The Meaning of Sex: Genes and Gender:
Correlations to National Standards

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Explanation of the individual lecture guide format and notation

1. "Unit/Subject Areas" are in correlation with a general Biology course outline.
2. "National Standards Alignments" are based on the "Content Standards: 9-12" of the National Science Education Standards, 1996, published by National Academy Press, Washington, D.C., ISBN 0-309-05326-9. Standards are identified according to the following notations:

Content Standard A: "As a result of activities in grades 9-12, all students should develop
1) Abilities necessary to do scientific inquiry
2) Understandings about scientific inquiry"

Content Standard C: "As a result of their activities in grades 9-12, all students should develop an understanding of
1) The cell
2) Molecular basis of heredity
3) Biological evolution
4) Interdependence of organisms
5) Matter, energy, and organization in living systems
6) Behavior of organisms"

Content Standard E: "As a result of activities in grades 9-12, all students should develop
1) Abilities of technological design
2) Understandings about science and technology"

Content Standard F: "As a result of activities in grades 9-12, all students should develop understanding of
1) Personal and community health
2) Population growth
3) Natural resources
4) Environmental quality
5) Natural and human-induced hazards
6) Science and technology in local, national, and global challenges"

Content Standard G: "As a result of activities in grades 9-12, all students should develop understanding of
1) Science as a human endeavor
2) Nature of scientific knowledge
3) Historic perspectives"

(The numbers have been added for specific identification.)

Lecture 1: Deciphering the Language of Sex

Chapter	Title	Subject Area	National Standards Alignment
3	Dr. Page's Bio	Careers: Process of Science	G1, 2
4	First thing parents asked about you	----	----
5 *	Characteristics of male and female	Sexual Reproduction; Anatomical Differences	C5
6	Electron micrograph of egg and sperm	Sexual Reproduction; Size difference	C5
7 *	Embryonic development and role of gonads	Hormone Secretion; Animal Development	C and Beyond
8 *	Sex determination cannot be explained by historical idea	History of Heredity	C2; G3
9	Historical ideas on environmental factors affecting sex determination	History of Science	G3
10	Early 20th century scientists find sex chromosomes in insects	History of Science	G3
11 *	What might the sex determining signal be?	Process of Science; Genetics/Chromosomes	C2; G1
12 *	In 1916, the sex of fruit flies is linked to an X chromosome	Process of Science; Genetics/Chromosomes	C2; G1
13 *	Discovery of how sex chromosomes operate in humans	Genetics/Chromosomes	C2
14 *	XX male and XY female suggest key genes for sex determination	Genetics/Chromosomes	C2
15 *	SRY, the sex determining gene in transgenic mice	Genetics: Process of Science; Molecular Bio	C2
16 (SQ)	Symptoms of XXY and XO	Description of Klinefelter and Turner Syndromes	C and Beyond
17 (SQ)	Cause of hermaphroditism?	Definition/Explanation of hermaphroditism	C and Beyond
18 (SQ)	Why do XX males not have sperm?	Development/Genetics	Beyond
19 (SQ)	Why XY females develop as female?	Development	Beyond
20 (SQ)	Does SRY determine if testes develop?	Development; Genetics	Beyond
21 (SQ)	Can Y activity be clearly observed in human body?	(unclear)	Beyond
22 (SQ)	Do XY females have male levels of testosterone?	Development	Beyond
23 *	Why two sexes? Are males really necessary?	Reproduction	A2; C5
24 *	Clonal Reproduction	Asexual Reproduction	C1
25 *	Comparing female to female cloning in whiptail lizards with sexual reproduction	Reproduction; Parthenogenesis; Mitosis	C1
26 *	Meiosis is the defining feature of sexual reproduction	Reproduction; Meiosis	C1, 2
27	Is sex evolutionarily good?	Student responses	----
28	Demo: Fresh fruit vs. rotting vegetables	Genetics; Mutation	C2
29	Demo: Fruits vs. vegetables with mutations	Genetics; Mutation	C2
30	Demo: Meiosis can weed out rotten genes	Genetics; Mutation; Meiosis; Fertilization	C2

Chapter	Title	Subject Area	National Standards Alignment
31	Animation: Meiosis	Meiosis	C2
32	Animation: Embryonic development	Development	C5
33	Animation: X chromosome gaines SRY gene	Meiosis: Crossing over	C1, 2
34 (SQ)	With a recessive mutation, would a clonal producer be better?	Reproduction: Evolution	----
35 (SQ)	Is lizard cloning the same as sheep cloning and Dolly?	Comparative cloning	----

* indicates a chapter with a chart or diagram

(SQ) indicates a student question

Lecture 2: Hermaphrodites: The Safer Sex

Chapter	Title	Subject Area	National Standards Alignment
3	Interview with Dr. Meyer	Careers	G1
4 *	Why study model organisms?	Unity of Life; Evolution; Protein Chemistry	C3, 5
5 *	Intro to *C. elegans* nematode	Animal characteristics; Research Process	A1; G1
6 *	Anatomy of *C. elegans* - every cell is known; genome sequenced	Molecular Biology	G and Beyond
7 *	The two sexes of *C. elegans* - male and hermaphrodite	Animal structure; Genetics somewhat	C2
8	Video: *C. elegans* mating	Nematode Reproduction	Beyond
9 *	*C. elegans* sperm (picture)	Gamete structure	C1
10	Video: amoeboid sperm of *C. elegans*	Gamete structure	Beyond
11	Behavior gene in *C. elegans* is related to human kidney function gene	Comparative animal study; Genetics	C6
12 *	Life cycle of the hermaphrodite	Animal structure	Beyond
13 *	Fertilization mechanisms in *C. elegans*	Structure; Fertilization	C and Beyond
14 *	Early embryonic development of *C. elegans*	Animal development; Polar bodies of meiosis	C6
15	Video: From fertilization to egg laying in *C. elegans*	Mitosis	C1
16 *	Using mutations to study sex determination in *C. elegans*	Molecular Biology	C and Beyond
17 *	Activation of sex determination gene	Molecular Biology; Gene Regulation	C and Beyond
18 (SQ)	Why can't human hermaphrodites self-fertilize?		
19 (SQ)	Why are there no female (*C. elegans*) worms?		
20 (SQ)	Do hermaphrodites use male sperm preferentially?		
21 (SQ)	Do male sperm permanently displace hermaphrodite sperm?		
22 (SQ)	Did hermaphrodites evolve from females?		
23 (SQ)	Can hermaphrodites mate with each other?		
24 (SQ)	At what stage can you determine the sex of the worm?		
25 *	Basis of sex determination in *C. elegans*?	Chromosomes	C2
26 *	Activity of *xol*-1 sex determining gene depends on the ratio of X chromosomes to autosomes	Animal Development; Molecular Biology	Beyond
27 *	Balance of X signal elements (XSEs) and autosomal proteins regulates *xol*-1 activity	Molecular Biology; Gene Regulation	Beyond
28	Demo: Balance of molecules in XO	Molecular Biology	Beyond

Chapter	Title	Subject Area	National Standards Alignment
29	Demo: Balance of molecules in XX	Molecular Biology	Beyond
30	Demo: Balance of molecules in XX with lower levels of XSEs	Molecular Biology	Beyond
31	Demo: Balance of molecules in XX with much, much lower levels of XSEs	Molecular Biology	Beyond
32 *	Review of central dogma of genetics	Protein Synthesis; Gene regulation	C1, 2
33 *	An XSE represses transcription of *xol*-1	Transcription with repressor	C and Beyond
34	XSE also acts to prevent proper splicing of *xol*-1 mRNA transcript	Molecular Biology; RNA splicing	Beyond
35	Summary of repression mechanism of *xol*-1	Molecular Biology; Gene regulation	Beyond
36	Does *xol*-1 at low levels have any functions?	Molecular Biochemistry	Beyond
37 (SQ)	What is the purpose of low levels of *xol*-1 in hermaphrodites?		
38 (SQ)	Is *xol*-1 comparable to SRY in humans?		
39 (SQ)	What is the difference between blue and yellow XSEs in the demo?		
40 (SQ)	What do we know about human hermaphrodites?		
41 (SQ)	Is it possible to produce a worm that lacks *xol*-1?		
42 (SQ)	Do all organisms require a gene to be switched on for male development?		
43 (SQ)	Can you add *xol*-1 to a hermaphrodite and make it male?		

* indicates a chapter with a chart or diagram

(SQ) indicates a student question

Lecture 3: Sex and Death: Too Much of a Good Thing

Chapter	Title	Subject Area	National Standards Alignment
3	Introductory interview with Dr. Meyer	Careers	G1
4 *	Too many chromosomes: Down Syndrome	Genetics; Chromosomes	C2
5 *	How humans deal with too many X chromosomes	Genetics; Chromosomes (Barr bodies)	C2
6 *	How the nematode deals with having too many X chromosomes	Transcriptional Control	C and Beyond
7 *	Dumpy (DPY) gene: a dosage compensation mutant	Molecular Biology	Beyond
8 *	The sdc gene affects both dosage compensation and sex determination	Molecular Biology	Beyond
9 *	Demo: Branched pathway for dosage compensation and sex determination	Molecular Biology; X expression	Beyond
10	Demo: The sdc is turned on in normal hermaphrodite development	Animal Development	Beyond
11	Demo: An sdc mutant hermaphrodite develops as a male without dosage compensation	Animal Development	Beyond
12 *	Demo: Blocking of sex determination pathway only	Animal Development	Beyond
13 *	Demo: Blocking of dosage compensation branch only	Animal Development	Beyond
14 *	How does sdc protein interact with the X chromosome	Protein Activity; Molecular Biology	Beyond
15 *	How does the male X chromosome avoid dosage compensation	Molecular Biology	Beyond
16 *	What happens in a *xol*-1 mutant	Molecular Biology	Beyond
17 *	How can you keep a *xol*-1 mutant from dying?	Molecular Biology	Beyond
18 *	How can you manipulate *xol*-1 mutants to become male?	Molecular Biology	Beyond
19 (SQ)	How do you get a 50% reduction in gene activity?		
20 (SQ)	Does dosage compensation occur on autosomes?		
21 (SQ)	Can a nematode get Down Syndrome?		
22 (SQ)	How can Turner Syndrome have effects if X in activation occurs?		
23 (SQ)	What happens in XXX nematodes?		
24 (SQ)	What actually kills when there is no dosage compensation?		
25 (SQ)	How do genes on X chromosomes escape inactivation?		
26 (SQ)	Do autosomes have genes that determine sex?		
27	Topics of second portion of lecture	----	----

Chapter	Title	Subject Area	National Standards Alignment
28 *	Review of mitotic chromosome segregation	Mitosis; Cell structure and function	C1
29 *	Dosage compensation proteins evolved from mitotic proteins	Molecular evolution; Chemical comparison	C3 and Beyond
30 *	*MIX*-1 protein has roles in both mitosis and dosage compensation	Molecular evolution; Chemical comparison	C3 and Beyond
31 *	How does *MIX*-1 carry out the two roles without confusion?	Molecular protein chemistry/coupling	Beyond
32 *	Where and when is *SMC*-4 found?	Molecular Biology	Beyond
33 *	*SMC*-4 is only expressed in mitotic cells.	Molecular Biology	Beyond
34	Video: Embryonic cell division in wild type and *SMC*-4 mutants	Molecular Biology	Beyond
35 *	Animation: *SMC*-4 and *MIX*-1 proteins in mitosis	Molecular Biology	Beyond
36 *	Animation: *SMC*-4 and *MIX*-1 proteins in dosage compensation and mitosis	Molecular Biology	Beyond
37 *	*DPY*-28 protein is involved in meiosis	Reproduction; Meiosis Review; Meiosis Extension	C1, 2
38	Summary of Lecture 3	----	----
39 (SQ)	Can you tag *SMC*-4 and use it as a marker for meiosis?		
40 (SQ)	At what developmental stage does dosage compensation start?		
41 (SQ)	Is the dosage compensation mechanism similar to cell division in any way?		
42 (SQ)	How does *DPY*-28 control the number of crossings over?		
43 (SQ)	Without *SMC*-4, would a chromosome stay tangled?		

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(SQ) indicates a student question

Lecture 4: Sexual Evolution: From X to Y

Chapter	Title	Subject Area	National Standards Alignment
3	Introductory interview with Dr. Page	Careers	G1
4	Description of study measuring testosterone levels of student subjects	Process of Science	A1; G1, 2
5	Testosterone Study; Student predictions	Process of Science	A1; G1
6 *	Testosterone Study: Interpretations	Process of Science	A1; G1, 2
7	What does the Y chromosome do?	Gene function (SRY)	C2
8 *	Cartoon map of Y chromosome	Chromosome mapping	C2
9 *	Real map of Y chromosome	Chromosomes; Meiosis	C2
10 *	Map of Y chromosome with its 3 classes of genes	Gene function; Chromosome mapping	C and Beyond
11 *	Overview of 300 million years of Y chromosome evolution	Evolution	C3
12	Synopsis of Y chromosome evolution (from animation)	Meiosis; Evolution; Molecular chromosome change	C2, 3 and Beyond
13	Animation: SRY gene evolves and an autosome becomes a Y chromosome	Meiosis; Evolution; Molecular chromosome change	C2, 3 and Beyond
14	Animation: Y chromosome degrades over time	Meiosis; Evolution; Molecular chromosome change	C2, 3 and Beyond
15 *	Animation: Y chromosome gaines new genes	Meiosis; Evolution; Molecular chromosome change	C2, 3 and Beyond
16 (SQ)	Why doesn't inversion occur on other chromosomes?	Genetics; Molecular evolution	C2, 3
17 (SQ)	How does temperature determine the sex of a reptile?	Environmental influence on animal development	C5
18 (SQ)	Why doesn't the X chromosome undergo inversions?	Genetics; Chromosome behavior	C2
19 *	Deletions on the Y chromosome are a leading cause of male infertility	Anatomy	A2; F1, 2
20	Video: Sperm motility in normal and low sperm count samples	Anatomy	F1
21 *	Some males with low sperm count are missing part of the Y chromosome	Molecular Bio; Genetics	C2; F1
22 *	Review of spermatogenesis	Anatomy; Human development	C2; F1
23 *	Seminiferous tubules of male without DAZ gene	Comparative histology	F1
24 *	Intracytoplasmic sperm injection (ICSI) as a remedy for low sperm count	Reproductive technology	E2; F1
25	Video: ICSI procedure	Reproductive technology	E2; F1
26 *	Problem with ICSI and male babies	Fertilization; Reproductive technology	E2; F1
27	Ethical issues with ICSI	Ethics application: Genetic counseling	E2; F1; G1
28 (SQ)	Does ICSI always work?	Reproductive technology	E2; F1
29 (SQ)	Does my dog have more genes on its Y chromosome than my brother?	Comparative genetics	C2
30 (SQ)	In ICSI, how is the embryo returned to the uterus?	Reproductive technology	E2, F1

31 (SQ)	Will evolution lead to the complete destruction of the Y chromosome?	Evolution	C3
32 (SQ)	Will Y chromosome deletions always be transmitted?	Reproduction	C2 and Beyond
33 (SQ)	Could we program the sex of a would be child?	Reproductive technology	E2; F1
34 (SQ)	What is considered a normal sperm count?	Anatomy/Health	F1
35 (SQ)	Why do flies have the Y, but reptiles don't?	Comparative Genetics	Beyond
36 (SQ)	Could we reinsert DAZ genes in sperm with DAZ deletions?	Gene therapy	F1 and Beyond

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