Strategies for Teaching Molecular Biology at Grammar School Level: from Theory to Laboratory Practice

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Curricular Documents in the Czech Republic

Diagram 1 – The System of Curricular Documents


* The other FEPs – other framework education programmes which are also delimited by the Education Act and have not been listed above.

Source: Framework Education Programme for Secondary General Education (Grammar Schools), Research Institute of Education in Prague, 2007, p. 5.
Molecular Biology in FEP SGE

GENETICS
Expected Outcomes
The pupil shall:
- use his/her knowledge of genetic principles to understand the diversity of organisms
- analyse the possibilities of using the knowledge from the field of genetics in everyday life

Subject Matter
- molecular and cellular fundamentals of heredity
- heredity and mutability
- human genetics
- population genetics

Source: The educational content of molecular biology in the Framework Education Programme for Secondary General Education (Grammar Schools).
Edition 2007, p. 34.
Molecular biology in SEP – cluster analysis

Cluster analysis:

- 106 SEPs in analysis (27.8% of all grammar schools)
- k-means clustering
- subsequent chi-square test for independence (p < 0.0003)
- 3 clusters of SEPs

### Cluster 1

<table>
<thead>
<tr>
<th>Grade 9</th>
<th>Grade 10</th>
<th>Grade 11</th>
<th>Grade 12</th>
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<td>SEMINAR</td>
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49.1% of grammar schools (n = 52)

### Cluster 2

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31.1% of grammar schools (n = 33)

### Cluster 3

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19.8% of grammar schools (n = 21)
Molecular biology in SEP – educational content analysis

Grammar schools with an optional subject focused on molecular biology
Molecular Biology Seminar – Palacký Grammar School

- optional subject of instruction, since the school year 2005 – 2006;
- scheduled for grade 12 students with deep interest in biology;
- altogether 145 students successfully participated in this seminar (which is 15.8 % of school graduates during the period 2006 – 2014)
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1) „Journal Club“ – critical discussion of non-fiction and scientific papers in the classroom

- an effort to reduce the gap between the educational content of molecular biology in textbooks and the current state of scientific knowledge in the field
- we prepared worksheets for students with questions about the content of each paper to facilitate reading and comprehension of the text (and the discussion of the article)
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2) Bioinformatics tasks – inquiry-based analysis of the biological data

- lessons performed in the computer classroom equipped with interactive whiteboard
- simple bioinformatics tasks included analysis of DNA and protein sequences, computer based 3-D visualization of virus particles and protein structure and construction of phylogenetic trees
- teaching activities were either adopted and modified from educational literature or newly developed
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3) Laboratory exercises: hands-on activities promoting biology inquiries

Simple laboratory exercises:

- DNA extraction from human cheeks cells
- agarose gel electrophoresis using household materials
- observation of mitosis in the onion root tip

Feasibility of advanced laboratory exercises for grammar school students:

a) Laboratory exercise was performed at the grammar school laboratory with equipment from the Mobile Laboratory for Molecular Biology

b) Laboratory exercise was performed as an out-of-school laboratory course at the Faculty of Science, Charles University in Prague
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Three different inquiry-based advanced laboratory exercises were tested:

a) Restriction analysis of bacterial plasmids

b) SDS-PAGE electrophoresis of proteins


c) PCR detection of human CCR5 genetic polymorphism


Brief questionnaire survey at the end of each exercise (five-point Likert type scale items, open-ended questions).
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Students' rating of different aspects of three advanced laboratory exercises in molecular biology.
Data collected during the period 2011 - 2013, n = 353 students.
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Students’ rating of different aspects of three advanced laboratory exercises in molecular biology.
Comparison of the grammar school teacher and the university lecturer.
Thank you for your attention!
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http://www.cetpo.upol.cz/

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