Non-gynecological education of Cytotechnologists

V. Anic, I. Kardum Skelin
Department of Clinical Cytology and Cytogenetics, Merkur University Hospital, Zagreb, Croatia
Many years of following the changes in cytodiagnostics, positions and workloads of Cytotechnologists in Europe, it is clear that changes in education and additional training of Cytotechnologists are necessary.

Expansion of existing or adoption of other diagnostic tests in cytodiagnostics is required.
Today in most of the European countries cytotechnologists perform screening in gynecological cytology.

Given the changes that are already taking place such as automatization and HPV vaccination, and will be more pronounced in gynecological cytodiagnostics, Cytotechnologists slightly lose their importance, and there will be less and less necessary for the purpose of screening.
There is a need to redirect existing and future generations of Cytotechnologists in other branches of cytodiagnostics such as non-gynecological cytodiagnostic.
Considering that in some European countries exists deficient education in non-gynecological cytodiagnostic, I would like to present a model of education for Cytotechnologists of the Croatian Society for Clinical Cytology of the Croatian Medical Association, which carried out a program of education for Cytotechnologists from 1968. Head of the course till 1993 was a Prof. Inga Črepinko, than prof. Znidarčić and after 2008, Prof. Ika Kardum Skelin.

Lecturers who participate in education are cytologists and cytotechnologists with many years of experience in the diagnostic cytopathology.

After basic education (whether this is a laboratory technician or bachelor) is obligatory one-year training in cytotechnology in duration of 630 teaching hours (lectures, seminars and practice) including 200 hours of practical training.
Most of the lectures relates to gynecological cytology, but it also includes training in non gynecological cytodiagnostic - exfoliative and aspiration cytology.

The curriculum in order to provide a quality basic education of Cytotechnologists includes assistance in taking samples, the principles of cytopreparation and the cytological evaluation of cell samples with an emphasis on pre-screening of cytopathology specimens from all non-gynecological body sites.
Example of education from non gynecological cytology which has a very high quality educational base and can easily be expanded with additional required courses.
What this education provides?

- Assisting and preparation of smears at aspiration and biopsies of bone marrow, lymph nodes, breast, thyroid, salivary glands, abdominal organs and other soft tissue tumors under ultrasound control - and CT.

- Basics of collecting samples for additional tests: immunophenotyping, genetics, molecular methods, microbiology and others.
Download and processing of bronchoscopic materials

Processing and knowledge how the smear sputum, urine, gastric juice, cyst and effusion.

Preparation and production of cyto-centrifuge sediments.
Fixation and proper staining Papanicolaou, Pappenheim and others.

Cytochemical and immunocytochemical analysis.

The basic principles of chemical reactions - alkaline and acid phosphatase, peroxidase, non-specific esterase, of carbohydrates (PAS), lipids, iron, AgNOR, Feulgen etc.

Introduction of other technologies: cytogenetics, immunophenotyping, polymerase chain reaction (PCR) and others.
Theoretical and practical knowledge from obtaining and processing of material to microscopic examination and differentiation of normal, inflammatory and pathologically changed cells in the following cytodiagnostic fields:

- gastroenterology
- urology
- breast
- endocrinology
- hematology
- pulmology
- effusions
- cerebrospinal fluid and musculoskeletal system
- other organs, tumors
Microscopic control of stained smears:

- Quality assessment of stained smears: cellularity, accuracy of smearing, quality of the staining.

- Microscopic examination ("screening") of stained smears, identification of normal cells, inflammatory and degenerative changes, atypical and tumor cells.

- Labeling foreign, suspicious or atypical cells on slides.
Semi-quantitative analysis in cytological smears: determination of certain types of cells in the blood smears, in fine needle aspirates and other samples.

Determination of the level of enzymatic activity in individual cells ("score"), analysis of other cytochemical and immunocytochemical reactions.

Determination of the cells viability.
Covers the theory and practice from the following chapters:

- Anatomy and physiology with selected chapters in pathology and histology of non gynecological tissues and organs: breast, thyroid, gastrointestinal tract, uropoietic system, skin, central nervous system and hematopathology.

- Basic skills in the histopathological laboratory: downloading and processing, fixation, paraffin procedures, HE and special stainings.

- Biology and human genetics - chromatin structure, cell cycle, the human genome, the types and laws in the process of inheritance, the application of genetics in certain areas of medicine, laboratory analysis. Cell cultures, the processing of samples for analysis, the preparation of culture media, processing cells, microscopic examination of the specimens.
Chemistry and medical biochemistry.

- Epidemiology of malignant tumors – introduction and methods.

- Theoretical and practical knowledge of the basics of microscopy techniques and types of microscopes - light, phase invert, electron microscope.
Introduction and special techniques in cytodiagnostics: methods of collection, processing and analysis of materials for cytchemical, i.m. analysis, flow cytometry, molecular analysis, computer analysis of the image (morphometry, densitometry, DNA cytometry ...). The principles of flow cytometry, monoclonal and polyclonal antibodies, qualitative and quantitative analysis of the i.m. reaction, the biological behavior of the tumor, kinetic methods, the cell cycle, molecular biology, hybridization and amplification methods.

Preparation of reagents: fixing and staining solutions, buffers, substrate solutions, solutions for contrast-staining etc.
- Safety at work and automatization in laboratory medicine.
- Quality control in laboratory medicine and the organization of medical - laboratory services.
- Basics of medical informatics, computer processing of laboratory data.
- Foreign language - english and elective courses.
- Processing of findings according to the type of samples, issuing and archiving of findings, slides storage, managing of laboratory documentation and computer data processing.

- Inventory guidance and procurement of necessary chemicals and other materials for laboratory work, maintenance and servicing of the appliance.

- The implementation of quality control.
### CURRICULUM OF SPECIALIZED EDUCATION IN CYTOTECHNOLOGY

<table>
<thead>
<tr>
<th>Topic</th>
<th>Lectures, seminars, and practice: 630 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basics of microscopy techniques</td>
<td></td>
</tr>
<tr>
<td>Selected topics in biology and human genetics</td>
<td></td>
</tr>
<tr>
<td>Selected topics in chemistry</td>
<td></td>
</tr>
<tr>
<td>Epidemiology of malignant tumors</td>
<td></td>
</tr>
<tr>
<td>Basics of medical informatics</td>
<td></td>
</tr>
<tr>
<td>Selected topics in pathology</td>
<td></td>
</tr>
<tr>
<td>Introduction to cytodiagnostics</td>
<td></td>
</tr>
<tr>
<td>Special techniques in cytodiagnostics</td>
<td></td>
</tr>
<tr>
<td>Cytodiagnostics in gynecology</td>
<td></td>
</tr>
<tr>
<td>Cytodiagnostics in pulmonology</td>
<td></td>
</tr>
<tr>
<td>Cytodiagnostics in hematology</td>
<td></td>
</tr>
<tr>
<td>Cytodiagnostics in urology</td>
<td></td>
</tr>
<tr>
<td>Cytodiagnostics in gastroenterology</td>
<td></td>
</tr>
<tr>
<td>Cytodiagnostics of breast</td>
<td></td>
</tr>
<tr>
<td>Cytodiagnostics of thyroid</td>
<td></td>
</tr>
<tr>
<td>Cytodiagnostics of cerebrospinal fluid and effusions</td>
<td></td>
</tr>
<tr>
<td>Cytodiagnostics of locomotor system</td>
<td></td>
</tr>
<tr>
<td>Professional practice: 200 hours</td>
<td></td>
</tr>
<tr>
<td>----------------------------------</td>
<td></td>
</tr>
<tr>
<td>Cytodiagnostics in gynecology: 80 hours</td>
<td></td>
</tr>
<tr>
<td>Cytodiagnostics in pulmonology: 40 hours</td>
<td></td>
</tr>
<tr>
<td>Cytodiagnostics in hematology: 40 hours</td>
<td></td>
</tr>
<tr>
<td>Cytodiagnostics of other areas: 40 hours</td>
<td></td>
</tr>
</tbody>
</table>
Upon passing exams and completed practical training, students take the final exam. The final exam consists of practical and theoretical parts, and includes all the listed courses of cytodiagnostic.

This model of education is a good example of the basic educational program that can be easily extended with additional classes due to requirements imposed by the implementation of new technologies.

This model provides an educated cytotechnologists that after the training have the basic skills and knowledge from a wide range of cytological preparations, procedures and technologies used in cytopathology.

In this way cytotechnologists can easily accept tasks from non gynecological cytology and thereby maintain their position in cytodiagnostics.
asistiranje i izrada preparata pri punkcijama i biopsijama koštane srži, limfnih čvorova, dojke, štitnjače, žlijezda slinovnica, abdominalnih organa te ostalih meko tkivnih tumora pod kontrolom UZV – a i CT – a

• preuzimanje i obrada materijala pri bronhoskopskim analizama u pulmološkoj citodijagnostici

• obrada i način razmazivanja sputuma i urina, želučanog soka i izljeva, sadržaja cista

• fiksiranje i odgovarajuće bojanje razmaza – fiksiranje i bojanje po Papanicolaou i Pappenheimu, bojanje i fiksiranje za citokemijske i imunocitokemijske analize

• sudjelovanje u dodatnim tehnologijama iz citološkog uzorka: imunofenotipizaciji ( IF ), lančanoj reakciji polimeraze (PCR), citogenetici...

• mikroskopska kontrola razmaza: pregled obojenog razmaza s obzirom na procjenu kvalitete razmazivanja i bojanja te količine materijala u razmazu

mikroskopski pregled (“skrining”) čitavog razmaza, identificiranje stanica normalnog tkiva u određenom materijalu: upalnih, degenerativno promijenjenih te atipičnih i tumorskih stanica

označavanje stranih i suspektnih stanica na preparatima

probir suspektnih i pozitivnih nalaza

semikvantitativna analiza u citološkim razmazima: određivanje pojedinih vrsta stanica u razmazima krvi i razmaza drugih uzoraka

određivanje stupnja enzimatske aktivnosti u pojedinim stanicama ( "score" )

određivanje odnosa vitalnih i nevitalnih stanica

• priprema reagencija za rad: otopine za fiksiranje i bojanje, puferi, otopine supstrata, otopine za kontrastno bojanje pojedinih dijelova stanice, druge tehnologije

• obrada nalaza prema vrsti uzoraka: izdavanje nalaza, arhiviranje i slaganje nalaza, slaganje zbirki preparata, vođenje stručne laboratorijske dokumentacije, priprema za kompjutersku obradu podataka

• vođenje inventara: postupak oko nabave potrošnog materijala, sitnog inventara i osnovnih sredstava za potrebe kliničko–citološkog laboratorija, briga oko uzdržavanja i servisiranja aparature te popravka pribora u laboratoriju

• provođenje kontrole kvalitete

Nakon bazične edukacije citotehnologa na visokim i srednjim učilištima obavezna je jednogodišnja specijalistička edukacija u trajanju od 630 nastavnih sati, uključujući i praktični dio edukacije.