

Aquaculture Biotechnology

Genetic Engineering

Chromosome Engineering

Genetic engineering

- Genetic engineering technology is now beginning to find application in:
- the production of aquaculture feed to assist in reducing the dependency on fishmeal and fish oil
- to improve the terrestrial animal- and plant-based feed ingredients.

Genetic engineering

➤ Examples include:

- (1) genetically engineered yeast for production of important feed ingredients such as fish growth hormone and carotenoid pigments
- (2) pre-processing techniques of plant material to reduce the effects of antinutritional factors
- (3) breeding of plants with a better amino acid profile and less antinutritional factors
- (4) converting low grade land animal by-products into high-value protein.

Short term genetic improvement strategies

Short-term genetic improvement techniques:

- may not require the same level of record keeping nor management as long-term projects
- can impart significant gains with simple technologies in a short period of time.

Hybridization and crossbreeding

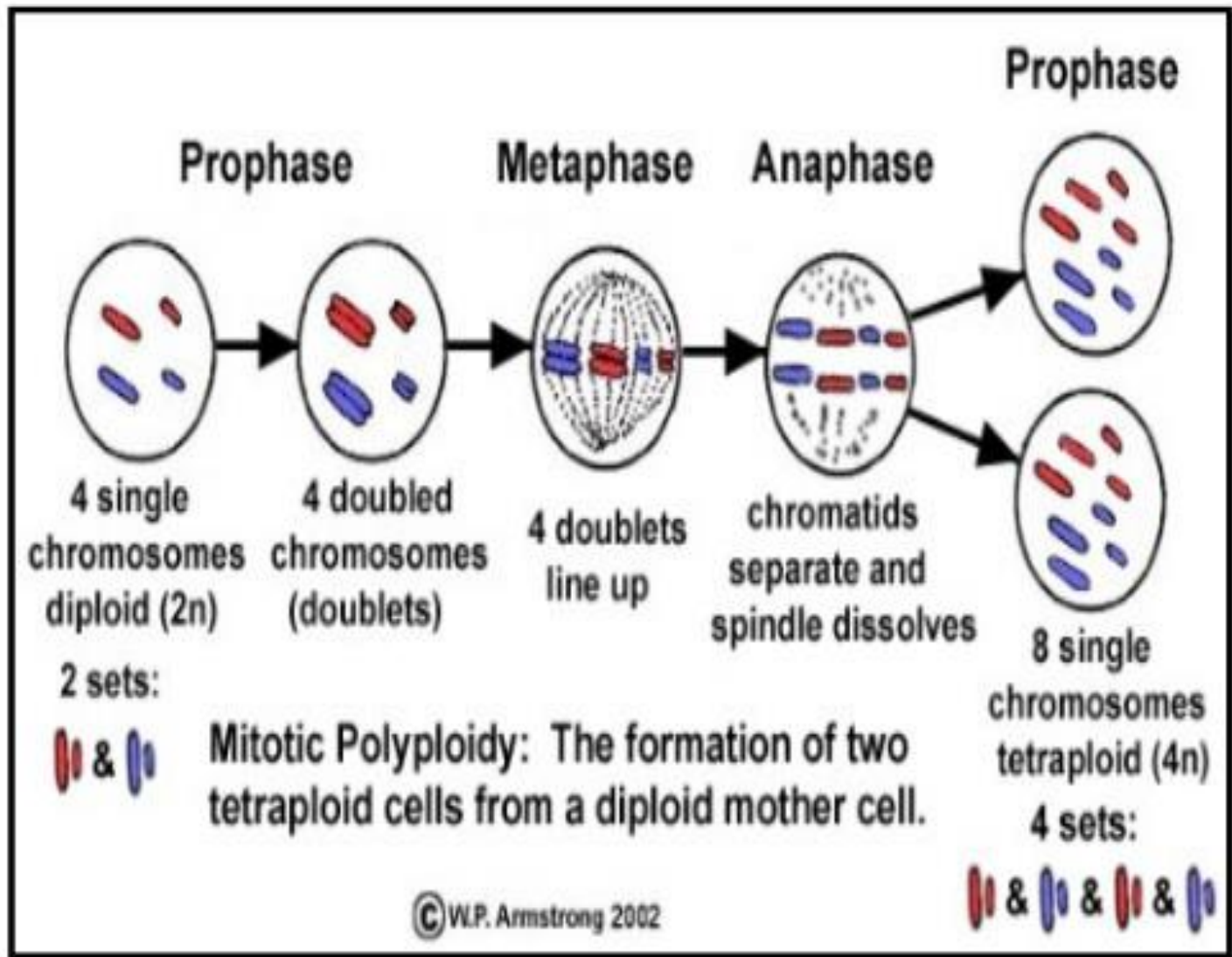
- ❑ Crossbreeding and hybridization can be utilized to combine favourable qualities from two genetically different groups
- ❑ to take advantage of hybrid vigour (heterosis). Interspecific hybridization has resulted in fish with improved growth rates, manipulated sex ratios, sterile animals, improved flesh quality, increased disease resistance, improved tolerance to environmental extremes and other altered traits.

Chromosome engineering

Manipulation of chromosome-sets (**Polyplodization**)

has been accomplished for many aquatic species through thermal and chemical shocks to developing embryos.

Triploid organisms are useful because they are sterile and therefore able to put more energy into the growth process rather than into maturation and reproduction.



Chromosome Engineering

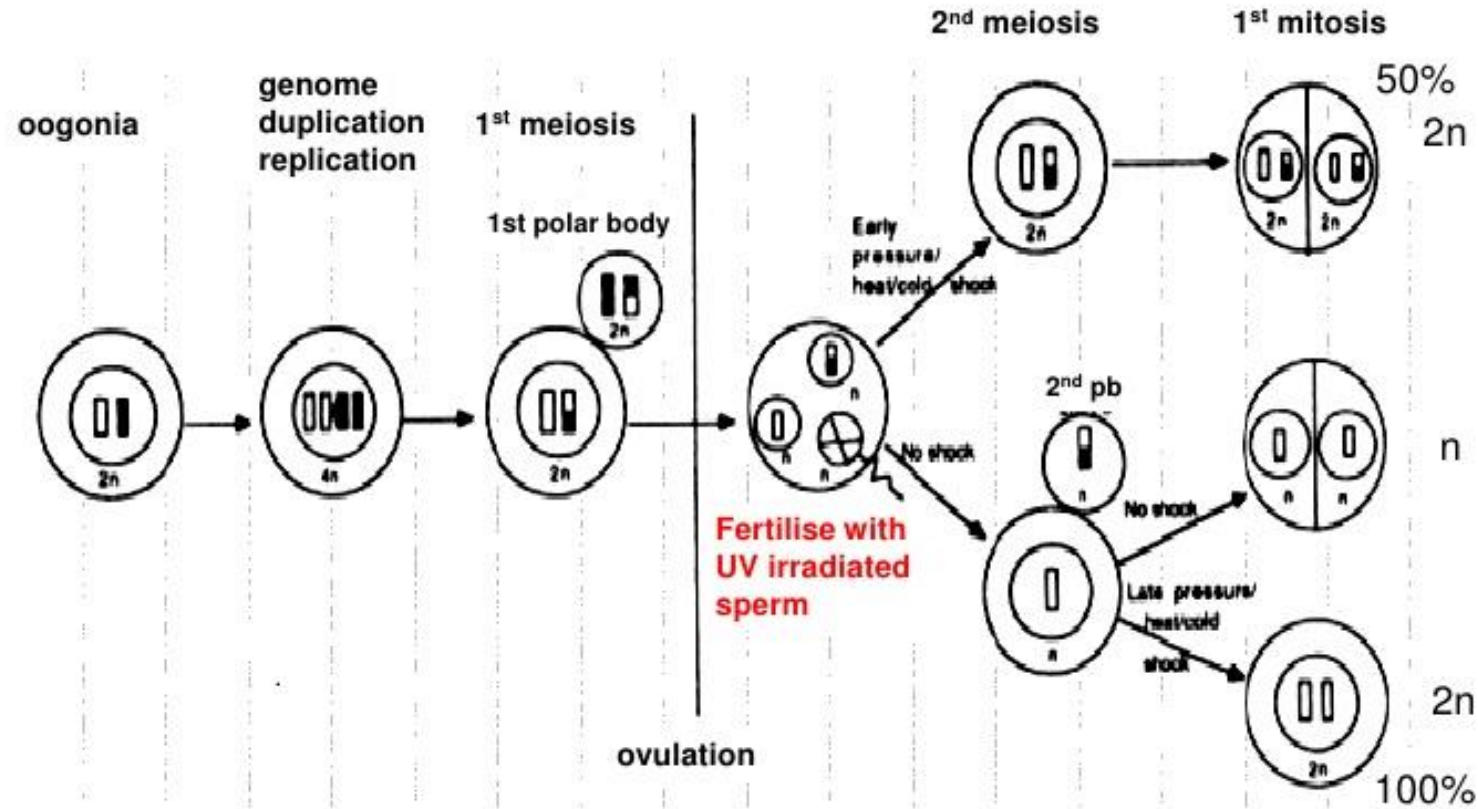
- Whilst chromosome-set manipulations have not resulted in many commercial applications for finfish
- the use of triploids has become an important part of the oyster farming industry and may have similar potential in other shellfish.
- For example, triploid Pacific oysters have shown 159% growth improvement over diploid controls

Chromosome Engineering

- At the same time, sterility reduces the risk of breeding with native species
- that may be of importance in stocking programmes such as the use of grass carp for vegetation control or to address environmental impacts of fish escaping from farms.

Chromosome set manipulation

Induction of gynogenesis in fish



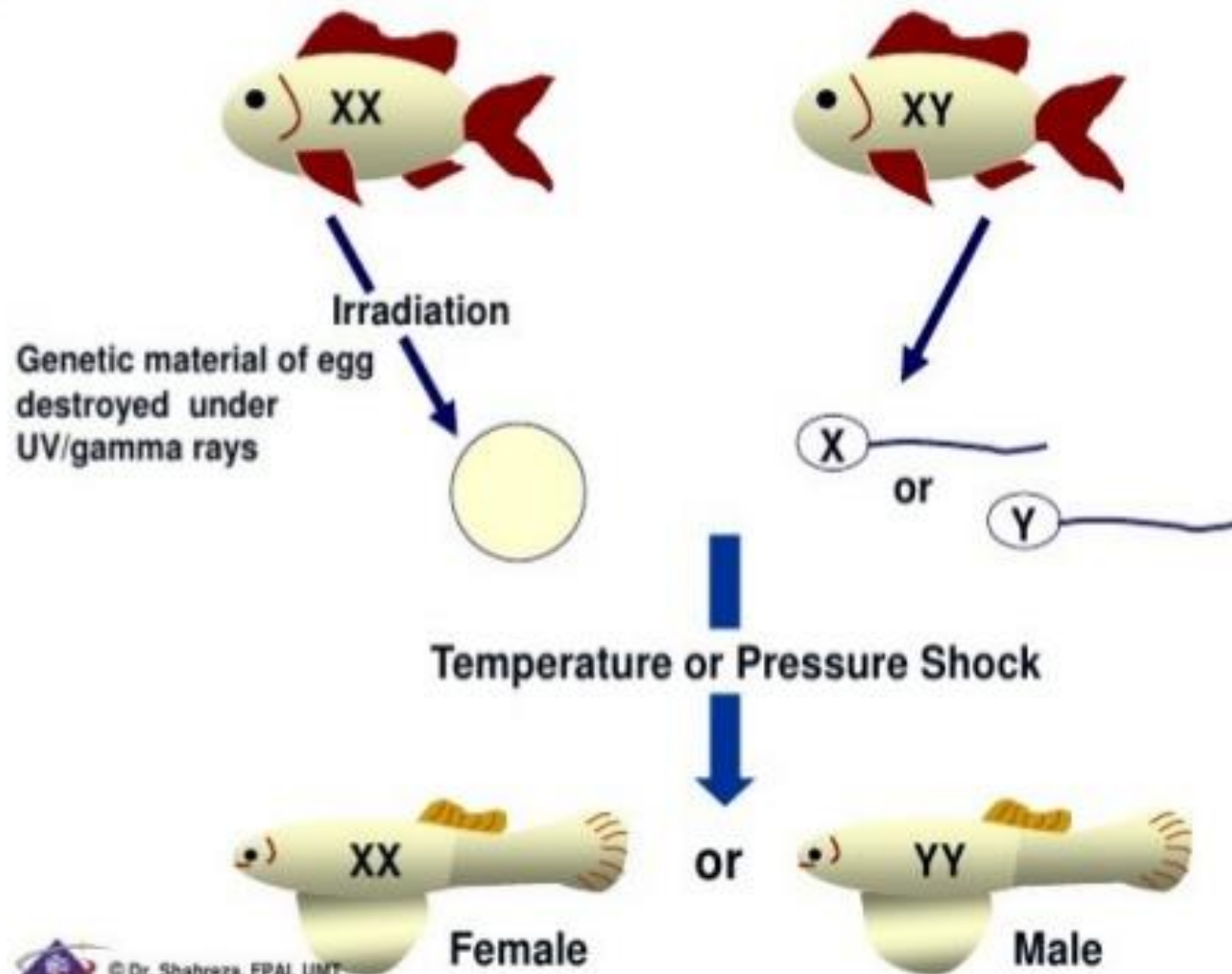
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Sex manipulation

- Manipulation of sex can be of advantage in species with sexual dimorphism in important traits or when reduced chance of reproduction is desired.
- Monosex male stocks have considerable commercial benefit in a number of species, most notably in tilapia due to problems of both precocious maturation and unwanted reproduction within the production system exhibited by this species.



CHROMOSOME MANIPULATION : ANDROGENESIS



Sex manipulation

- Also, female trout and salmon grow better and female sturgeon produce caviar.
- The sex of fish can be easily manipulated using hormonal treatments, but there has been concern about the use of hormones in animal production resulting in an increased use of other biotechnologies in those developing countries whose production goes to export markets.

Emerging technologies

A number of new genetic technologies are now beginning to be applied in cultured aquatic species including:

DNA marker

novel sequencing

gene discovery

genome mapping (showing the relative positions of genes along a chromosome) and

genome expression technologies that examine how genes actually function in the organisms.

Emerging technologies

These technologies will be useful to find important genes affecting traits such as **disease resistance, growth rate and sex determination**, allowing more precisely targeted selection to improve aquaculture performance. .

Other applications

Immunodiagnostic and molecular technologies are widely applied in:

pathogen screening and detection

elucidation of pathogenicity and

disease diagnosis

They have played an important role in health management due their high sensitivity, specificity, and ability for rapid diagnosis

Other applications and facts

- ❑ Linking the use of genetic technologies in fishing and aquaculture will increase efficiency and efficacy of the technologies.
- ❑ However, it should be noted that many of these technologies require specialized equipment and highly skilled staff.