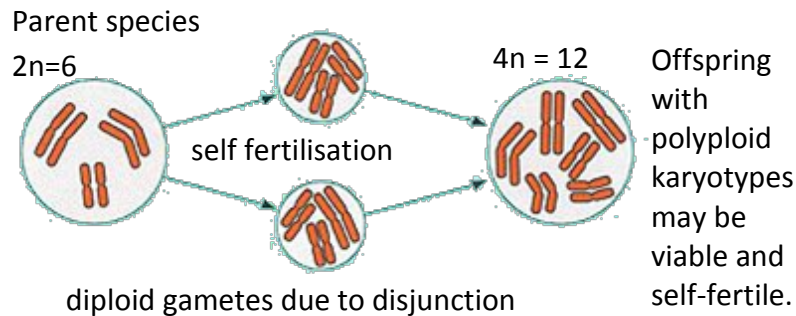


Polyploidy

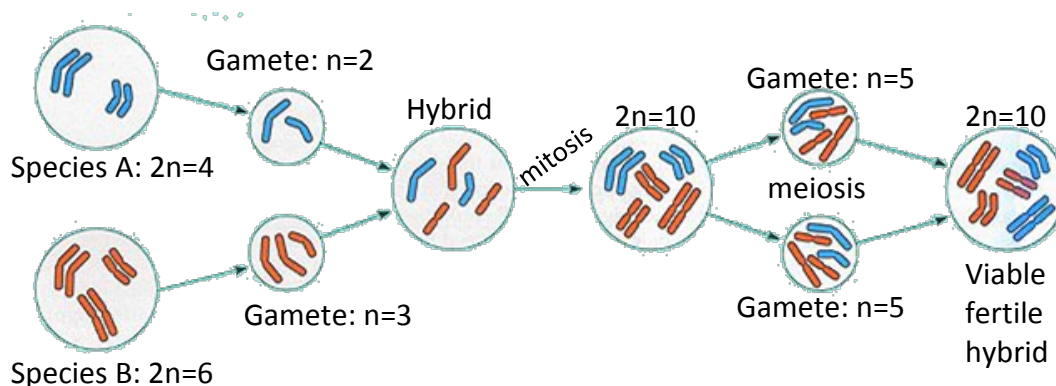
- Polyploidy means to possess more than two sets of chromosomes and is a condition in which a cell or organism contains three or more times the haploid number of chromosomes.
- Sometimes during meiosis spindles cause the incorrect number of chromosomes to be pulled to the wrong end resulting in gametes which have more or less chromosomes than normal. This process is called **non-disjunction** and may result in gametes which have $2n$ (not the normal n). If these are then fertilised by an n gamete, the zygote produced will be a sterile $3n$ or triploid. But if two $2n$ (diploid) gametes fuse a $4n$ or tetraploid is produced which may be fertile.
- In animals polyploidy usually does not occur. If it does it usually results in infertile offspring e.g. mules.
- Polyploidy is more common in plants because plants can self-pollinate and reproduce asexually resulting in more than one polyploidy being produced, therefore creating a number of the same polyploids which can later breed.
- Polyploidy results in instant speciation as the polyploids will not be able to reproduce with the original population

There are two main types:

- **Autopolloidy** (remember auto means self)
This occurs when polyploidy happens within the **same species** due to non-disjunction. They result in either a sterile hybrid ($3n$) or fertile hybrids ($4n$, $6n$ etc).



- **Allopolloidy** (remember allo means others)
This type of polyploidy results from the mating between **two different but closely related species**. If the two species are not closely related a hybrid would not be able to form. The resulting hybrid (with chromosomes from both parent species) maybe sterile ($3n$, $5n$ etc.) as it does not have homologous pairs of chromosomes, and so cannot form gametes. However, later on, if non-disjunction occurs in these sterile hybrids, a fertile hybrid maybe produced ($4n$, $6n$ etc).



Advantage of polyploids include:

- Polyploid plants usually have larger cells resulting in larger or resistant plants, with better characteristics than normal (diploid) plants. These are mainly useful in agriculture (bigger seeds) and horticulture (larger flowers).
- Polyploidy with uneven numbers of chromosomes are sterile, so any resulting fruit will have no seeds which is a commercial benefit (banana, seedless watermelons, seedless grapes).
- Polyploidy may have a greater advantage as they contain a range of adaptations resulting from the combination of characteristics they have got from the different species.

A common example of a polyploidy question is based on modern bread wheat as shown below.

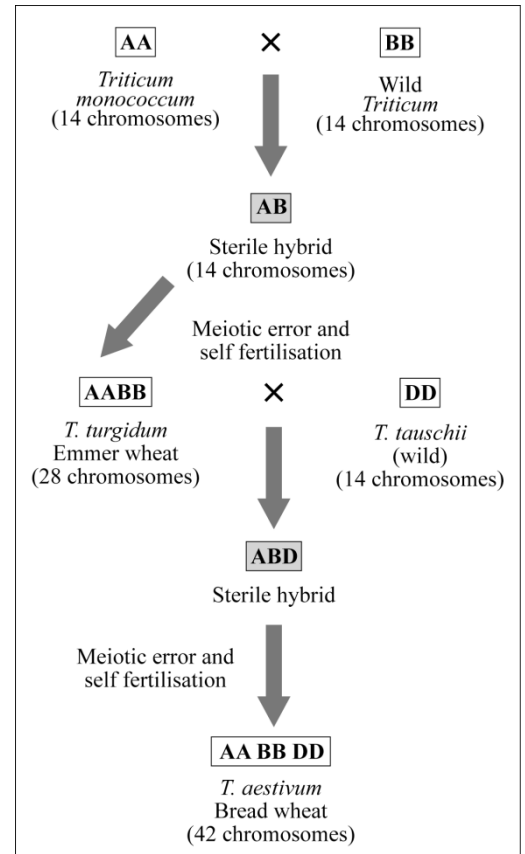
Bread wheat is an allohexaploid (an allopolyploid with six sets of chromosomes, two sets from each of three different species), AA, BB and DD. Each species contributes features to the resulting bread wheat such as genes contributed from goat grass BB (*Triticum tauschii*) give bread wheat greater cold hardiness and it can be cultivated throughout the world's temperate regions.

You will often be asked questions such as:

“Evaluate the role of polyploidy in the formation of the modern bread wheat species *T. aestivum*”.

In your answer, you should:

- use evidence from the diagram in the box opposite.
- explain the role of meiotic error and self-fertilisation in polyploidy events during the speciation of wheat
- consider the effect of polyploidy on the genotype and the formation of the bread wheat phenotype *T. aestivum*.
- outline any advantages that the bread wheat (polyploidy) may have over the original three species



To answer this question, first **define** allopolyploid.

Allopolyploid is a type of polyploidy resulting from the mating between two (or in this case three) different but closely related wheat species. If these species were not closely related a hybrid would not be able to form.

Then go on, using the information given in the question, to **explain the steps** that occurred during allopolyploid in wheat. You could either use their names from the diagram or use the letter provided.

- Step 1: AA and BB both undergo meiosis to produce gametes as normal A and B (7 chromosomes each). These gametes fuse to produce a sterile hybrid AB (14 chromosomes no matching homologous pairs).
- Step 2: The sterile hybrid AB may self-fertilise or as a result of non-disjunction occurring fuse to produce AABB (28 chromosomes / 14 homologous pairs).
- Step 3: If AABB produced gametes AB (14 chromosomes) which fused with the gametes produced by another close relative D (7 chromosomes) another infertile hybrid ABD is produced (21 chromosomes).
- Step 4: The infertile hybrids may self-fertilise or again non-disjunction could occur and ABD (21 chromosomes) fuses with ABD (21 chromosomes) to produce AABBDD (42 chromosomes)

Now go on and **outline the advantages** that the bread wheat (polyploidy) may have over the original three species. These include: disease resistance, larger plumper seeds which are held tightly on the plant so the seeds do not drop on the ground making their harvest easier. Remember to compare bread wheat to its original species which were much smaller and dropped their seeds on the ground so were very hard for man to harvest.