LAS-Learning

Course Organisers Instructions

EU Module 3.1 - Basic and appropriate biology - Species specific: Zebrafish

Development of interactive e-learning modules on specific areas of the Education & Training framework facilitating the implementation of DIR 2010/63/EU

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Suported by:

Partners:

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1. Module Description

a. Overview

This module, *Basic and appropriate biology - Species specific: Zebrafish*, will introduce you to the fascinating world of zebrafish, providing insights into their care to ensure they remain healthy in experiments, thereby producing reliable data. Fish are vertebrate animals protected under EU scientific legislation, and zebrafish have become a popular experimental model. Understanding their biology is essential for maintaining their health and welfare.

This document provides guidance and suggestions to support the course organiser's efforts. Each module is aligned with the learning outcomes outlined in the EU Education & Training framework for laboratory animal science.

We recommend consulting the EC Training and Education framework guidance document if you are accessing the site independently. This resource offers an overview of training requirements for individuals with different responsibilities under their relevant national legislation.

Further reading and additional education and training may be necessary to meet national or institutional training requirements. At the end of each module, you will find a list of recommended further readings and references cited throughout the content. Links to these references are provided whenever possible.

This module was developed by Lynne U. Sneddon and Ana Maria Valentim, two prominent researchers in the field of animal welfare and pain perception in aquatic animals, particularly fish. Their work spans research, publications, and training in these fields. The module was further revised by an international Reflection Group panel, with coordination led by Nuno H. Franco.

The module is currently in the testing phase. We appreciate your collaboration in integrating it into your courses and providing feedback. After completing a module, please fill out the form below with your feedback.

b. Learning Objectives

This module will equip participants with essential knowledge and skills to navigate animal research's ethical, legal, and practical aspects. The key learning objectives include:

2. Biological functioning of zebrafish.
3. Zebrafish development.
4. Zebrafish behaviour.
5. Zebrafish in the laboratory.
6. Good husbandry practice.
7. Common events in the aquaria.
8. Zebrafish strains.

2. Course Program

The module is organised into different chapters, with lessons and learning objectives for the participants as follows:

Chapter	Lesson	Learning objectives
Introduction	1	Get to know the learning objectives
Biological functioning of zebrafish	2-12	Basic anatomy and physiology Cardiovascular system Respiratory system Digestive system Nervous system Reproductive system Sensory systems Skin Osmoregulation The genetics of the zebrafish Assess your knowledge
Zebrafish development	13-17	Introduction Embryogenesis Larval stage Juvenile and Adult Stages Assess your knowledge
Zebrafish behaviour	18-23	The Natural Environment and Geographical Habitat Mating Behaviour Social behaviour Stress and anti-predatory behaviours Sexual dimorphism Assess your knowledge
Zebrafish in the laboratory	24-29	Animal care and management in the European legislation Aquatic systems Filtration setup and maintenance Freshwater Chemistry and Physical Parameters Impact of management and research on zebrafish Assess your knowledge
Good husbandry practice	30-43	Husbandry and handling Physical parameters for zebrafish husbandry Stocking density and individual housing Feeding zebrafish Breeding Rearing zebrafish Environmental enrichment Biosecurity Anaesthesia and analgesia

		Health monitoring Record Keeping Human health and safety Impact of Husbandry on experimental data Assess your knowledge
Common events in the aquaria	44-46	Transport Common laboratory procedures Assess your knowledge
Zebrafish strains	47-50	Strains Strain differences Genetic modifications Assess your knowledge
Summary and knowledge check	51-53	Module summary List of references and further reading Assess your knowledge

Table 1 - Learning objectives per parts and lessons.

a. Progress Tracking

Once learners begin working through a module, their progress is automatically tracked. This allows them to pause and resume their studies at any point. Upon completing the module, learners retain access to all sections, enabling them to revisit and review specific topics to reinforce their understanding.

b. Model Structure and Implementation Guidance

The module is structured into several parts, which were designed to be followed in sequence but can also be taken iteratively based on the learner's needs. Please note that a **certificate of completion** is issued exclusively to learners who finish all parts of the module.

From a pedagogical perspective, each tutor is responsible for deciding which materials to use in face-to-face sessions, which parts learners should complete independently, and whether to mandate their completion. However, it is essential to consider the time required to complete the eModule or its parts to avoid overburdening learners.

We highly recommend completing the module to ensure it aligns with your course's content and scope. Familiarising yourself with the material will also enable you to engage more effectively with students on the various topics covered in the eModule.

c. In-Depth Explanation Lesson by Lesson

Lesson	Title	LO	Explanation
1	Introduction		Short introduction with 1 photo
2	Basic anatomy and physiology	3.1.1	Image and short introduction

			Zebrafish anatomy with 1 image
3	Cardiovascular system	3.1.1	Image and short introduction Zebrafish anatomy and circulatory system Schematic summary of the regenerative process after cryoinjury in the zebrafish heart with 1 image/diagram
4	Respiratory system	3.1.1	Image and short introduction Oxygen uptake in zebrafish with 1 image
5	Digestive system	3.1.1	Image and short introduction Evolution of the digestive system with 1 image
6	Nervous system	3.1.1	Image and short introduction Peripheral and central nervous system Schematic representation of the embryonic brain and simplified representation of the adult brain and main domains in 1 image
7	Reproductive system	3.1.1	Image and short introduction Reproductive biology: differences between male and female zebrafish with 1 image
8	Sensory systems	3.1.1	Text descriptions of the sensory systems: Vision, Hearing, The lateral line, Olfactory system, Taste, Touch and pain
9	Skin	3.1.1	Image and short introduction Text description of zebrafish epidermis with 1 image
10	Osmoregulation	3.1.1	Image and short introduction Text description on osmotic balance
11	The genetics of the zebrafish	3.1.1	Image and short introduction Text description of zebrafish genome
12	Knowledge-check		Assesses progress and knowledge acquired during the chapter
13	Introduction	3.1.1	Short introduction Early development of the zebrafish embryo with 1 diagram
14	Embryogenesis	3.1.1	Image and short introduction Description on the production of eggs and their development Video on zebrafish development
15	Larval stage	3.1.1	Image and short introduction Characterisation of the larval stages: Text for early larvae, 1 image, Text for larval development and Text for larval behaviour
16	Juvenile and adult stages	3.1.1	Zebrafish stages (juvenile and adult) with 1 image
17	Knowledge-check		Assesses progress and knowledge acquired during the chapter
18	The Natural Environment and	3.1.1	Image and short introduction

	Geographical Habitat		Information on zebrafish habitat and distribution with 2 images
19	Mating Behaviour	3.1.1	Image and short introduction Mating courtship with a diagram The behaviour of both males and females during breeding Differences in a female body with 1 image
20	Social behaviour	3.1.1	Image and short introduction Social behavior of zebrafish with 1 video
21	Stress and anti-predatory behaviours	3.1.1	Stress Fear and anti-predatory behaviour with 1 diagram with information points
22	Sexual dimorphism	3.1.1	Image and short introduction Characteristics of males and females with 1 image with information points
23	Knowledge-check		Assesses progress and knowledge acquired during the chapter
24	Animal care and management in the European legislation	3.1.2	Image and short introduction Zebrafish and the law in Europe
25	Aquatic systems	3.1.2	Image and short introduction Modern self-cleaning aquariums Stand-alone units with 1 image Large, centralised units Special aquatic systems with 2 images
26	Filtration setup and maintenance	3.1.2	Image and short introduction Filtration systems with stacked cards Filter maturity Reverse osmosis process with 1 diagram Ultraviolet sterilisation with 1 image of the recirculating water system
27	Freshwater Chemistry and Physical Parameters	3.1.2	Image and short introduction Good husbandry conditions with 2 images
28	Impact of management and research on zebrafish	3.1.2	Image and short introduction Maintenance and management of zebrafish colonies and research practices
29	Knowledge-check		Assesses progress and knowledge acquired during the chapter
30	Husbandry and handling	3.1.3	Image and short introduction Recommendations for handling zebrafish
31	Physical parameters for	3.1.2	Text description on physical parameters for zebrafish husbandry

	zebrafish husbandry		
32	Stocking density and individual housing	3.1.3	Image and short introduction Text analysis on how many zebrafish are in a tank
33	Feeding zebrafish	3.1.5	Image and short introduction Correct nutrition Different forms of live feeds with 2 images
34	Breeding	3.1.3 3.1.9	Short introduction How to breed zebrafish Breeding programs Breeding techniques with 2 images Natural fertilisation - in-tank technique Reasons for poor egg production with checkbox marking
35	Rearing zebrafish	3.1.3	Short introduction How to rear zebrafish in a 6-step process
36	Environmental enrichment	3.1.3 3.1.6	Image and short introduction Environmental enrichment with 4 tabs and 2 dropdown texts Testing enrichment types with 1 table
37	Biosecurity	3.1.3 3.1.9	Image and short introduction Biosecurity strategy and health measures
38	Anaesthesia and analgesia	3.1.3	Anaesthetics and analgesics
39	Health monitoring	3.1.3 3.1.9	Image and short introduction Monitoring for disease with description of non-infectious diseases and bacterial diseases
40	Record Keeping	3.1.9	Image and short introduction Keeping animal records with a list of elements to keep track of
41	Human health and safety	3.1.3 3.1.9	Image and short introduction Safe working with zebrafish with a list of potential zoonotic diseases Allergic reactions to zebrafish and how to protect yourself with 2 text tabs
42	Impact of Husbandry on experimental data	3.1.3 3.1.4	Introduction Confounding factors to zebrafish research
43	Knowledge-check		Assesses progress and knowledge acquired during the chapter
44	Transport	3.1.2 3.1.9	Image and short introduction Required documentation for transport

45	Common laboratory procedures	3.1.2 3.1.9	Image and short introduction Common laboratory procedures in zebrafish, their consequences and possible refinements in 1 table
46	Knowledge-check		Assesses progress and knowledge acquired during the chapter
47	Strains	3.1.7	Different strains of zebrafish
48	Strain differences	3.1.7	Image and short introduction Differences between strains description
49	Genetic modifications	3.1.8	Different genetic modifications with 4 cards
50	Knowledge-check		Assesses progress and knowledge acquired during the chapter
51	Summary		Module summary
52	References and Further Reading		References for additional materials
52	Knowledge-check		Assesses progress and knowledge acquired during the module

Table 2 - Explanation lesson by lesson.

3. Participants' Profile

This module is intended for scientists using zebrafish as a model species. Therefore, as zebrafish are used across a wide variety of scientific fields, this course will interest (bio)medical researchers, laboratory animal science students, university students, biology/medical teachers, animal carers and technical staff, ethical board members, and anyone interested in learning more about the biology of zebrafish

No specific prior knowledge is necessary. However, a basic understanding of the zebrafish as a model organism and a background in laboratory animal science can be beneficial.

4. eModule

The eModule provides clear definitions, essential knowledge, and interactive components designed to enhance understanding of key animal ethics theories and develop critical thinking skills. Participants will learn to ethically frame and evaluate animal research from a broad perspective and a case-by-case approach.

The content and references are curated from expert sources, including researchers and information specialists, ensuring high-quality and reliable information. The module is presented dynamically, combining text, images, built-in exercises, and videos to engage learners effectively. It can be integrated into courses as homework or used during a lecture day. Many lessons are designed to deliver comprehensive information and understanding without additional in-class interaction.

a. Limitations

Basic information is provided for all learning objectives, but this is no means an in-depth comprehensive coverage of each topic, and this would make the module unmanageably long. It is important to understand that the basic information presented to students is enough for them to understand the relevance of the materials to caring for zebrafish and using them as an experimental animal. By being aware of these limitations, researchers can better design their studies, interpret their results, and apply appropriate controls to mitigate potential issues, thereby maximising the utility of zebrafish as a model organism. Not every tool or method could be explained in detail within this eModule. However, references and further reading suggestions open vast possibilities for interested users to learn more about this topic.

b. Blended Learning Approach

E-learning modules offer significant advantages, particularly for learners who may find it challenging to attend traditional intensive training sessions spanning several days. Such sessions can disrupt work schedules and limit participants' ability to balance learning with other responsibilities. While this eModule covers all required learning outcomes, we do not advocate entirely replacing face-to-face teaching (or "live" online discussion sessions) with e-learning. Instead, we recommend a blended learning approach (hybrid or mixed-mode learning). This approach combines the flexibility of e-learning with the engagement of interactive, live sessions, ensuring that learners receive the necessary information while accommodating those who require greater flexibility.

The modules are split into short, manageable lessons, allowing participants to integrate learning activities into their daily schedules seamlessly.

5.Implementing Blended Learning Strategies

Flipped Classroom Arrangement

Before face-to-face classes, learners are introduced to the course contents (for example, by completing our e-learning modules). You can recommend that learners take the whole course (and request a certificate of completion) or focus on specific lessons or chapters.

This approach can:

- Familiarise learners with the content in advance, helping them better understand complex concepts.
- Prepare and motivate learners to engage more actively in their learning and during face-to-face classes.
- Harmonise learners' knowledge levels before in-person classes.
- Provide sufficient background knowledge for group work, allowing for more focused and productive discussions.
- Provide a starting point for interactive discussion.

Consolidate Learning and Prepare for Exams

The courses are designed to align with the learning outcomes of traditional laboratory animal science courses. Learners can use each module to study and prepare for the final exam. Additionally, the built-in quizzes allow learners to test their knowledge and track their progress.

Address Expertise Gaps in Your Facility

Gathering expertise across all subjects covered in the EU-functions modules can be challenging, especially in smaller establishments. This may hinder the ability to deliver training that meets all outcomes of the Education and Training framework to a high standard. Using these modules as a basis, tutors and learners can access quality reference material that could mitigate such gaps and ensure education and training are up to standard.

Use Modules as Teaching Resources

Tutors can integrate various components—such as text, videos, images, interactive exercises, and quizzes—into their teaching activities. This not only boosts engagement but also caters to different learning styles. For each module, we provide suggestions for topics that can be incorporated into interactive discussion sessions.

6. Textbooks and Reading Materials

The **"References and Further Reading"** lesson provides most references and readings. They comprise scientific articles, sections of books, websites, and videos. Clicking on any link will open a new window to download or visualise the additional material. Several links to further resources can also be found in the module contents to better guide the reader.

The additional materials provide more information on specific topics, tools, and resources. They are ideal for learners who wish to expand their knowledge or gain a more comprehensive understanding of the issues.