



FACULTY OF ENGINEERING & TECHNOLOGY
DEPARTMENT OF BIOTECHNOLOGY

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Maps



Genetic Maps

- Order and location of markers assigned to chromosome on the basis of linkage analysis
- Distance measured in Morgans (M)



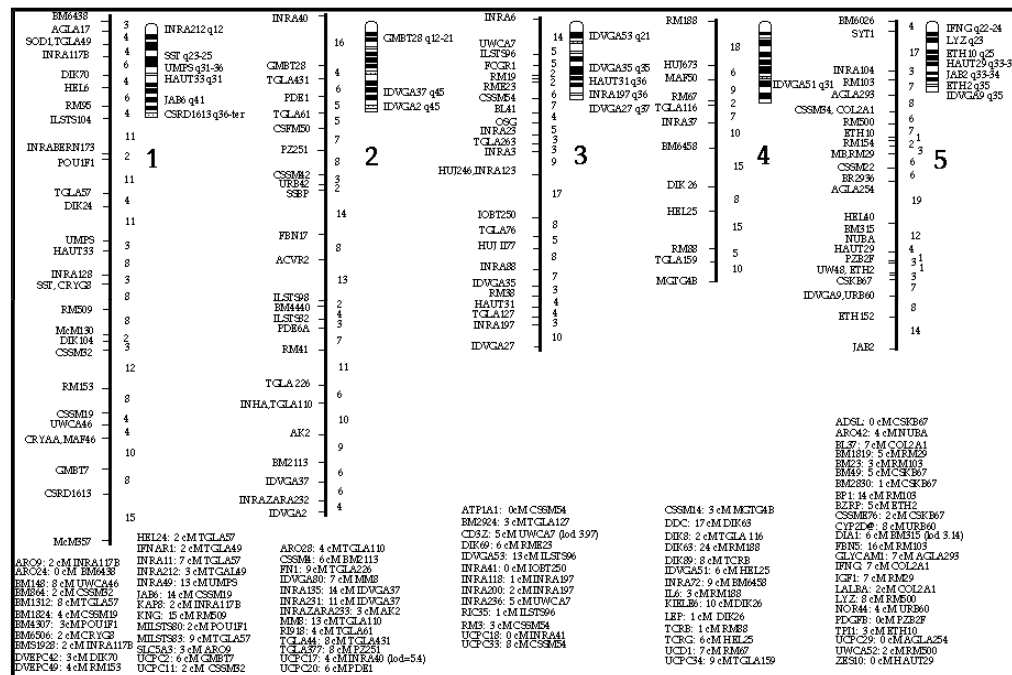
Physical Maps

- Actual structure of genetic material
- At highest level DNA sequence
- Distance measured in 10^6 bp (Mbp)
- Genetic and physical maps are usually 'linked' together



Example of a map

- Cattle chromosomes 1-5, from Cattle Genome Database hosted at the Queensland Biosciences Precinct: <http://www.cgd.csiro.au>



Genetic maps

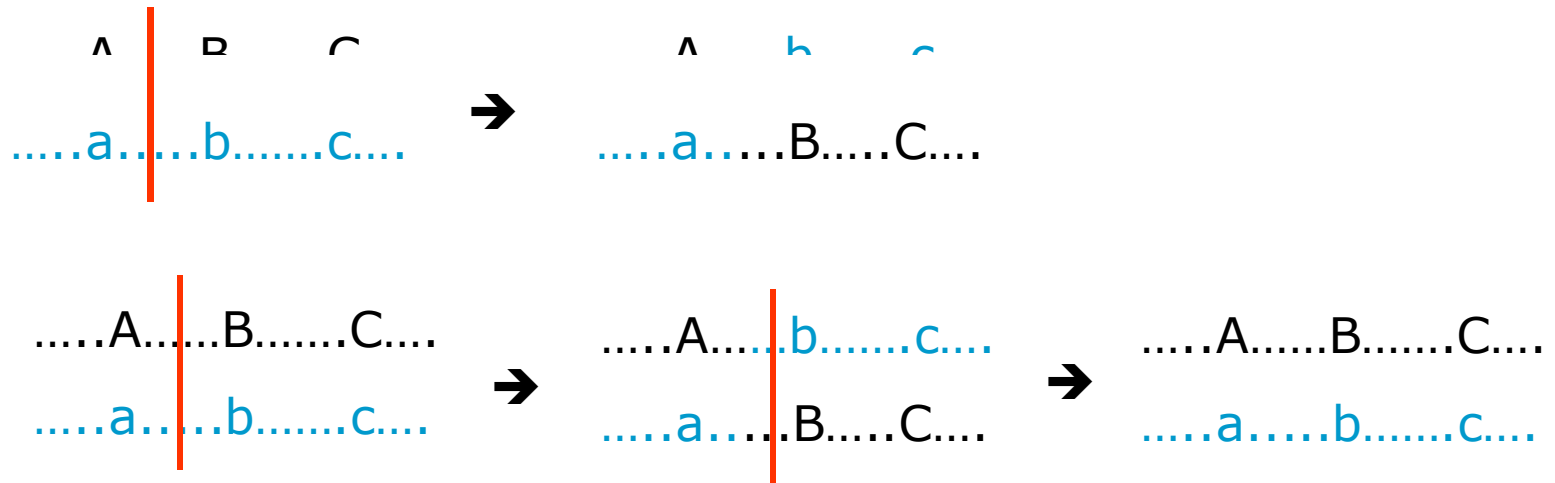
- Map distance is determined from the number of observed recombination events
- $1\text{cM} = 1$ recombination event per 100 meiosis (*simple mapping function*)



Map distance versus r

■ Only odd number of crossover events are observed

- r = probability of an odd-number of cross-over events
- $1-r$ = probability of an even number of cross-over events, including zero



Mapping functions

- Mapping functions predict the number of crossover events from observed recombination events
- Also account for interference (where a recombination event in one region affects the likelihood of a recombination event in a closely aligned region)



Different Mapping functions

■ Haldane

- assumes no interference (crossovers occur randomly and independently over the entire chromosome)
- $M = -(\ln(1-2r))/2$

■ Kosambi

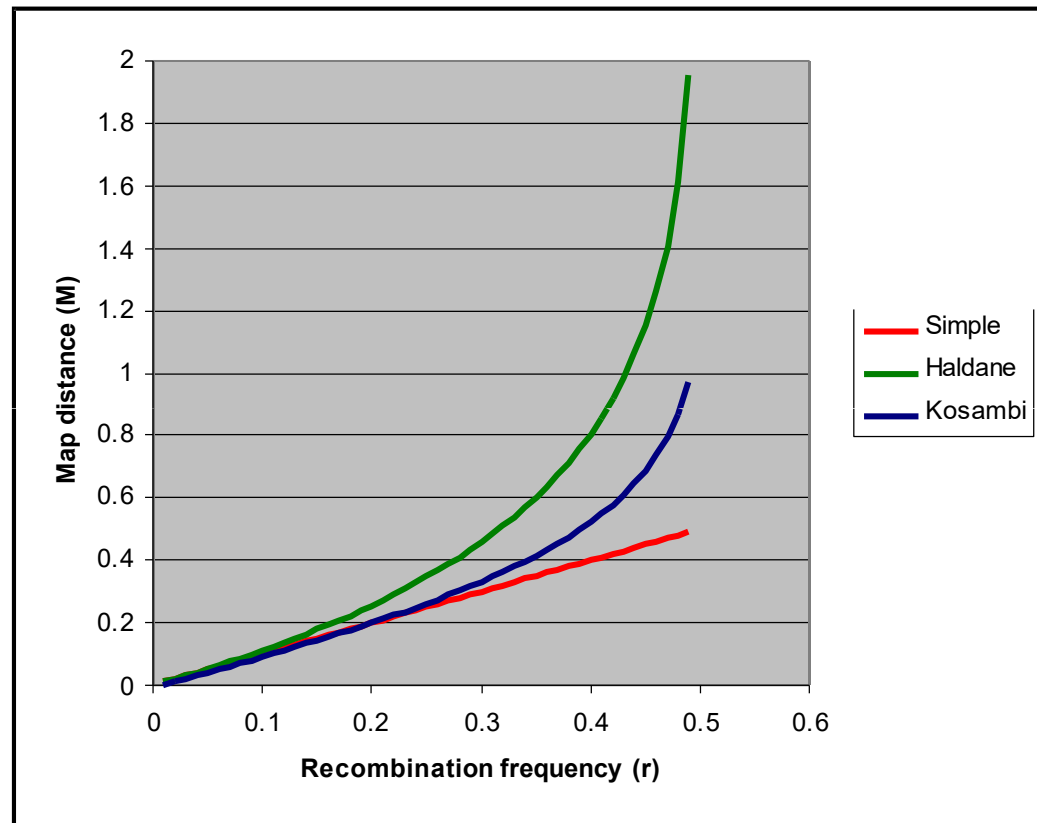
- assumes moderate interference (i.e. some crossover interference at adjacent sites)
- $M = \frac{1}{4} \ln (1+2r/1-2r)$

■ Simple

- assumes complete interference
- $r = M$



Comparison of mapping functions



Construction of linkage maps

- Simple example is 3 point testcross
- (see lecture notes)



Construction of linkage maps

- In practice genetic maps are often constructed from complex pedigrees
 - First need to determine parental phase, such that gametes can be classed as recombinant or non-recombinant
 - Typically use a maximum likelihood approach



Construction of linkage maps

- Identification of recombinant gametes is easier if
 - linkage phase of parents is known
 - Sire AaBb x Dam AABB → 9 AABB, 1 AaBB, 1 AABb, 9 AaBb
 - Sire thus gave gametes in frequency 0.45 AB, 0.05 aB, 0.05 Ab, 0.45ab
 - Most likely phase is AB ab
 - haplotype of gametes transmitted from parents to offspring is known
 - AaBb x AABB → AaBb, sire gave ab dam gave AB
 - AaBb x AaBb → AaBb, cannot determine transmitted haplotypes



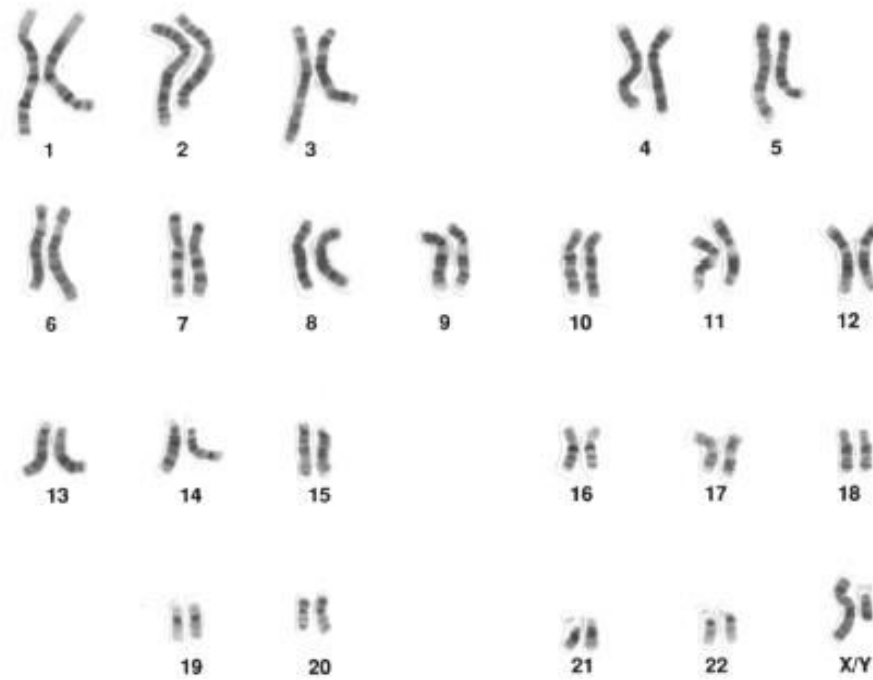
Physical maps

– Cytogenetic maps

- banding pattern observed under light microscopy of stained chromosomes
- low resolution (only estimates of the number of bp)



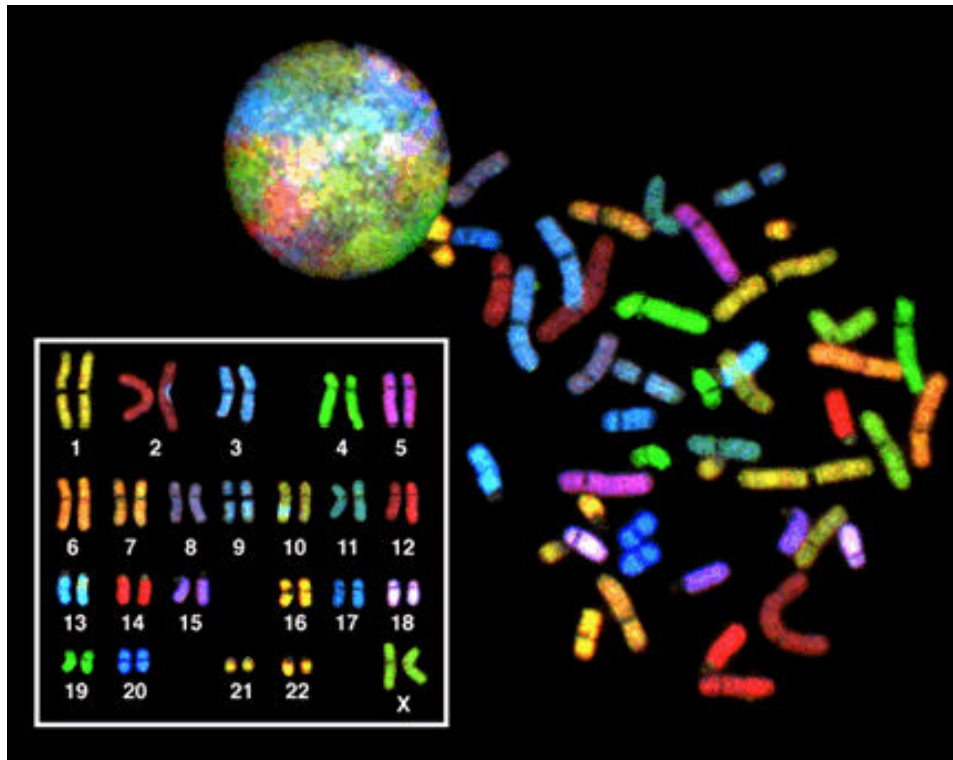
Human Karyotype



Talking glossary of genetics, 2008



Human Karyotype



Talking glossary of genetics, 2008



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Physical maps

- Radiation hybrid
 - Use breaks induced by radiation to determine the distance between two markers



Physical maps continued

- Sequence tag sites (STS)
 - STS are short, unique DNA sequences with known location
- Sequence maps
 - ‘the ultimate’
 - now available for a number of livestock species



NC_000001.9 - Homo sapiens chromosome 1, reference assembly, complete sequence - NCBI Sequence - Windows Internet Explorer

http://www.ncbi.nlm.nih.gov/projects/sviewer/Tid=NC_000001.9&v=11961297..11997811

Links: Google, Nature, VEJA, Yahoo

NC_000001.9 - Homo sapiens chromosome 1, ref...

NCBI Home PubMed GenBank BLAST Sequence Viewer 2.0.β

Homo sapiens chromosome 1, reference assembly, complete sequence gi|89161185|ref|NC_000001.9|NC_000001.9
Accession NC_000001.9

Shift Origin 0 Search for Theme NCBI Overview

Position 11,96M..12.00M Theme NCBI Details

11,965 K 11,970 K 11,975 K 11,980 K 11,985 K 11,990 K 11,995 K

Main Features:

Alignments:
- mRNA product mapping alignment

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Relationship between genetic and physical distance

- No universal relationship
 - Comparison of human genetic and sequence based physical maps, Yu et al. “Recombination rates varied greatly along each chromosome, from 0 to at least 9 centiMorgans per megabase”
- Various depending on
 - species
 - chromosomal region: crossovers often suppressed at centromeres, telomeres
 - Sex: female mammals usually have greater map distances than males, no crossover in male *Drosophila*



Australian Sheep Gene Mapping Website

Australian Sheep Gene Mapping Web Site

Welcome to the Australian Gene Mapping Web Site. Please follow the links, to the left or below, to the page that interests you. Some recent pages that have been added to the site or elsewhere are shown below.

Discrepancies between Virtual Sheep Genome and linkage map 27th June 2007

Sheep QTL database 9th May 2007

Sheep, cattle and human comparisons using CMap v0.14 22nd April 2007
Note: CMap now contains VSG maps

Sheep, cattle and human comparisons using CMap v0.16 22nd April 2007
Note: CMap now contains VSG maps

Current sex averaged, female, male distances for framework maps (v4.7) 22nd March 2007
ascii tab delimited file

Search tool for sheep BES microsatellites in Virtual Sheep Genome map 5th January 2007

Current sex averaged, female, male distances for best position maps (v4.7) 3rd December 2006
ascii tab delimited file:

sheepGENOMICS - sheep BES aligned to cattle (v2) sequence map 12th January 2006
New loci mapped to sheep chromosomes 3rd January 2006

Sheep BES microsatellites aligned to cattle sequence map - search by cattle Mb position 2nd December 2005

Sheep BAC end sequences from 12x BAC library deposited in NCBI Trace Archive, trimmed sequences in GenBank 10th October 2005

Bos taurus version 2 assembly Ensembl, NCBI MapView 5th October 2005

Diagram showing distribution and informativeness of markers on sheep map (v4.4) 14th July 2005

Predicted Sheep Map v 1.4 - Gene positions inferred from sheep-human comparisons 5th July 2005

Predicted Human Positions for Sheep GenBank Genomic Sequences 1st February 2005

Predicted Human Positions and Microsatellites for Sheep BAC Ends 28th January 2005

Locus Assignments for GenBank Sheep EST and RNA sequences 22nd April 2004

Latest Sheep versus Human Comparisons 17th December 2003

Sheep vs Cattle (MARC 2003) Comparisons 16th October 2003

Sheep vs Human comparisons (XIX International Congress of Genetics poster) 5th July 2003

Navigation menu (left sidebar):
Sheep Markers
Sheep Maps
Map Comparisons
Sheep Mapping Experiments
Sheep Mapping Successes and DNA Tests
Sheep Libraries
Other Genome Sites
Annotation
Other Links
Jill's Gene Mapping Tips
ASGM Meeting Notes
Obsolete Pages
Home Page



<http://rubens.its.unimelb.edu.au/~jillm/jill.htm>

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Extract from Australian Sheep Map

Sheep Best Positions Linkage Map Version 4.4

| Chromosome | Sex Av cM | Female cM | Male cM | Locus Code | Marker |
|------------|-----------|-----------|---------|----------------------|-------------------------|
| 1 | 0.0 | 0.0 | 0.0 | \RM309 | RM309A |
| 1 | 14.2 | 6.6 | 22.5 | \BMS2833 | BMS2833 |
| 1 | 16.7 | 10.1 | 24.4 | \TGLA127 | TGLA127 |
| 1 | 16.7 | 10.1 | 24.4 | \INRA197 | INRA197 |
| 1 | 16.7 | 10.1 | 24.4 | \MCM46 | MCM46 |
| 1 | 19.0 | 12.5 | 26.6 | PPT1 | PPT |
| 1 | 24.3 | 19.6 | 30.9 | \EPCDV022 | EPCDV22 |



<http://rubens.its.unimelb.edu.au/~jillm/jill.htm>



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