Genetic Isolation

- Chromosomal reorganization.
- Accumulated point mutations.
- Developmental incompatibility
- Phenotypic Incompatibility

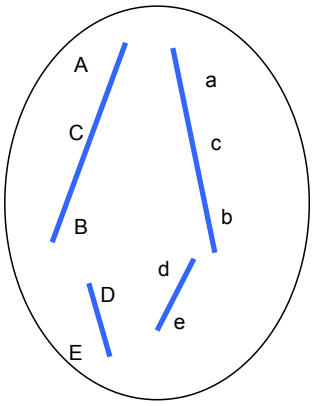
Genetic Isolation

- Chromosomal reorganization.
  - Non-disjunction –chromomes don't separate during meiosis
  - Polyploidy – a new organism if formed by the fusion of two gametes that were formed by nondisjunction
  - Chromosmal reaarrangement
    - Cromosomes are reorganized so that there are now a different number of chromosomes or the genes are relocated to different locations on chromosomes.

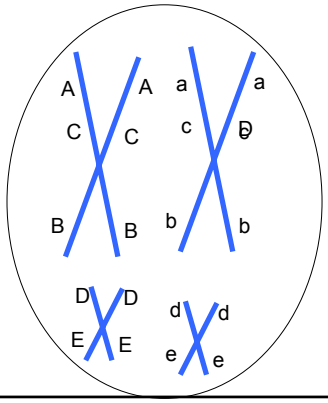
  New arrangement are not meiotically compatible with old arrangement (meiosis wont pair up alleles)

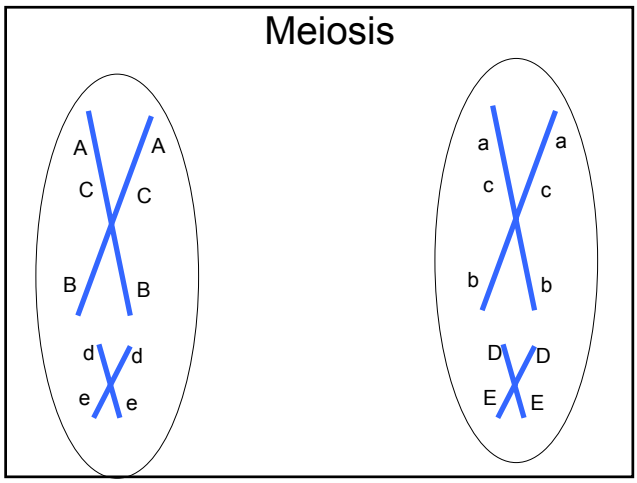
  Post zygotic barrier.

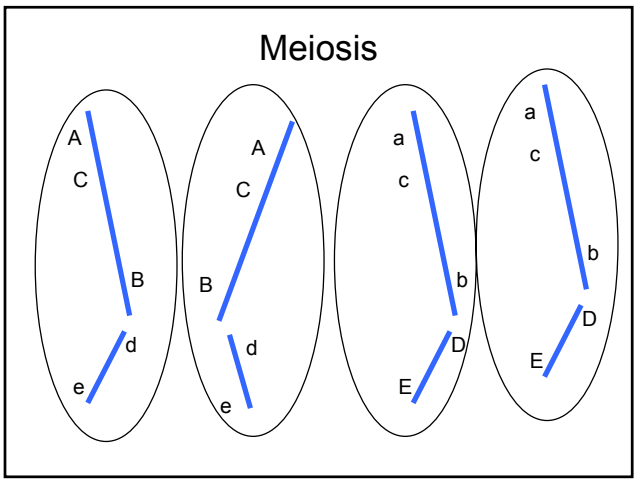
Meiosis



Meiosis




Meiosis
A
A
C
C
B
B
d
d
e
e
a
a
c
c
b
b
D
D
E
E


Meiosis
A
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D
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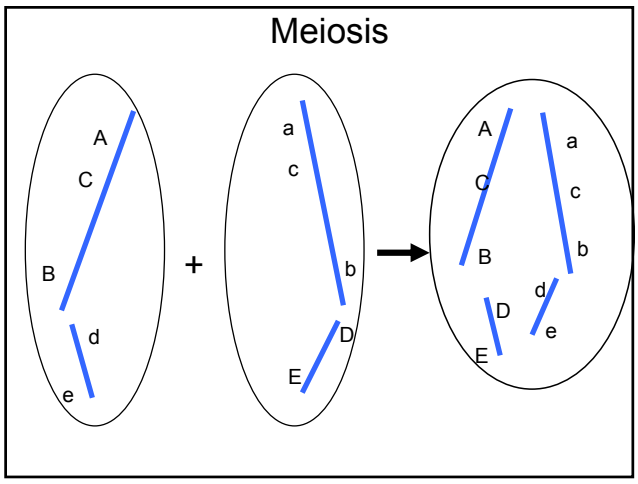
Meiosis
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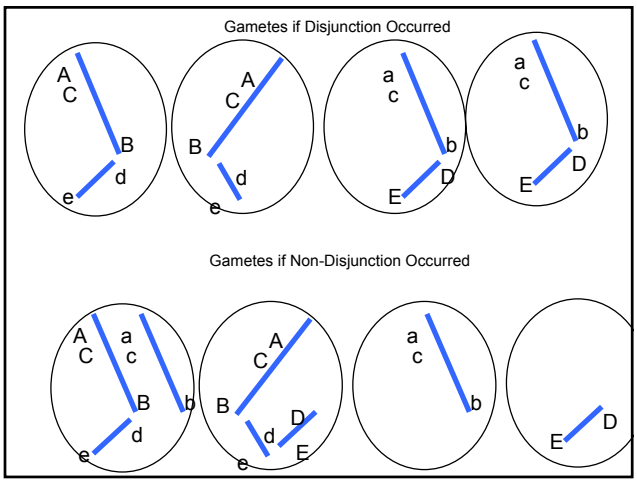
Gametes if Disjunction Occurred
A
C
B
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A
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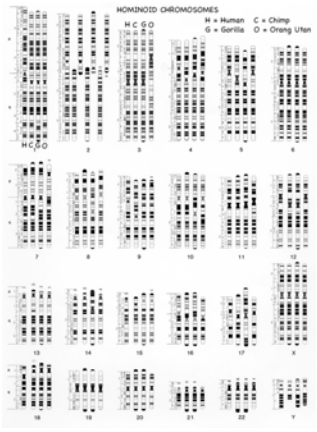
e
a
c
b
D
E
a
c
b
D
E
Gametes if Non-Disjunction Occurred
A
C
a
c
B
b
d
e
A
C
B
d
D
E
e
a
c
b
E
D

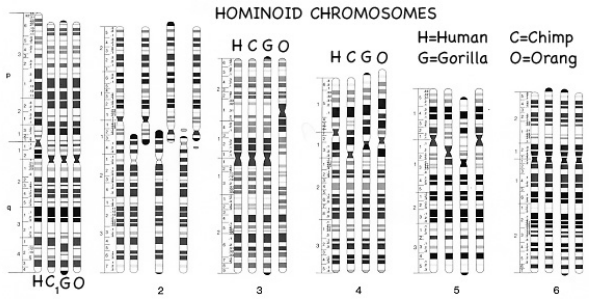
Polyploidy

- Wheat
  Einkorn – 14 chromosomes
  Emmer or Durum -28 chromosomes
  Bread Wheats – 42 chromosomes
- Phlox
- Grasses – Themeda
  - Multiple copies of each gene

Polyploidy

- Autopolyploidy
  - Contain multiple copies of the same chromosomes & genes
  - Most likely formed through self-fertilization of a single non-disjunction event
    - AAA (autotriploidy), or BBBB(autotetraploidy)
- Allopolyploidy
  - Derived from hybridization of parents that had differences between their basic genomes.
  - Typical alloploypoids are AABB (allotetraploid), AABBCC (allohexaploid), etc. Allopolyploids are also called as Contain different chromosomes





Genetic Isolation

- Accumulated point mutations.
  - Accumulate point mutations change the function of genes to the point they no longer serve the same function

Genetic Isolation

- Developmental incompatibility
- Phenotypic Incompatibility

Allopatric and Sympatric Speciatoin

- Allopatry occurs when a population becomes subdivided into two geographically isolated sub-populations
- Possible examples
  - Darwin's Finches
  - Grand Canyon Squirrels
  - Purple finch & House Finch
  - Cichlid fishes in young lakes
  - Faeroe Island mouse
  - Lake Nagubago.

Allopatric and Sympatric Speciatoin

- Sympatric speciation occurs when a new species forms without first becoming geographically isolated
- Possible examples
  - Hawthorn & Apple Maggot flies
  - Polyploidy

Tempo and pace of evolution

- Darwin theory assumed Gradualism
  - Gradualism assumes slow constant rates of change
- The fossil record suggest that some species composition of may not alter for "long" periods of times followed by "short" periods of rapid speciation
- S.J. Gould proposed a theory called the "punctuated equilibrium model"

Punctuated Equilibrium Model

- Predicted that speciation usually occurred at relative low rates (Normal evolution)
- Predicted that over long periods of time there would be stasis (lack of change), during which climate, habitats and species all remained relatively unchanging
- These were interrupted (punctuated) by short periods of drastic change in climate and habitats and rapid formation of new species.

Punctuated Equilibrium Model

- Consistent with the fossil record
  - long periods of slow gradual changes
    - Diversity gradual increases
  - Periodic mass extinctions
    - Sudden drops in specie abundance
  - Rapid adaptive radiations
    - Rapid increases of species abundance usually following mass extinction

- Punctuated equilibrium is consistent with our knowledge of speciation and evolution in general
- Small populations will evolve most quickly
- Isolated population will be most likely to form new species
- Strong selection will favor fast rates of evolution
- Mass extinction is likely to cause drastic changes in population size, alter habitats and isolate small subpopulations. All conditions that favor rapid evolution

Rapid and Slow are relative terms

- In geological time 10,000, 100,000 years or even 1,000,000 years may be be considered rapid.

5 or 6 mass extinctions

1. Ordovician- Silurian ≈432 mybp
2. Devonian-Carboniferous ≈ 380mybp
3. Permian-Triassic ≈223mybp
4. Triassic-Jurassic ≈192mybp
5. Cretaceous-Tertiary ≈ 65mybp
6. Present

The Fossil Record

Era	Period	MYBP
Cenozoic	Quaternary	0-1.7
	Tertiary	1.8-65
Mesozoic	Cretaceous	65-135
	Jurassic	135-192
	Triassic	192-223
Paleozoic	Permian	223-280
	Carboniferous	280-345
	Devonian	345-405
	Silurian	405-432
	Ordovician	432-495
	Cambrian	495-570
Proterozoic & Archaeozoic	Precambrian	570-4,600

Mnemonics

- Memory devices.
- **Q**uaternary, **T**ertiary, **C**retaceous, **J**urassic, **T**riassic, **P**ermian, **C**arboniferous, **D**evonian, **S**ilurian, **O**rdivician, **C**ambrian, **P**recambrian
- **Q**uiet **T**om **C**onvinced **J**udy **T**o **P**urchase **C**elery, **D**ip, **S**alsa, **O**lives & **C**hips.

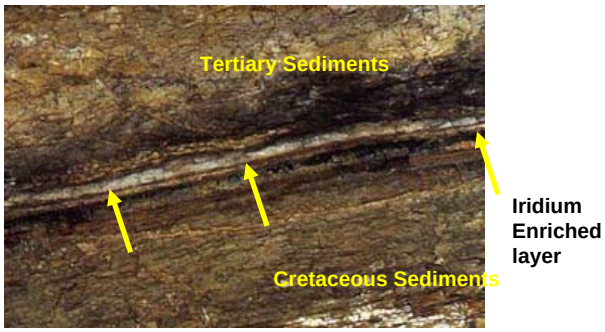
5th Mass Extinction

- Sometimes called the K-T extinction event
- End of Cretaceous, Beginning of Tertiary
- 85-90 % of all species lost.

Consensus

- K-T extinctions coincided with a permanent global climate change.
  - Mesozoic was warmer, Cenozoic was cooler
- Some evidence of a transient more severe cooling. (nuclear winter)
- The extinction impacted both terrestrial and marine taxa.

Alvarez and Alvarez



Alvarez and Alvarez

- Studied K-T transition in Italy in the early 1970s
- Found a layer between the K and T sediment that was enriched in the element Iridium.
- Iridium is common in metorites and asteroids but rare on earth.

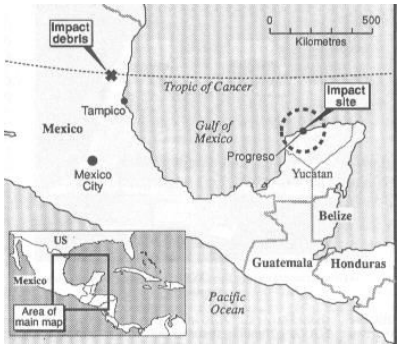
Alvarez and Alvarez

- Proposed that a meteorite impact at the time of the K-T extinction created a cloud of iridium rich dust.
- Dust cloud would block sunlight and cause a global winter, perhaps lasting as long 2-5 years.
- As dust settled to earth a layer of iridium enriched dust would form sediments on a global level.

Alvarez and Alvarez

- Predicted Iridium rich sediments at the K-T border have since been confirmed at many locals on the globe.
- “Shocked” quartz and impact ejecta have also been used as evidence.
- Periodicity of impacts and ort clouds ?

Chicxulub Crater



Weaknesses with Asteroid Impact Theory

- Other explanations of Iridium layers – volcanism
- Extinction may have taken as long as 50,000 years
- Resistance by gradualist and others

Cambrian Explosion

Oldest undisputed evidence of life - Stromatolites - (3800MYBP)
Banded iron formations – O_2 in atmosphere (2500MYBP)
First Eukaryotes -- (2000MYBp)

First evidence of multi-cellular life (well before (570MYBP)

Soft-bodied Inverts – ecadarians

Cambrian Explosion – Inverts every where, first chordates, algae abundant. Most extant phyla present by end of Cambrian.

Usually given as an example of adaptive radiation

Cambrian Explosion

- Burgess Shale
  - A fossil rich layer of sediments found in the Canadian Rockies
  - Sediment formed during the early Cambrian
  - High diversity – many unusual forms
- New life forms could exploit new environment promoting rapid evolution