



TECHNICAL UNIVERSITY OF MOMBASA

FACULTY OF APPLIED AND HEALTH SCIENCES
DEPARTMENT OF ENVIRONMENT & HEALTH SCIENCES

UNIVERSITY EXAMINATION FOR:
BACHELOR OF SCIENCE IN FISHERIES AND OCEANOGRAPHY
BSFO 22S /YEAR 4/ SEMESTER 1

AFO 4303: FISH GENETICS AND BREEDING

END OF SEMESTER EXAMINATION
SERIES: AUGUST 2024
TIME: 2 HOURS

Instructions to Candidates

This paper consists of FIVE questions

Answer question ONE (COMPULSORY) and any other TWO questions.

This paper consists of two printed pages.

Mobile phones are NOT allowed in the examination room

QUESTION ONE. (30 MARKS)

Give an account of the following:

- | | |
|---|-----------|
| a) Animal breeding | (2 marks) |
| b) Domestication | (2 marks) |
| c) Exon and Intron | (4 marks) |
| d) Genetic Code | (2 marks) |
| e) Gene expression | (4 marks) |
| f) Dominant allele and Recessive allele | (4 marks) |
| g) Overdominance and Incomplete dominance | (4 marks) |
| h) Breeding value | (2 marks) |
| i) Artificial selection and Natural selection | (4 marks) |

QUESTION TWO

Discuss any FIVE challenges hindering aquaculture development in sub-Saharan Africa (20 marks)

QUESTION THREE

b) Discuss the consequences of Inbreeding and Outbreeding depression (20 marks)

QUESTION FOUR

Discuss any FIVE selection methods that are available to fish farmers (20 marks)

QUESTION FIVE

Discuss any FOUR undesirable side effects of breeding programmes (20 marks)

MARKING SCHEME

QUESTION ONE. (30 MARKS)

Give an account of the following:

- a) Animal breeding (2 marks)
- The process of selective mating of domesticated animals with desirable genetic traits, either to maintain or enhance those traits in future generations
- b) Domestication (2 marks)
- The process by which a population of animals becomes adapted to man and the captive environment, facilitated by some combination of genetic changes occurring over generations, and environmentally induced developmental events recurring during each generation
- c) Exon and Intron (4 marks)
- Exon: Regions within a gene that can be transcribed into a mRNA
 - Intron: Regions within a gene than can not be transcribed into mRNA
- d) Genetic Code (2 marks)
- The relationship between codons and amino acids
- e) Gene expression (4 marks)
- The biochemical processes that occur within a cell, including duplication, transcription, splicing and transcription that leads to either a protein or RNA
- f) Dominant allele and Recessive allele (4 marks)
- An allele whose phenotypic characteristic is expressed in a heterozygous and homozygous gene
 - An allele whose phenotypc characteritics are expressed when the allele occur in a homozygous state in the gene
- g) Overdominance and Incomplete dominance (4 marks)
- **Overdominance/heterozygote advantage:** a condition where individuals have a higher fitness than homozygous individuals
 - **Incomplete dominance:** is a form of intermediate inheritance in which one allele for a specific trait is not completely expressed over its paired allele. This results in a third phenotype in which the expressed physical trait is a combination of the phenotypes of both alleles
- h) Breeding value (2 marks)
- Refers to the **value** of an animal in a **breeding** program for a particular trait. An animal's **breeding value** is estimated to be twice the expected performance of its progeny
- i) Artificial selection and Natural selection (4 marks)
- Artificial selection occurs within domesticated animals

- Natural selection: Occurs in the wild, and may include balancing, diversifying and directional selection

QUESTION TWO

Discuss any FIVE challenges hindering aquaculture development in sub-Saharan Africa (20 marks)

- Much of the focus is placed on environmental impacts (environmental projects) rather than fish production,
- There is stiff competition for water resources,
- Increasing demand for aquaculture products due to increasing human population
- Underdeveloped aquaculture practices (e.g. low-quality seeds/ diseases/feeds etc).

QUESTION THREE

b) Discuss the consequences of Inbreeding and Outbreeding depression (20 marks)

- Inbreeding is the name given to a mating or system of mating where the mates are more closely related than are the average members of the population available for intermating.
- Outbreeding depression is when progeny resulting from crosses between genetically distant individuals (outcrossing) exhibit lower fitness in the parental environment than either of their parents or than progeny from crosses between individuals that are more closely related.
- Outbreeding depression manifests most significantly in two ways:
- Intermediate genotypes are not adapted to either parental habitat. For example, selection in one population might favor a large body size, whereas in another population small body size might be more advantageous, while individuals with intermediate body sizes are comparatively disadvantaged in both populations.
- Breakdown of biochemical or physiological compatibility. Within isolated breeding populations, alleles are selected in the context of the local genetic background. Because the same alleles may have rather different effects in different genetic backgrounds, there is the potential evolution of different locally adapted gene complexes. Outcrossing between individuals with differently adapted gene complexes can result in disruption of this selective advantage, resulting in a loss of fitness.

QUESTION FOUR

Discuss any FIVE selection methods that are available to fish farmers (20 marks)

- Pedigree selection
- Individual selection
- Family selection
- Within family selection
- Progeny testing

QUESTION FIVE

Discuss any FOUR undesirable side effects of breeding programmes (20 marks)

- Genetic pollution through escapees
- Development of unintended traits

Lecturer: Dr Thomas K. Mkare

Contacts: Cell No. 0797295532; Email: thomasmkare84@gmail.com

Contact hours 45

Prerequisites: AFO 4208: Aquatic Vertebrate Zoology

Purpose:

To introduce the student to fish breeding and domestication

Learning outcomes:

By the end of this course unit the student should be able to

- i. Understand about the present status of breeding, cross breeding in aquaculture
- ii. Define and gain insight in the performance on breeding, growth, disease resistance, productive and reproductive traits.
- iii. Discuss genetic techniques for stock improvement

Course Description

Historical development of fish breeding: domestication, performance, endocrine control of reproduction, effect of breeding programme on genetic diversity of farmed animals, reproductive cycle, breeding techniques, genetic techniques for stock improvement, hatchery set up, fingerling production. Constraints to production - biological, environmental and economic factors. Case study of culture of selected species. Ocean ranching. Environmental impacts of aquaculture developments. State of world aquaculture. Water quality management. Mariculture. Aquaculture in cages, fish pens and net enclosures. State of aquaculture in Kenya. Feed formulation and feeding. Principles of aquaculture. Aquaculture systems and techniques – mono-and polyculture, integrated culture. Pond siting, construction, stocking and maintenance. Pond management - control of aquatic plants, predators and diseases. Pond manuring. Feed formulation and feeding. National breeding policy.

Teaching Methodologies:

Lectures, field experiments and observations, mapping, group discussions assignments as well as library research and tutorials.

Instructional Materials/Equipment:

Overhead projector, slide projector, maps, poster diagrams aerial photographs and satellite images, laboratory apparatus, computers and handouts.

Course Assessment:

Continuous assessment 30% and final exam 70%.

Core text books for the course:

- i. Hoar WS & Randall DJ. (2009). Fish Physiology. Academic Press. ISBN: 97815884887829
- ii. Kinghorn BP. (2011). Quantitative Genetics in Fish Breeding. University of Edinburgh. ISBN: 978047175156
- iii. Purdom CE. (2009). Genetics and Fish Breeding. Chapman & Hall. ISBN: 0131857851

Core journals for further reading:

- i. Breeding Science
- ii. East African Journal of Genetics and Plant Breeding ISSN:1005-3877
- iii. Journal of Animal Breed and Genetics ISSN:10813810

Supplementary text books for further reading:0711066000

- i. Purdom CE. (1993). Genetics and Fish Breeding. Chapman & Hall. 9780412330407

- ii. Snustad DP & Simmons MJ. (1999). Principles of Genetics. (2nd Edition). John Wiley & Sons. 9780471504870
- iii. Stansfield WD. (1991). Theory and Problems of Genetics. McGraw-Hill. 9780070608450
- iv. Tave D. (1993). Genetics for Fish Hatchery Managers. (2nd Edition). Chapman & Hall. ISBN: 9780442004170

Supplementary journals for further reading:

- i. Advances in Genetics Incorporating Molecular Genetic Medicine ISSN:
 - ii. Animal Genetic Resource Information
- Animal Genetics ISSN 0268-9146.