveries in Biological Time (2000)	Biological Clocks	Lecture	Lecture 4: The Mammalian Timekeeper, Ch. 33	Summary of the four lectures. (49:20–51:41) *This chapter summarizes the material in the four lectures covering biological clocks.*
The Meaning of Sex: Genes and Gender (2001)	Sex Determination	Lecture	Lecture 1: Deciphering the Language of Sex, Ch. 13–15	Discovery of how sex chromosomes operate in humans. (20:13–25:39) *This material discusses the genes associated with sex determination and specifically the SRY gene in males.*
The Meaning of Sex: Genes and Gender (2001)	Sex Determination	Lecture	Lecture 2: Hermaphrodites: The Safer Sex, Ch. 12–17	Life cycle of a hermaphrodite. (17:22–23:37) *This section uses* Caenorhabditis elegans *as a model organism to study embryonic development, gene expression, and the activation of sex-determining genes.*
The Meaning of Sex: Genes and Gender (2001)	Sex Determination	Lecture	Lecture 2: Hermaphrodites: The Safer Sex, Ch. 25–27	The basis of sex determination in *C. elegans.* (28:44–32:13) *This segment explains the role of the sex-determining genes in this model organism and how there is a balance of signal elements and protein activity.*
The Meaning of Sex: Genes and Gender (2001)	Sex Determination	Lecture	Lecture 2: Hermaphrodites: The Safer Sex, Ch. 32–35	Review of the central dogma of genetics. (38:17–44:40) *This segment begins with a review of basic gene expression and concludes with a summary of the repression mechanisms of* xol-1 *during RNA splicing.*

Holiday Lecture	BioInteractive Topic	Resource Type	Resource	Resource Summary
The Meaning of Sex: Genes and Gender (2001)	Sex Determination	Animation	MIX-1 	This animation shows how MIX-1 facilitates both chromosome condensation and dosage compensation. (3 min. 38 sec.)
Learning from Patients: The Science of Medicine (2003)	Neuroscience	Animation	X - Inactivation 	This animation shows how the random deactivation of one of the X chromosomes in a pair can lead to a mozaicism in the expression of genes. (55 sec.)
The Meaning of Sex: Genes and Gender (2001)	Sex Determination	Lecture	Lecture 3: Sex and Death: Too Much of a Good Thing, Ch. 5–9	How do humans deal with having too many X-chromosomes? (7:19–13:35) *This segment teaches dosage compensation and sex determination and the role of various genes in the expression process.*
The Meaning of Sex: Genes and Gender (2001)	Sex Determination	Lecture	Lecture 3: Sex and Death: Too Much of a Good Thing, Ch. 14–18	How does SCD protein interact with the X chromosome? (16:23–24:14) *These chapters address the role of the* xol-1 *mutant in sex determination and dosage compensation.*
The Meaning of Sex: Genes and Gender (2001)	Sex Determination	Lecture	Lecture 3: Sex and Death: Too Much of a Good Thing, Ch. 22	Student question: How can Turner syndrome have effects if X inactivation occurs? (26:09–28:26)
The Meaning of Sex: Genes and Gender (2001)	Sex Determination	Lecture	Lecture 3: Sex and Death: Too Much of a Good Thing, Ch. 23	Student question: What happens in XXX nematodes? (28:26–29:11)
The Meaning of Sex: Genes and Gender (2001)	Sex Determination	Lecture	Lecture 3: Sex and Death: Too Much of a Good Thing, Ch. 24	Student question: What actually kills when there is no dosage compensation? (29:11–29:55)
The Meaning of Sex: Genes and Gender (2001)	Sex Determination	Lecture	Lecture 3: Sex and Death: Too Much of a Good Thing, Ch. 25	Student question: How do genes in X chromosomes escape inactivation? (29:55–30:52)

Gene Regulation and Human Disease

This table includes HHMI animations, video clips, interactives, and lecture material pertaining to DNA Structure and Function.
All of these resources can be accessed via www.BioInteractive.org and via Holiday Lectures on Science DVDs.
If you have downloaded this document from BioInteractive.org, simply click on the thumb print photo or lecture title to open the resource.

Holiday Lecture	BioInteractive Topic	Resource Type	Resource	Resource Summary
Learning from Patients: The Science of Medicine (2003)	Cancer	Lecture	Lecture 1: Research Mechanisms: Putting the Brakes on Cancer, Ch. 27–31	Colorectal cancer pathway. (44:41–52:03) *This material discusses the molecular pathway of colorectal cancer and the role of mutations in the* p53 *gene that occur in most cancers.*
Learning from Patients: The Science of Medicine (2003)	Cancer	Animation	Using p53 to Fight Cancer 	This animation demonstrates how cancerous cells could be destroyed using a modified virus. (1 min. 1 sec.)
Learning from Patients: The Science of Medicine (2003)	Cancer	Lecture	Lecture 1: Research Mechanisms: Putting the Brakes on Cancer, Ch. 37	Q&A: Do cancer cells have multiple mutations in apoptosis factors? (56:05–57:11)
Learning from Patients: The Science of Medicine (2003)	Cancer	Animation	CML and Gleevec 	Chronic myeloid leukemia (CML) is caused by a mutation that leads to an abnormal protein that is always active. The drug Gleevec has a shape that fits into the active site of the abnormal protein and stops its harmful effects. (41 sec.)
Learning from Patients: The Science of Medicine (2003)	Cancer	Animation	Gleevec 	Ideally, cancer treatments target specific weaknesses in the cell processes that lead to cancer. The drug Gleevec has been designed to disrupt the growth of leukemia cells by blocking a binding site of a key protein found only in tumor cells and not in normal cells. (1 min. 3 sec.)

Holiday Lecture	BioInteractive Topic	Resource Type	Resource	Resource Summary
Learning from Patients: The Science of Medicine (2003)	Cancer	Print Article	Evolution of Cancer	Cancers grow and spread by a process akin to evolution. A cancer cell accumulates mutations, each of which can give the cell a growth advantage over its neighbors. This single cell will divide to populate the tumor until another cell with an even better growth advantage crops up. At that point, the more aggressive cell reproduces rapidly, taking over the tumor. It's survival of the fittest, with every cell for itself.
Learning from Patients: The Science of Medicine (2003)	Cancer	Print Article	Understanding Cancer Diversity	The human body operates, in essence, like a large, multicellular society. Within this tight-knit community, trillions of cells, organized into hundreds of different tissues, collaborate for the good of the whole organism. Some cells convert food into energy, some transport oxygen or nutrients throughout the body, some fight infections, and some shuttle the organism's genes into the next generation.
Learning from Patients: The Science of Medicine (2003)	Neuroscience	Lecture	Lecture 3: A Healthy Nervous System: A Delicate Balance,Ch. 21–22	Is SCA1 caused by a loss-of-function mutation or a gain-of-function mutation? (33:31–36:46)
Learning from Patients: The Science of Medicine (2003)	Neuroscience	Video	Rett Syndrome 	Dr. Zoghbi introduces the topic of Rett syndrome by showing how development usually progresses in a young girl. She then shows an excerpt from *Silent Angels*, introduced by Julia Roberts, which shows how Rett syndrome affects development. (2 min. 51 sec.)
Learning from Patients: The Science of Medicine (2003)	Neuroscience	Lecture	Lecture 4: The Strength of Families: Solving Rett Syndrome, Ch. 39	Q&A: How is Rett Syndrome turning some genes off? (55:25–56:32)
The Double Life of RNA (1995)	RNA	Lecture	Lecture 2: RNA as an Enzyme: Discovery, Origins of Life, and Medical Possibilities, Ch. 16–19	Possible uses of ribozymes to fight diseases. (40:22–55:43) *These chapters discuss specific uses of ribozymes to regulate cellular processes related to disease.*
Scanning Life's Matrix: Genes, Proteins, and Small Molecules (2002)	Genomics and Chemical Genetics	Lecture	Lecture 1: Reading Genes and Genomes, Ch. 19	Q&A: Do genes involved in the same disease have the same promoter? (28:58–30:24)
Scanning Life's Matrix: Genes, Proteins, and Small Molecules (2002)	Genomics and Chemical Genetics	Lecture	Lecture 4: Chemical Genomics: New Tools for Medicine, Ch. 4–6	Chemical genetics is used to explore many biological questions. (5:15–10:07) *This segment discusses type II diabetes and the use of chemical genetics to investigate the glucose-sensing pathways.*
Potent Biology: Stem Cells, Cloning, and Regeneration (2006)	Stem Cells	Lecture	Lecture 2: Adult Stem Cells and Regeneration, Ch. 35–38	Muscular dystrophy (MD) overwhelms stem cell capacity. (42:11–49:30) *This lecture explains the problems associated with MD gene expression pathways and attempts to repair damaged cells.*

RNA Interference (RNAi)

This table includes HHMI animations, video clips, interactives, and lecture material pertaining to DNA Structure and Function.
All of these resources can be accessed via www.BioInteractive.org and via Holiday Lectures on Science DVDs.
If you have downloaded this document from BioInteractive.org, simply click on the thumb print photo or lecture title to open the resource.

Holiday Lecture	BioInteractive Topic	Resource Type	Resource	Resource Summary
The Double Life of RNA (1995)	RNA	Interactive Click and Learn	RNA Interference 	RNA interference is an exciting new research tool for shutting down genes. It could also yield new medical treatments. Learn how RNA interference was discovered and how it works. (16 slides)
The Double Life of RNA (1995)	RNA	Video	Enzymes that are Not Proteins: The Discovery of Ribozymes 	Listen to former HHMI President Dr. Thomas Cech discuss his Nobel Prize–winning discovery of RNA's catalytic properties. (19 min.)
The Double Life of RNA (1995)	RNA	Lecture	Lecture 2: RNA as an Enzyme: Discovery, Origins of Life, and Medical Possibilities, Ch. 16–19	Possible uses of ribozymes to fight diseases. (40:22–55:43) *These chapters discuss specific uses of ribozymes to regulate cellular processes related to disease.*
The Double Life of RNA (1995)	RNA	Video	NOVA Science NOW: RNAi (RNA Interference) 	A story from the PBS science newsmagazine detailing RNAi's discovery and how it functions. (15 min. 18 sec.)
Exploring Biodiversity: The Search for New Medicines (2009)	Biodiversity	Lecture	Lecture 4: Eavesdropping on Tiny Conspiracies Ch. 11–15	The *Lux* signaling cascade in low cell density. (12:41–21:01) *This material discusses the specifics of the molecular cascade involved in quorum sensing and the role of RNA interference during the process.*