

## Eco-friendly methods of bioindication and biotesting in the training of postgraduate biologists (using the example of the T.H. Shevchenko National University “Chernihiv Colehium”, Chernihiv, Ukraine)

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### INTRODUCTION & AIM

During the global pandemic, in Ukraine distance learning with the active involvement of information and communication technologies was used. Distance education continues to be used even in the conditions of war in Ukraine. Distance learning technology is a set of methods and means of learning and management that ensure the educational process at a distance using modern information and telecommunication tools. **The aim** of this study was to generalize the approaches to the process of training of postgraduate students-biologists studying eco-friendly methods of bioindication and biotesting during the war in Ukraine at the T.H. Shevchenko National University “Chernihiv Colehium”.

### MATERIALS & METHODS

Three types of distance learning technologies were used in the process of teaching graduate students: network technologies, television and satellite technologies, and case technologies.

For develop the program of the course “Bioindication of aquatic and terrestrial ecosystems”, educational and methodological set of didactic materials from the course, methods of theoretical research of available information, analysis of scientific and methodological sources on this problem, empirical method of accumulating facts, argumentation method of proving one’s own judgments were used.

### RESULTS & DISCUSSION

The educational discipline has 2 content modules, which contain the following topics:

**Content module 1. General aspects of biotesting and bioindication, integrative approach.**

TOPIC 1. Definition, strategies and principles of environmental bioindication/biomonitoring.

TOPIC 2. Bioindicators and environmental assessment.

**Content module 2. Bioindicators and test organisms in use.**

TOPIC 3. Biochemical and physiological reactions to anthropogenic stressors.

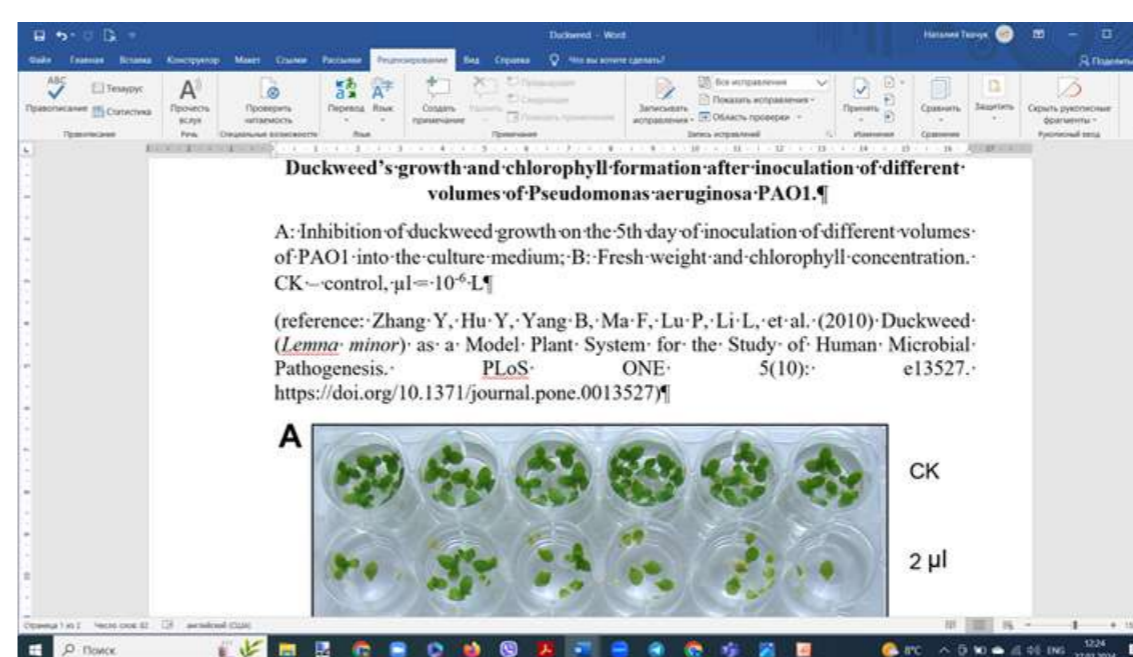
TOPIC 4. Bioindication at the tissue and organismal levels.

TOPIC 5. Bioindication at higher hierarchical levels: population, ecosystem, biocenosis.

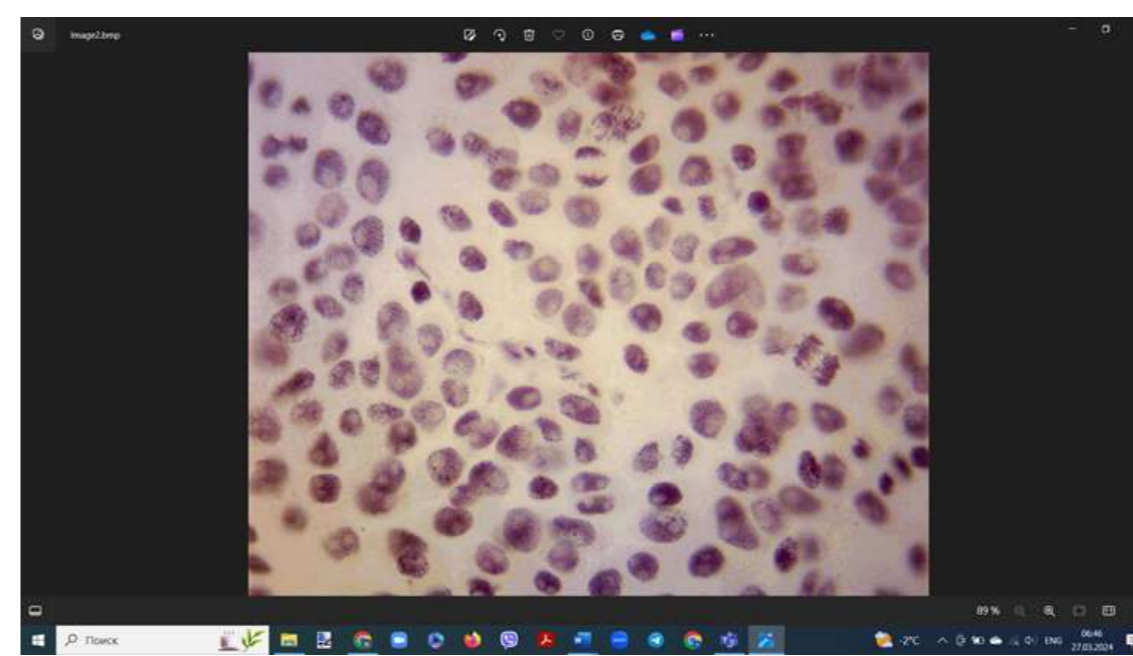
TOPIC 6. Fields of application of bioindicators.

**Table 1. Generalization of information about didactic materials used for the distance learning process of the course “Bioindication of aquatic and terrestrial ecosystems”**

Number of the topic	Lecture presentation by Zoom	Laboratory material is presented		
		The fragments of an informative text (Fig.1)	Educational digital photos (Fig. 2)	Educational video (Fig. 3)
1	+	+	-	-
2	+	+	+	+
3	+	+	+	-
4	+	+	+	+
5	+	-	-	-
6	+	+	+	+



**Figure 1.** A fragment of an informative text fragment for the laboratory work “*Lemna* sp. growth inhibition test” (teacher, Associate Professor N.V. Tkachuk)

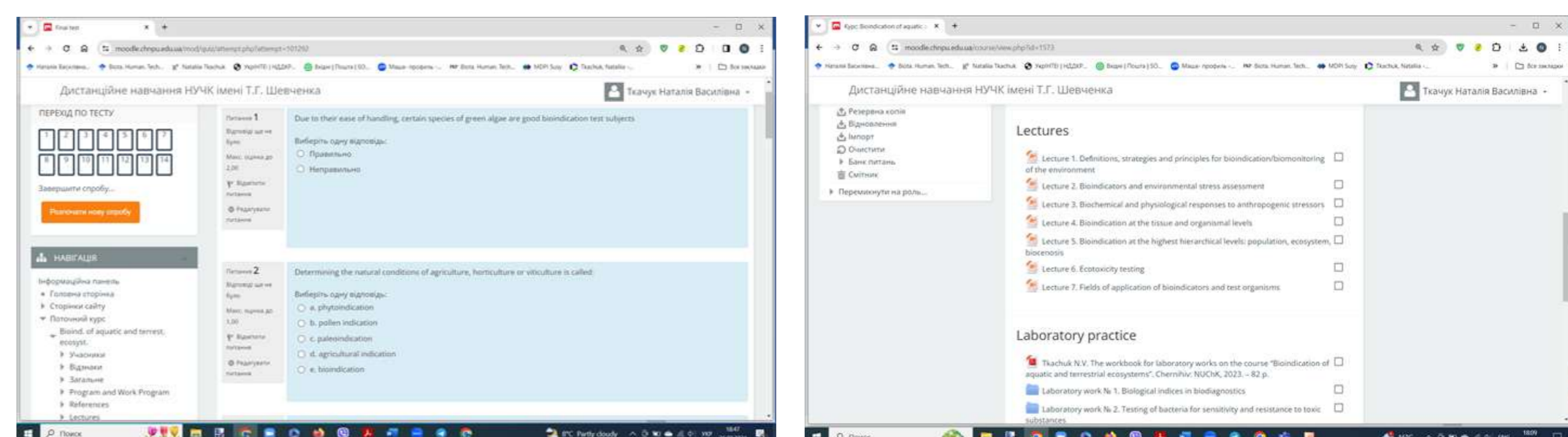


**Figure 2.** An example of a digital photograph used in the teaching of the topic “Study of mitotic index in onion root tip cells” (teacher, Associate Professor N.V. Tkachuk)



**Figure 3.** A fragment of the video for the laboratory work “The effect of chemicals on cress seed germination” (teacher, associate professor N.V. Tkachuk)

The powerful **Moodle** software complex was used to teach the discipline. In particular, the methodical material of the discipline was placed in the Moodle system: program and work program, syllabus, links to recommended literary sources, lecture presentations, methodical instructions for laboratory classes and material for their implementation, credit test (Fig. 4).



a

b

**Figure 4.** Fragment of the electronic educational course “Bioindication of aquatic and terrestrial ecosystems” in the Moodle system (teacher, Associate Professor N.V. Tkachuk): a - credit test; b - lectures

### CONCLUSION

The application of distance education using information and communication technologies in the teaching process of the course “Bioindication of aquatic and terrestrial ecosystems” at the T.H. Shevchenko National University “Chernihiv Colehium” ensures mastering by postgraduate biologists of eco-friendly methods of bioindication and biotesting, which are widely used for observation, assessment and forecasting of anthropogenic processes. All three types of distance learning technologies are used: network technology, satellite television and case technology. The used teaching methods using the Zoom platform, the Viber mobile application, the Moodle software complex and the Microsoft Office package allow students to master both the theoretical and practical material of the discipline.