

# SEX LINKAGE

1/13/92, rvsd 1/26/94, 1/11/95, 1/17/96, 1/13/97, 14 Jan 00, 10 Jan 01, 14 Jan 04, 10 Jan 05, 16 Jan 08, 14Jan09, 15Jan10, 12Jan11  
 GMSLG 7<sup>th</sup>: 38-40, 73-75, GWLC 9<sup>th</sup>: 61-65, 71-75

## SEX LINKAGE:

Any genes carried on either the X or Y chromosomes are said to be sex linked.

1891 Henking studied chromosomes in **Hymenoptera**:

Females: 22 chromosomes (11 pairs) females = XX  
 Males only 11 chromosomes males = XO

1905. [Stevens with beetle *Tenebrio*, named **heteromorphic** chromos: X and Y

[1906: [Sex linkage discovered by Doncaster and Raynor crossed **magpie moths** (*Abraaxas*):

### Reciprocal crosses:

light-winged females x dark males F<sub>1</sub>: all dark winged

dark-winged female x light male F<sub>1</sub>: 50:50 light-winged ♀, dark-winged ♂

**NOTE: Crisscross inheritance:** daughters like fathers, sons like mother  
 (worker + royal jelly = queen)

Bateson, crossed **chickens**, got similar results: **barred** x **uniform** colored chickens:

barred male x non-barred female progeny = all barred (*i.e.*, barred dominant)

non-barred male x barred female progeny = sons barred, daughters non-barred

Moths and chickens, sex is determined **and males carry recessive genes**:

males = ZZ, females = ZW = **heteromorphic** for shape, said to be **hemizygous** for genes (♀ here)

Different means of sex determination:	species	male	female
	Moths, chickens	ZZ	ZW
	Mammals, flies	XY	XX
	Hymenoptera	XO	XX

Thomas Hunt Morgan, 1909, studied *Drosophila melanogaster* genetics:

12 day life cycle, after emerge from pupa, ready to mate 12-14 hrs

Found a single white-eyed male, crossed times red-eyed female:

white-eyed male x red-eyed female: F<sub>1</sub> = all red.

F<sub>2</sub> = 1/4 white, but were *all* male

Sex-linked vs **autosomal** genes

## SEX-LINKED EXAMPLES IN HUMANS:

female = XX, male = XY (remember: XY condition called hemizygous)

### X linked human recessive traits (show sample pedigrees):

red-green colorblind:	affected ♂:
1/8	
hemophilia A, factor XIII missing:	1/2,500
Duchenne's muscular dystrophy: muscle atrophy by 6 yrs, dead by 20:	1/3,500

Sex Chromosome: signs: (MM, VX, p. 2148-2150)

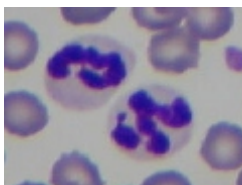
Turner's XO	pathognomic: lymphedema of dorsal hands&feet, neck	1/3000
triple X XXX	little effect, may be sterile, may be retarded	1/1000
Klinefelter's XXY	tall, eunuchoid, sterile, a few are retarded	1/700
super male XYY	acne, language dysfunction	1/1000

(1/15 of those in prisons: violent crimes)

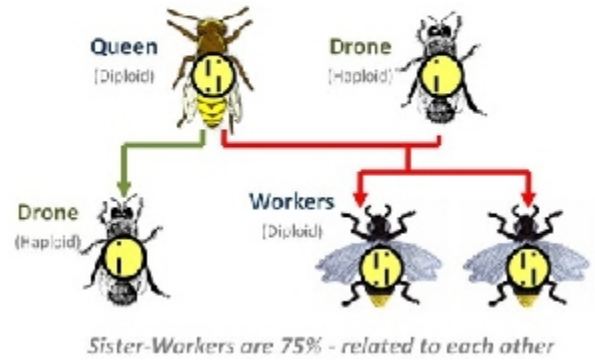
How to tell sex-linked for a rare phenotype (in humans and other XX, XY species):

- 1) many more **males affected**
- 2) None of offspring of affected males affected (usually).  
 All of his daughters are **carriers**, **half of their sons will be affected**
- 3) None of sons of affected male will be affected, will not transmit to offspring

Calico cats, Lyonization, Barr bodies, mosaics



## Haplo-Diploid Sex Determination in Bees



Magpie Moth:

