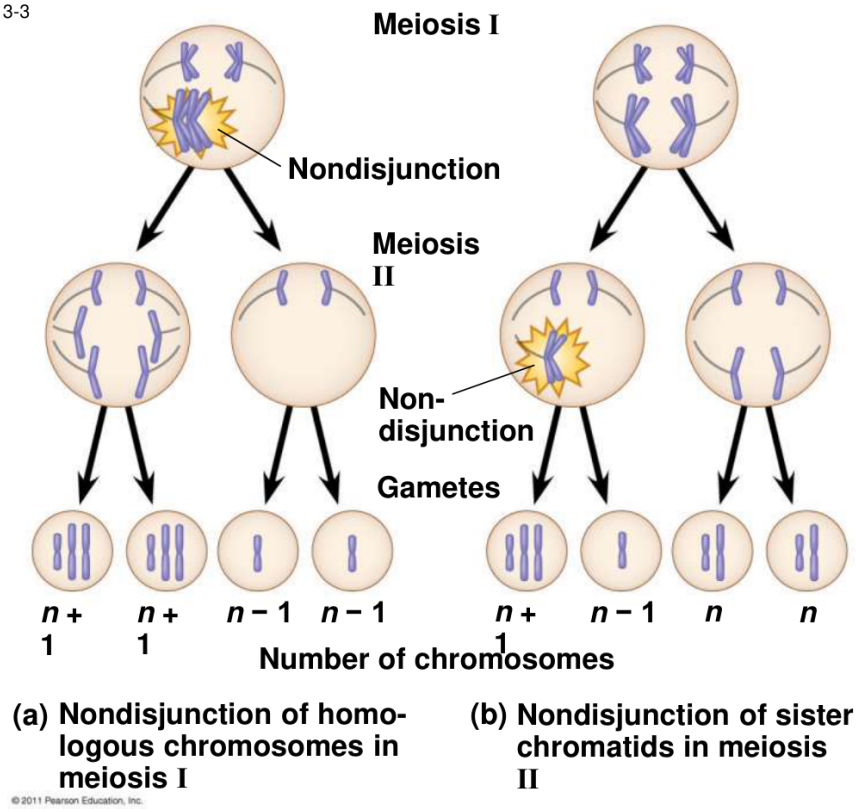
بسم الله الرحمن الرحيم

AUTOSOMAL CHROMOSOME AND NUMERICAL CHROMOSOMAL ABERRATIONS

Comprehensive Study Sheet

Organized directly from the lecture slides.

Figure 15.13-3



Nondisjunction outcomes in meiosis I and meiosis II

Lecture map

The sheet follows the lecture in order so every slide is covered.

Slides	Main topic
1	Title slide / nondisjunction
2-6	Abnormal chromosome number and nondisjunction
7-12	Aneuploidy, monosomy, trisomy, polyploidy, euploidy, triploidy
13-15	Structural chromosome alterations
16-17	Disorders due to chromosomal alterations and newborn incidence
18-32	Down syndrome / trisomy 21
34	Partial trisomy 21 (21q)
36	Trisomy 18 (Edward syndrome)
38	Trisomy 13 (Patau syndrome)

1. Numerical chromosome abnormalities

Nondisjunction is the failure of a chromosome pair to disjoin during meiosis I or the failure of sister chromatids to separate during meiosis II or mitosis.

Aneuploidy results from fertilization of gametes in which nondisjunction occurred, producing an abnormal number of a particular chromosome.

Monosomy means one copy of a particular chromosome. **Trisomy** means three copies of a particular chromosome.

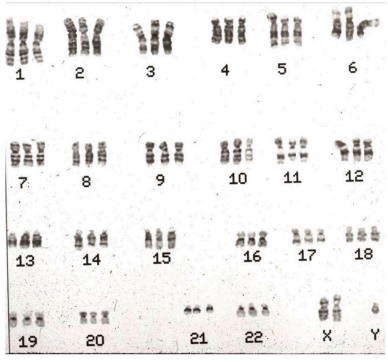
Concept	Lecture meaning
Meiosis I nondisjunction	Homologous chromosomes fail to separate. Result: two n+1 gametes and two n-1 gametes.
Meiosis II nondisjunction	Sister chromatids fail to separate. Result: two normal gametes, one n+1, and one n-1 gamete.
Polyploidy	More than two complete sets of chromosomes; triploidy = 3n, tetraploidy = 4n.
Euploid	A chromosome number that is an exact multiple of the haploid number (n).
Haploid / diploid / triploid / tetraploid	1 set / 2 sets / 3 sets / 4 sets.

- Polyploidy is common in plants, but not animals
- Polyploids are more normal in appearance than aneuploids

⚖️ Quick Comparison Table

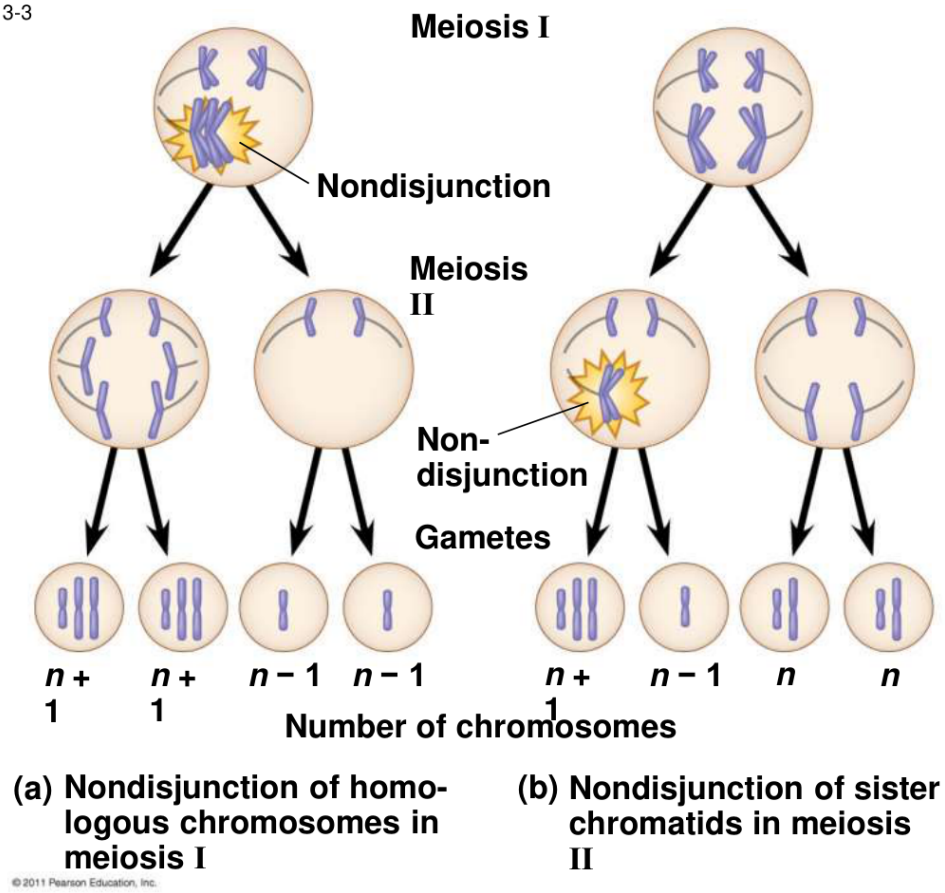
Feature	Aneuploidy	Polyploidy
What changes?	Individual chromosomes	Whole chromosome sets
Chromosome number	Not a multiple of n	Exact multiple of n
Example	Trisomy 21 (2n+1)	Triploidy (3n)
Viability in humans	Sometimes viable	Usually lethal
Common cause	Nondisjunction	Failure of cell division

to be understood



Triploidy 69,XXY

Figure 15.13-3



Slides 3-6: meiosis I vs meiosis II nondisjunction

2. Alterations of chromosome structure

Breakage of a chromosome can lead to four major structural changes:

- **Deletion**: removes a chromosomal segment
- **Duplication**: repeats a segment
- **Inversion**: reverses the orientation of a segment within the same chromosome
- **Translocation**: moves a segment from one chromosome to another

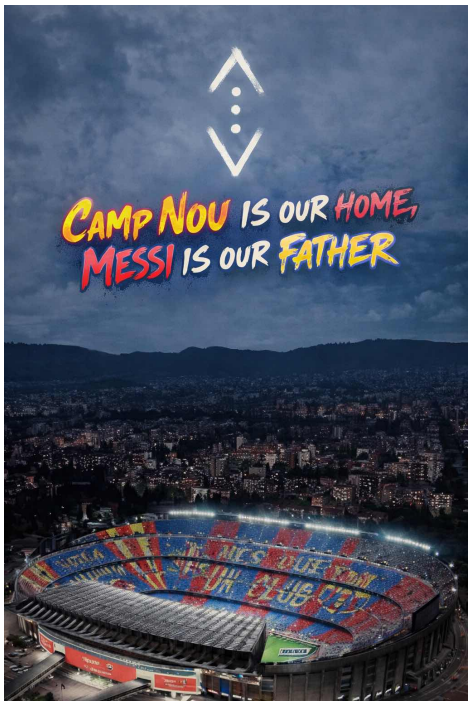
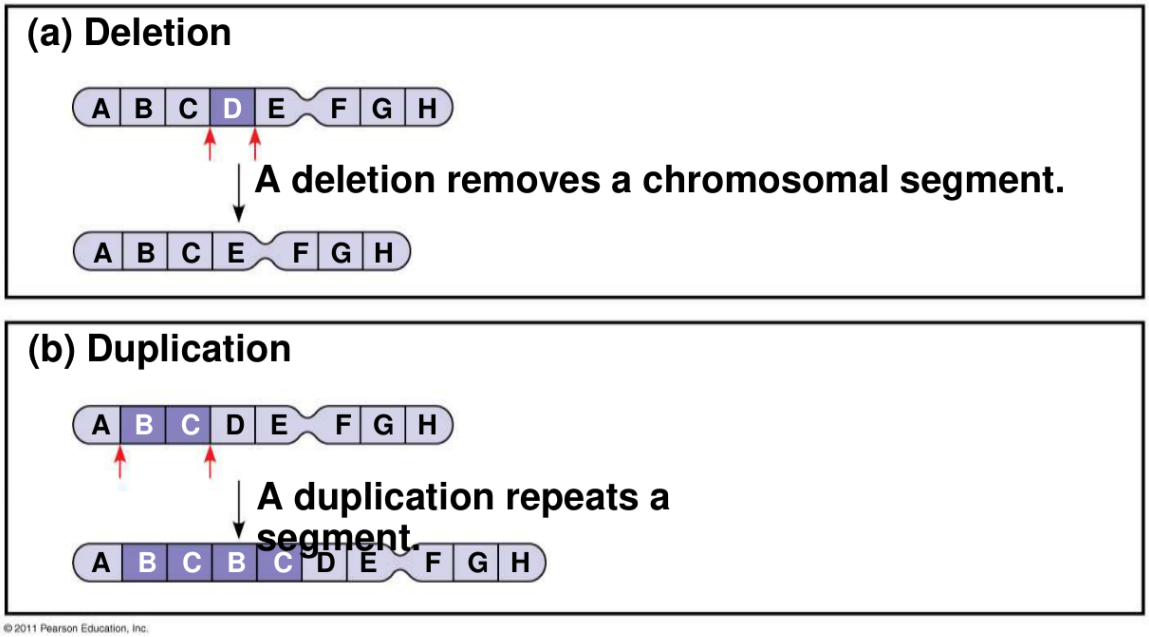


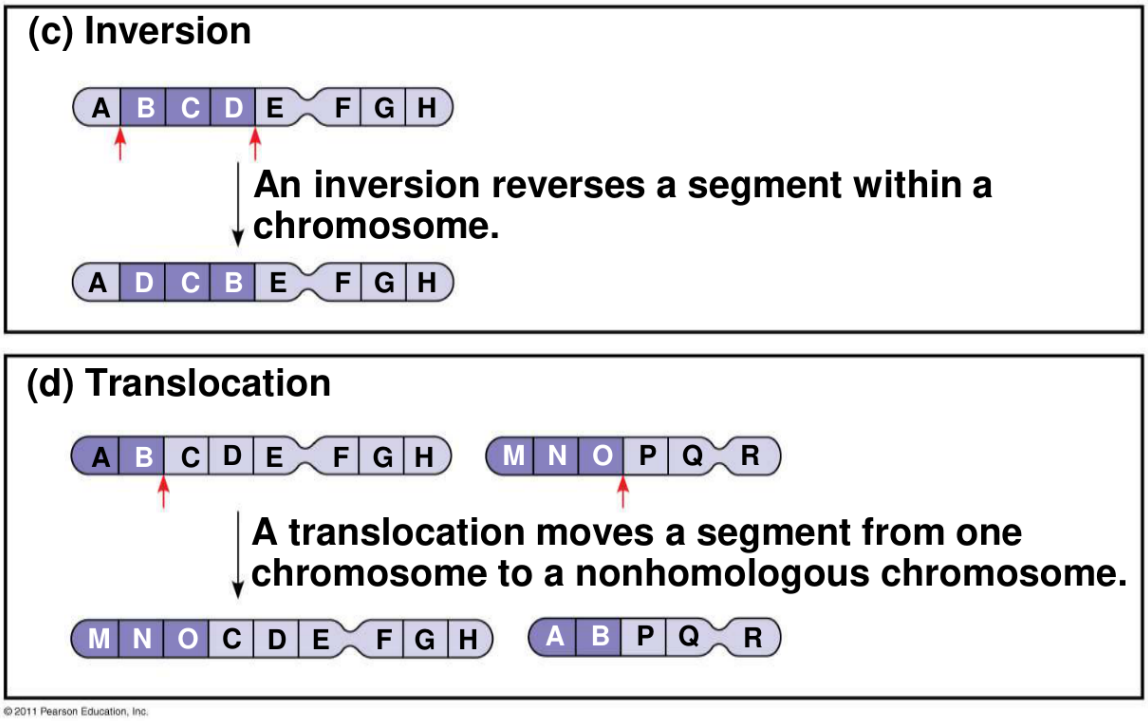
Figure 15.14a



© 2011 Pearson Education, Inc.

Deletion and duplication

Figure 15.14b



© 2011 Pearson Education, Inc.

Inversion and translocation

3. Disorders due to chromosomal alterations

Chromosome-number and chromosome-structure abnormalities can produce serious disorders. Some types of aneuploidy upset the genetic balance less severely, allowing survival to birth and beyond; the surviving individuals often show a characteristic syndrome.

Abnormality	Prevalence at birth
47,XXY	1/1000
47,XYY	1/1000
45,X	1/5000
47,XXX	1/1000
Trisomy 21	1/800
Trisomy 18	1/6000
Trisomy 13	1/10,000
Robertsonian rearrangement	1/1000
Other balanced rearrangements	1/885
Unbalanced rearrangements	1/17,000
All chromosome abnormalities	1/154

4. Down syndrome (trisomy 21)

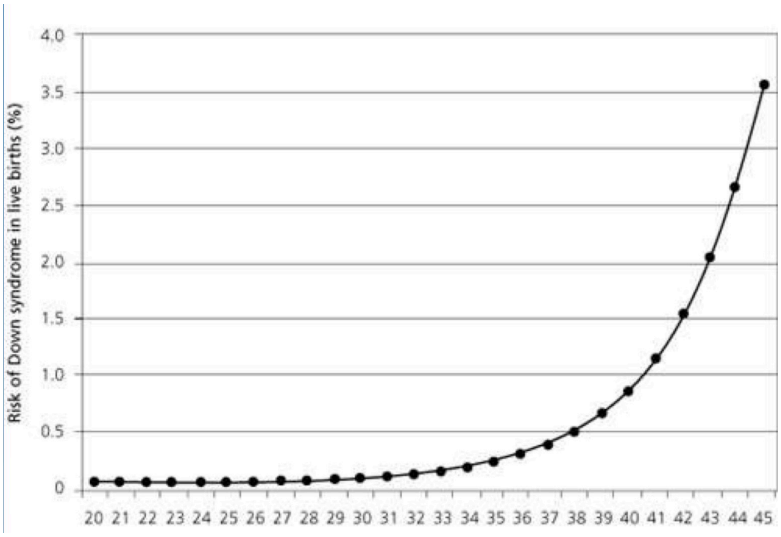
Definition: an aneuploid condition caused by three copies of chromosome 21.

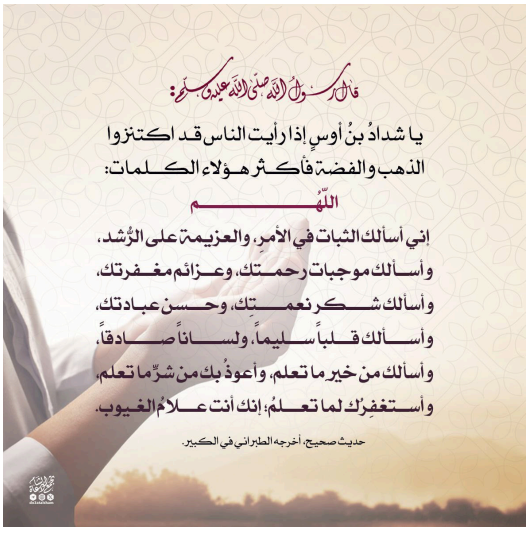
Frequency: about 1 in 700 children born in the United States.

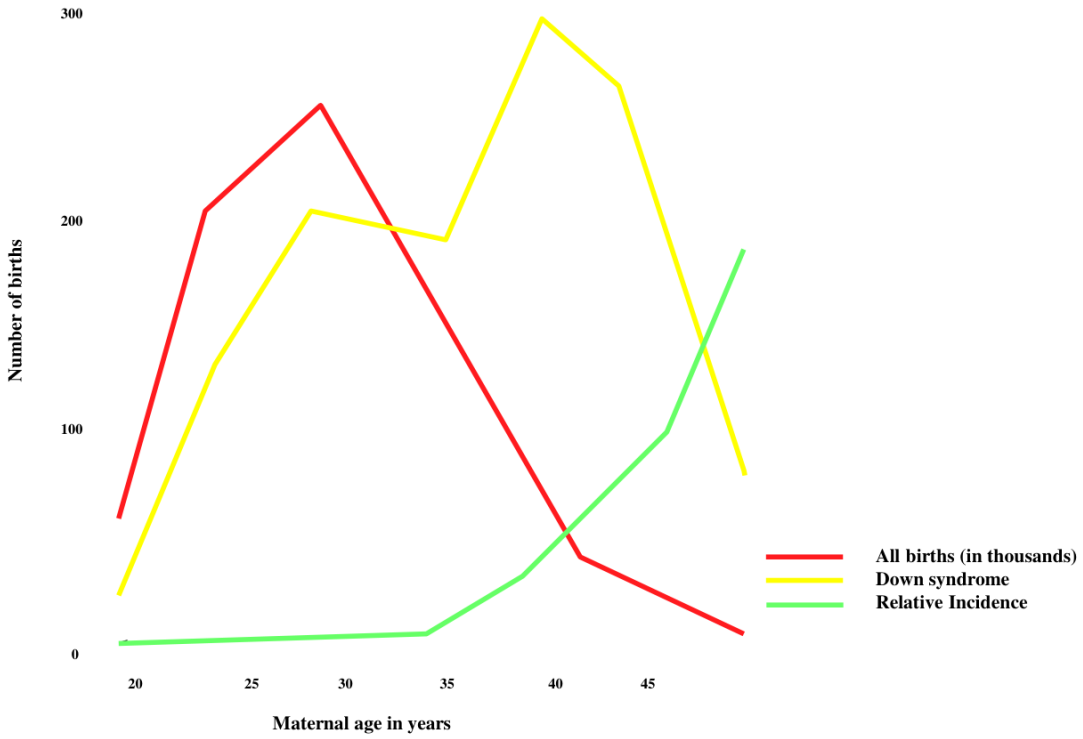
Risk factor: the frequency increases with maternal age.

Sex ratio: male:female = 3:2.

Most common numerical abnormality in liveborns is Trisomy 21 (Down syndrome)





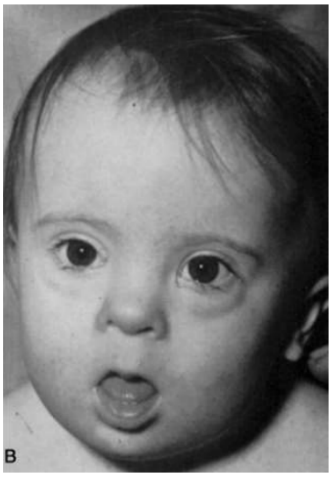


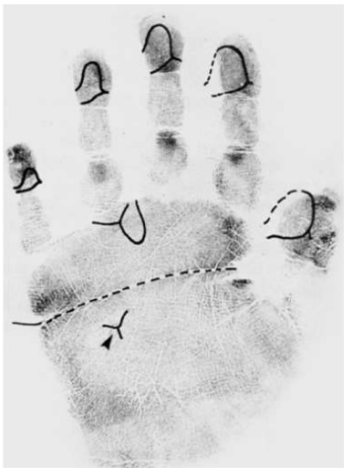
Maternal age and nondisjunction

Finding	What the slide says
Intellectual disability	IQ 25-50
Facial features	Epicanthic folds, low nasal bridge, upslanting palpebral fissures, small low-set ears, protruding tongue
Tone / growth	Hypotonia, growth retardation, intestinal problems
Hands / feet	Simian line, gap between first and second toes
Heart disease	30%-50%; VSD and AV canal are common
Other risks	15-fold increase in leukemia risk

The slide notes that these features are easily recognized at birth, and that about 40% of people with congenital heart disease die during the first year.

Down Syndrome





Mental retardation (IQ 25-50)
*Low nasal bridge (90%)
*Hypotonia (80%)
*Up slanting palpebral fissures (80%)
Small, low-set ears (60%)
*Congenital heart disease (30%-50%)**

*Epicanthic folds
Protruding tongue
Intestinal problems
Gap between first and second toes
15-fold increase in risk for leukemia
*Simian line (transverse crease) (45%)

These features are easily recognized at birth.

**The congenital heart problems noted in people having Down syndrome include ventricular septal defect (VSD) and arterioventricular defects (AV) canal. Approximately 40% with congenital heart disease die during the first year.

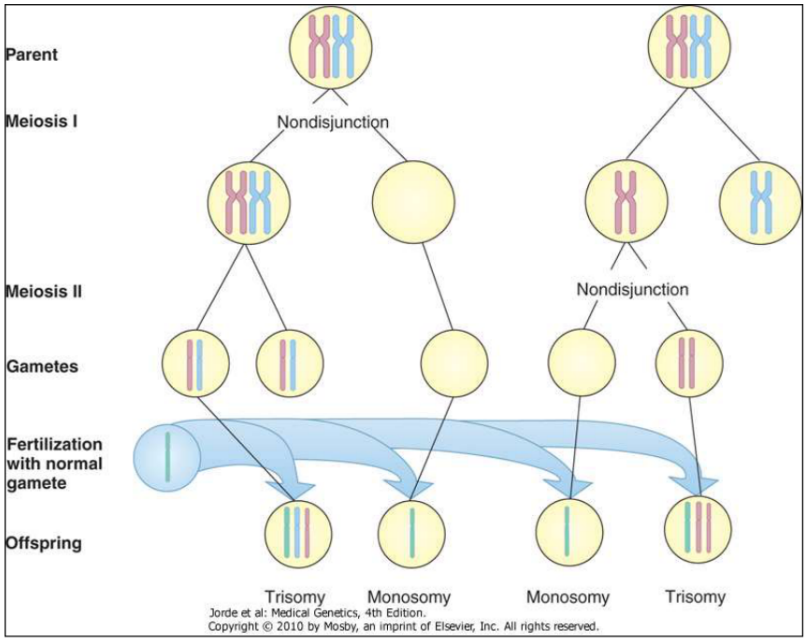
Classic Down syndrome phenotypic clues

Origin of the extra chromosome in trisomy 21

Maternal errors: 94% of cases (MI 64%, MII 19%, indeterminate 11%).

Paternal errors: 4.5% of cases (MI 1%, MII 3.5%).

Unknown: 1.5%.



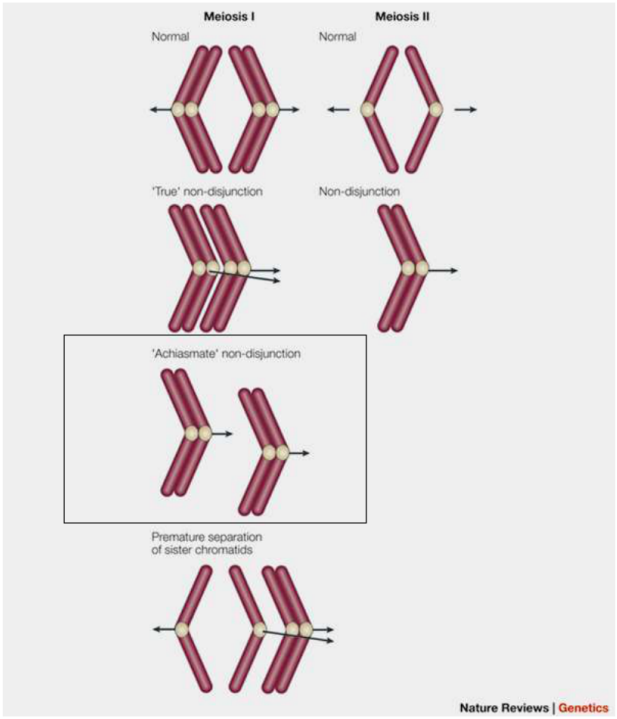
Trisomy 21

Maternal Errors: 94% of cases
- **MI 64%**
- **MII 19%**
- **Indeterminate 11%**

Paternal Errors: 4.5% of cases
- **MI 1%**
- **MII 3.5%**

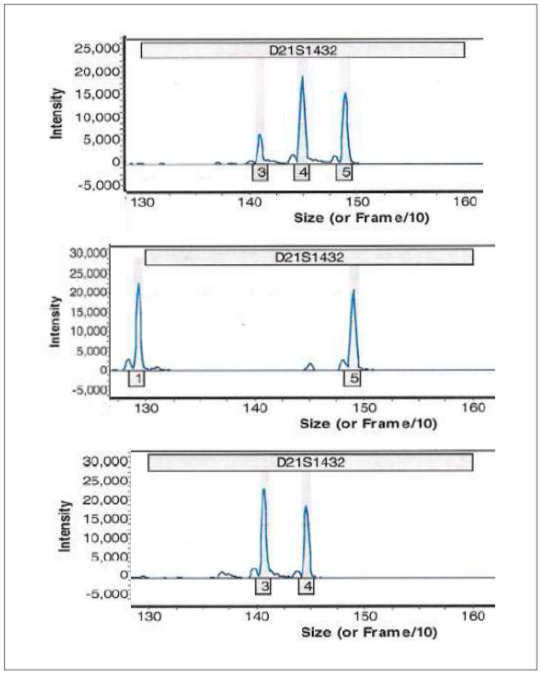
Unknown: 1.5%

Maternal and paternal nondisjunction pathways

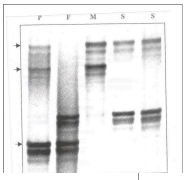


Mechanisms discussed as causal factors in nondisjunction

Evaluate the Origin of the Extra Chromosome Using Polymorphic Markers



DNA markers can be used to determine the parental origin of the extra chromosome in trisomic individuals

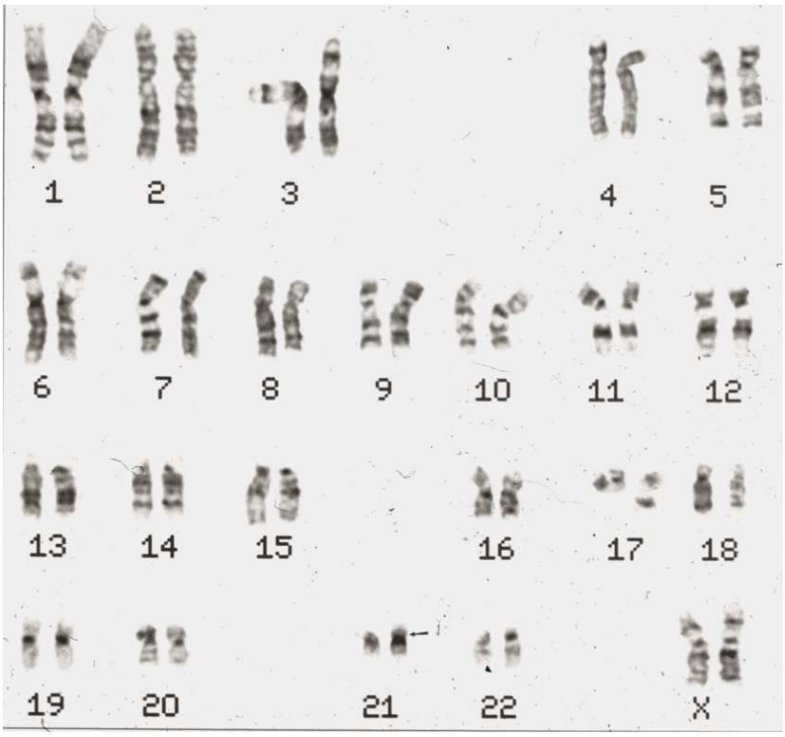


D21S1432 Tetranucleotide STRP

Polymorphic markers can determine the parental origin of the extra chromosome

Partial trisomy 21 (21q) means only part of chromosome 21 is duplicated, but the phenotype can still be Down syndrome-like.

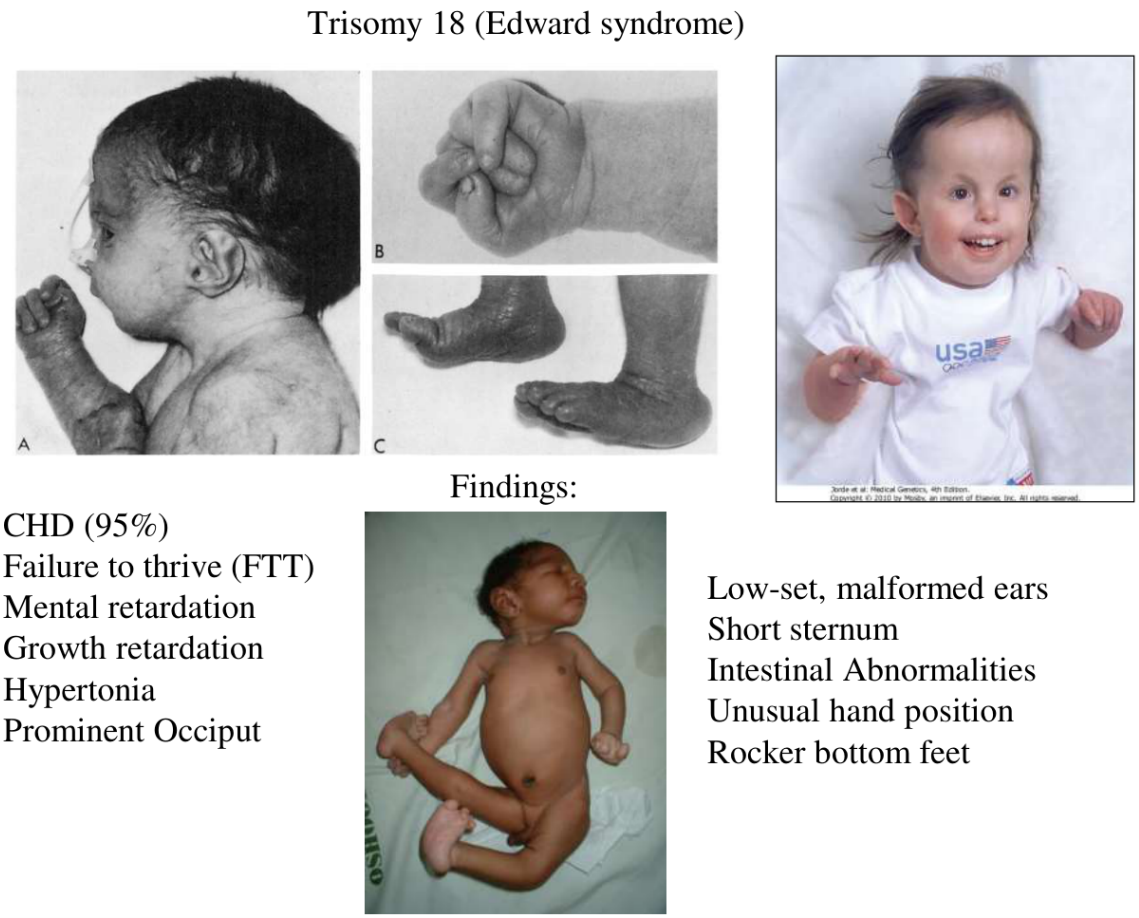
Partial Trisomy 21 (21q)



Partial trisomy 21 example

5. Other autosomal trisomies

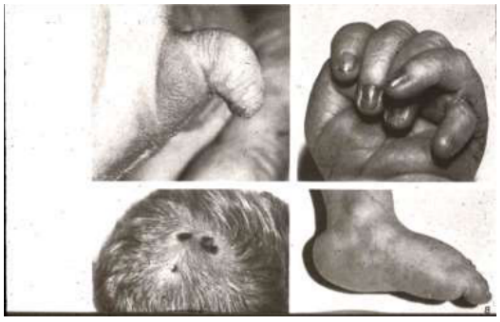
Trisomy 18 (Edward syndrome): CHD (95%), failure to thrive, mental retardation, growth retardation, hypertonia, prominent occiput, low-set malformed ears, short sternum, intestinal abnormalities, unusual hand position, and rocker-bottom feet.



Trisomy 18: classic findings

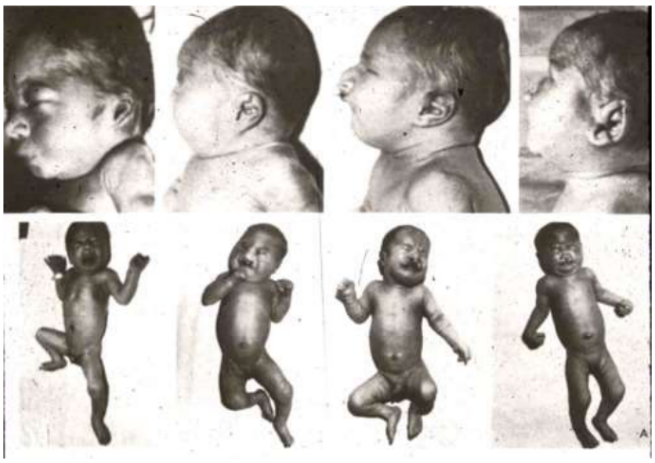
Trisomy 13 (Patau syndrome): CHD (85%), mental retardation, hyper- or hypotonia, scalp defects, microcephaly, small eyes, low-set malformed ears, cleft lip/palate, polydactyly and syndactyly, polycystic kidneys, and rocker-bottom feet.

Trisomy 13
(Patau syndrome)



Findings:

CHD (85%)
Mental retardation
Hyper- or hypotonia
Scalp defects
Microcephaly
Small eyes
Low-set, malformed ears
Cleft lip/palate
Polydactyly and syndactyly
Polycystic kidneys
Rocker-bottom feet



Trisomy 13: classic findings

دَعْوَىٰهُمْ فِيهَا سُبْحَٰنَكَ ٱللَّهُمَّ وَتَحِيَّتُهُمْ فِيهَا سَلَٰمٌ ۚ وَءَاخِرُ دَعْوَىٰهُمْ أَنِ ٱلْحَمْدُ لِلَّهِ رَبِّ ٱلْعَٰلَمِينَ

Thanks for using this.
If you found it helpful, please share it.