



Genetics Technology

Genetics Technology

- The program consists of 2 sub-disciplines
 - Molecular Genetics (MG)
 - Cytogenetics (CG)
- Clinical sites where you may be placed for training span the country from Alberta to Newfoundland
 - Ontario, Alberta, Saskatchewan, Nova Scotia, Newfoundland

Program Structure

- 17 months in length
- Two 13 week didactic semesters running from September to April
- One 12 week semester of Simulated Clinical at The Michener Institute from May to July
- 18 weeks of Hospital Clinical from September to January
 - Cytogenetics and Molecular

Program Structure

Hours of the Program:

- **Didactic:** 5 days a week, ~ 6 hours a day
– homework most nights & weekends
- **Simulated clinical:** 5 days a week, 5 hours a day
- **Clinical:** 5 days a week, 7 hr days, start/end times vary depending on hospital schedule

Program Structure

- Tuition information is available on the Michener website <http://www.michener.ca/>
- Upon successful completion of the course you are eligible to write a national certification exam with the CSMLS www.csmls.org

Working as a Technologist

- You must register with the CMLTO to obtain a license to work in Ontario www.cmlto.com
- You require a successful CSMLS exam result as evidence to obtain your licence
 - Outside of Ontario: Check with the individual provinces for specific regulatory requirements.
- Typical work schedules are 7-7.5 hrs/day, 5 days/week, some labs have weekend hours but no shifts
- Starting salary is approximately \$50,000
- **Location and availability of jobs varies from year to year**

Important Questions to Ask Yourself as you are considering Genetics Technology

- 1) How do you feel about working with human blood, amniotic fluid and tissues from miscarried or aborted fetuses?
- 2) Are you aware that women may make decisions to terminate pregnancies based on your work?
- 3) Will you be comfortable working in an environment with chemical, biological and radioactivity hazards?
- 4) Would you be able to sit at the microscope and concentrate for large periods of the day?
- 5) Are you aware that your results may influence the type of treatment a patient may receive for leukemia or other malignant condition?
- 6) Can you work quickly and accurately under pressure?

Standards

- Samples are prioritized according to urgency
- Turn around time (TAT) standards are set by hospital, lab director and regulating bodies.
 - e.g. Prenatal samples have a shorter TAT than adult bloods due to nature of the sample

Quality Control

- Procedure for processing a sample is standardized within a laboratory
- Following standard operating protocols (SOPs) reduces potential for errors to occur
- Technologists must follow the protocol that has been validated and tested for that lab
- Patients depend on you to do the right test to the right sample at the right time and do it correctly

Specimen Handling

- **Receipt of Specimens**

- Accessioning, checking reason for referral, prioritization of specimens
 - Verifying patient identification
 - Ensuring specimen is suitable and adequate for testing
- **Handling biological specimens** – one must treat every specimen as though they are infected with a contagious organism
- Safety is paramount to protect yourself and your coworkers

Cytogenetics

- Look at whole chromosomes down the **microscope**
- 46 chromosomes (23 pairs)
- Look at G banding pattern and number of chromosomes in metaphase
 - Abnormalities include additions, deletions, rearrangements, and aneuploidies

Cytogenetic Samples

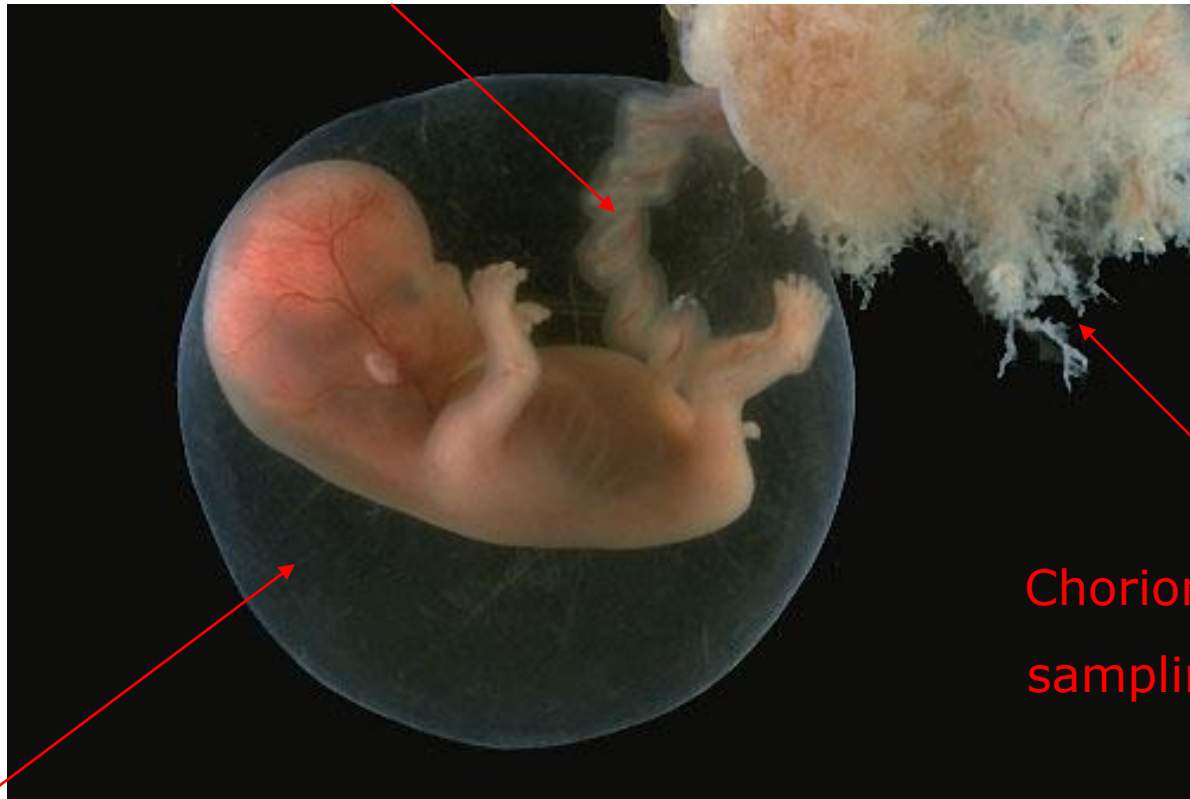
- Blood
- Amniotic fluid
- Chorionic villus sampling (CVS)
- Bone marrow
- Tissue
- Tumours
- Products of conception from miscarried or terminated pregnancies

Cytogenetics- Reasons for Testing

1. Fertility Problems
 - Couples with >2 miscarriages
2. Family History of Chromosome Abnormality
3. Prenatal Testing
 - higher risk for fetuses associated with advanced maternal age (>35)
4. Stillbirth & neonatal death
5. Problems of early growth & development
6. Neoplasia
 - Provide useful diagnostic or prognostic information (eg. Hematological malignancies)

Cytogenetics: Prenatal Testing

Cordocentesis



Chorionic villus
sampling (CVS)

Amniocentesis

Cytogenetics Procedures

- **Tissue Culturing – Short Term vs. Long Term Cultures**
 - Short Term (2-3 days): Blood
 - PHA (mitogen) stimulates cell growth/division
 - Long Term (7-10 days): AF, CVS, Fetal tissues
 - Factors affecting growth (eg. Cell type, media, environmental conditions)
 - Sterile culture techniques very important
 - > risk of contamination

Cytogenetics Procedures (cont'd)

- **Harvesting**

- Arrest cells in metaphase using specific chemicals
 - Automation is available for some harvesting
 - Use of robotic harvester (TECAN) for long term cultures



Images taken at Mount Sinai Hospital
Cytogenetics Lab

- Manual harvesting done for bloods

Cytogenetics Procedures (cont'd)

- **Slidemaking**

- Slidemaking chambers provide a constant temperature & humidity for slidemaking

- **Banding**

- Routine method employed is the G-Banding Technique - employs enzyme treatment and Giemsa stain to visualize the chromosomes
- Additional stains: C-staining, Ag-NOR staining, Q-banding

Cytogenetics Procedures (cont'd)

- **Analysis and Reporting**

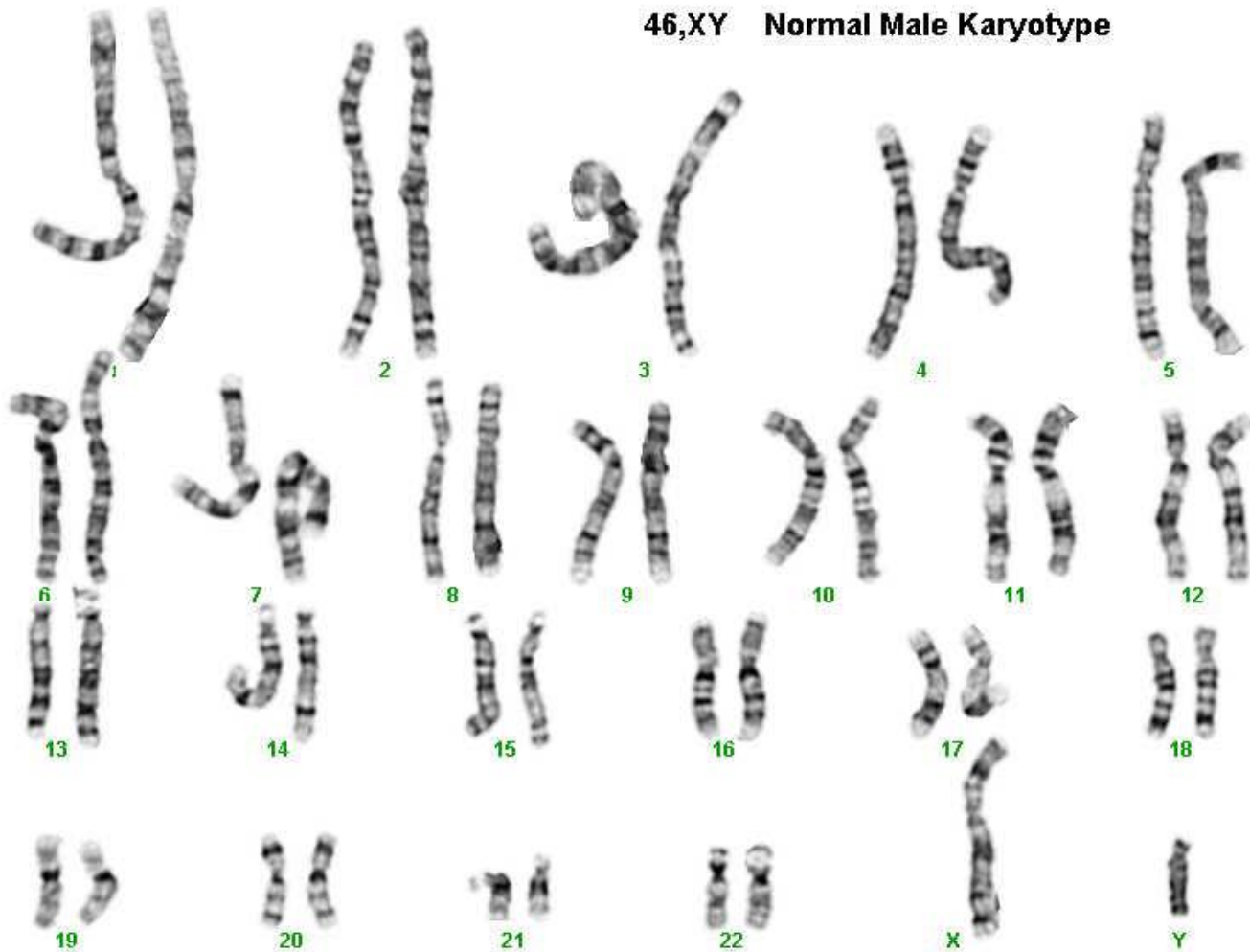
- Microscope analysis is a large part of the technologist's work day
- Chromosomes that are visualized at the microscope are then imaged using a computer imaging system
- Cases are checked by an experienced technologist and the report is generated by the Cytogeneticist (Lab Director)
- Report is sent to Physicians or Genetics Counsellors for communication to the patient

Patients are counselled on test results and make healthcare decisions based on the results that genetics technologists provide to their physician

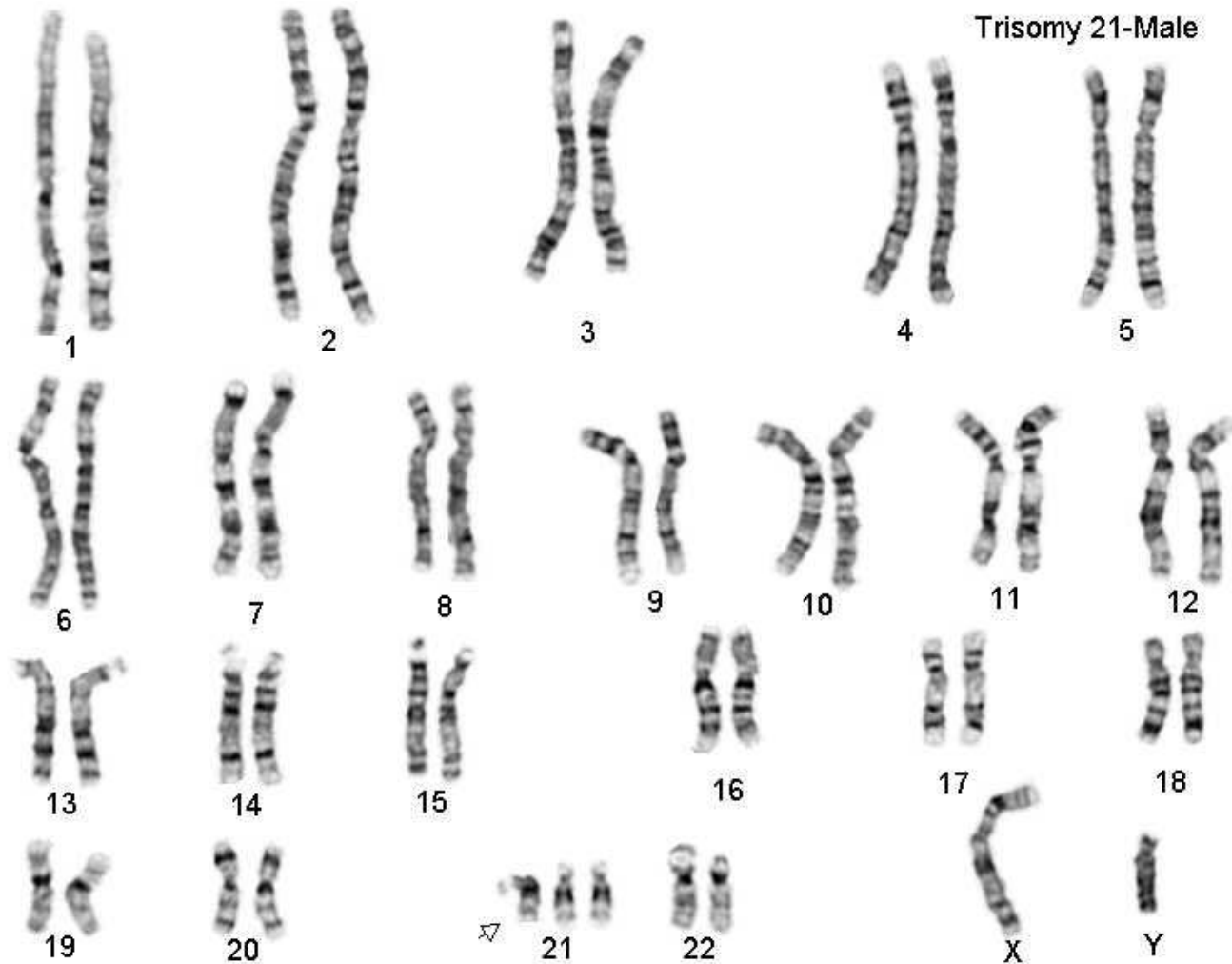
What you see under the microscope:



Karyotype



Karyotype – Down Syndrome



Cytogenetics – FISH

- Fluorescence In Situ Hybridization
- Sometimes called “Molecular Cytogenetics”

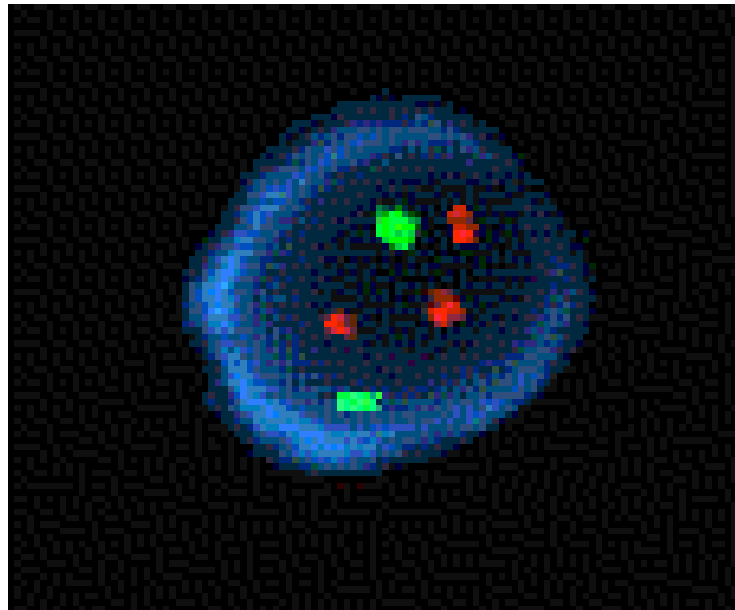
Interphase FISH

- Used in prenatal diagnosis to rule out common aneuploidy of X,Y, 13, 18 & 21.
- Metaphase FISH
- Other: M-FISH and SKY

Cytogenetics - FISH

eg. Down Syndrome

- 3 copies of chromosome 21 (red)



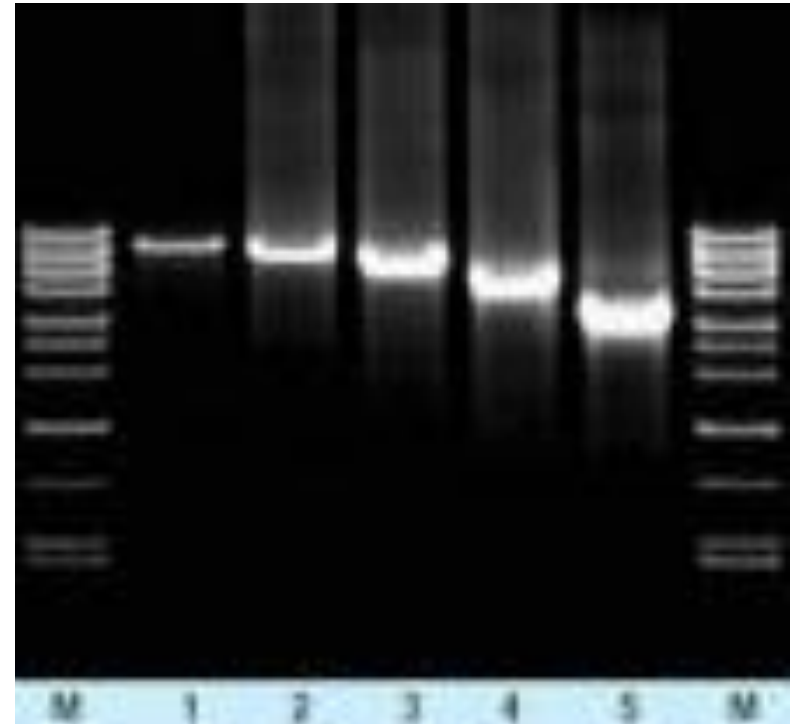
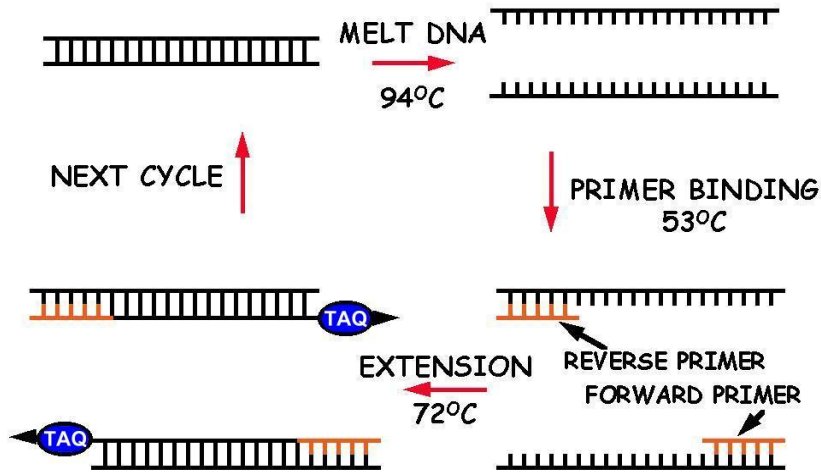
Molecular Genetics

- Each lab tests for different disorders:
 - e.g. HD, BRCA, CF, Thalassemia, Thrombophilia, CML
- Samples for testing include:
 - any bodily fluid or tissue
- Unlike in cytogenetics, samples are batched together for analysis
 - have to take care not to mix up samples

Techniques in Molecular Genetics

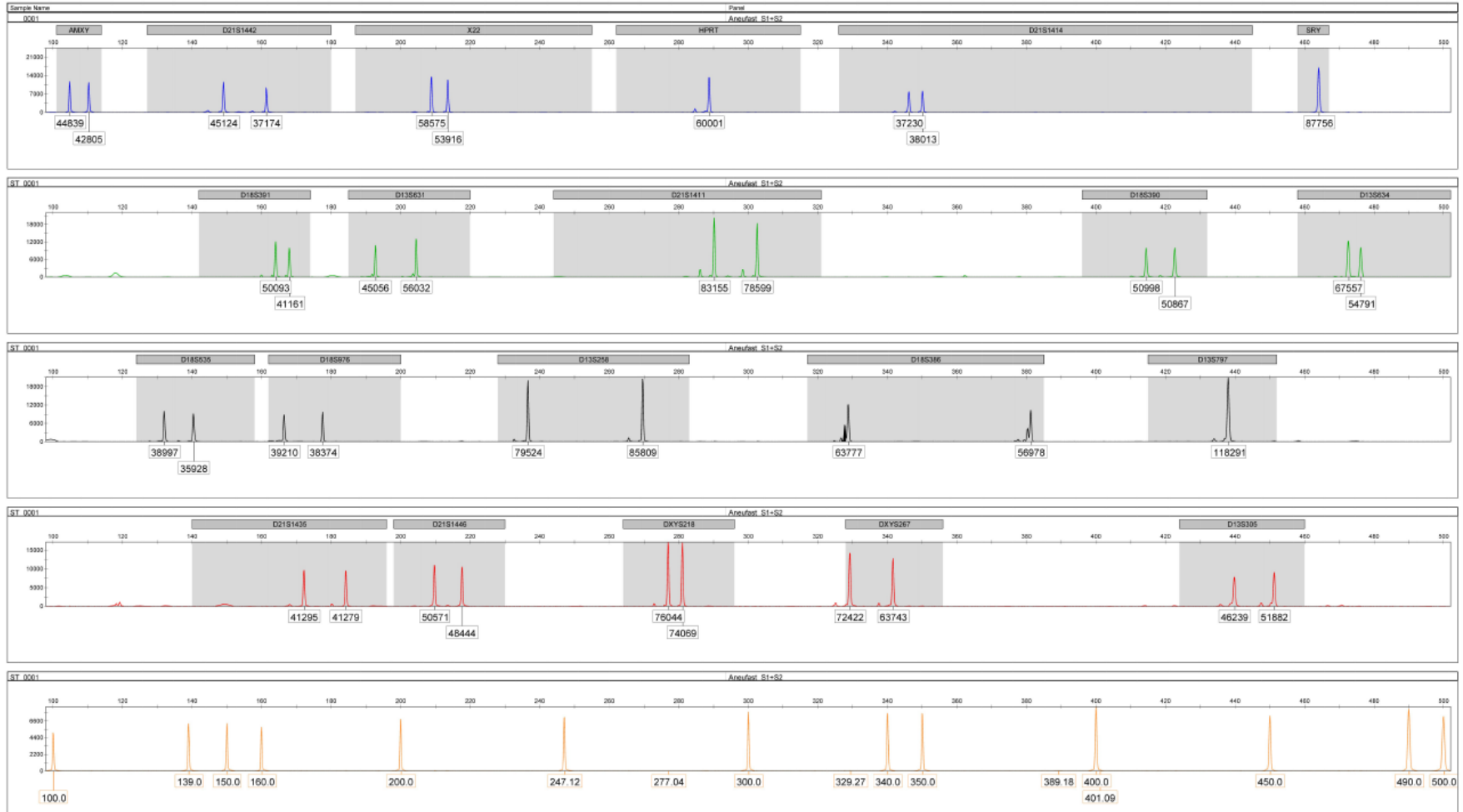
- Extraction for DNA and RNA
- PCR
- Fluorescent PCR
- Real-time PCR
- QF-PCR
- RT-PCR
- Fluorescent Sequencing
- Next Generation Sequencing
- MLPA
- Microarray

PCR



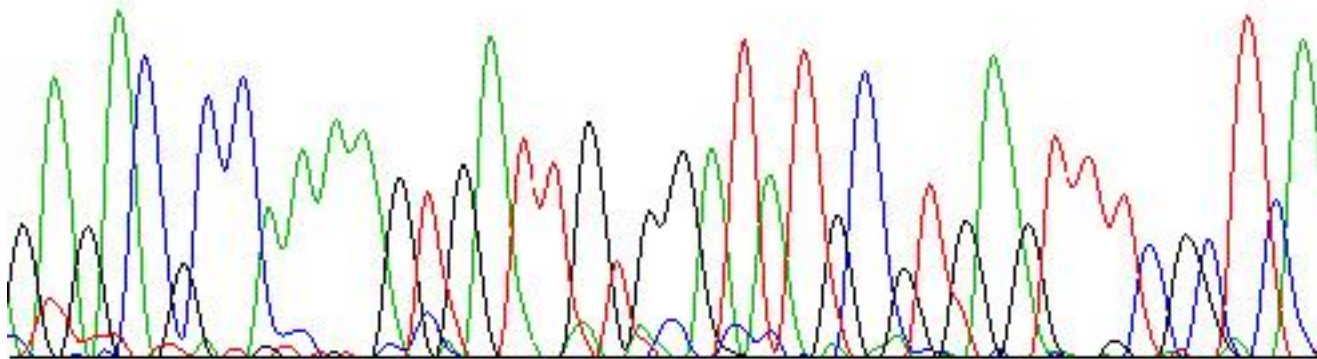
QF-PCR

Applied Biosystems
GeneMapper Software 5

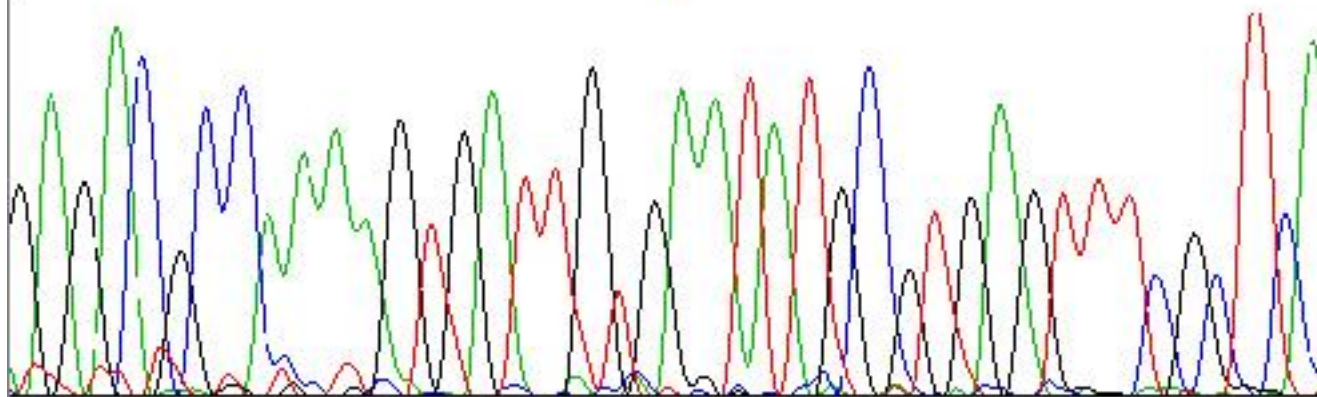


Fluorescent Sequencing

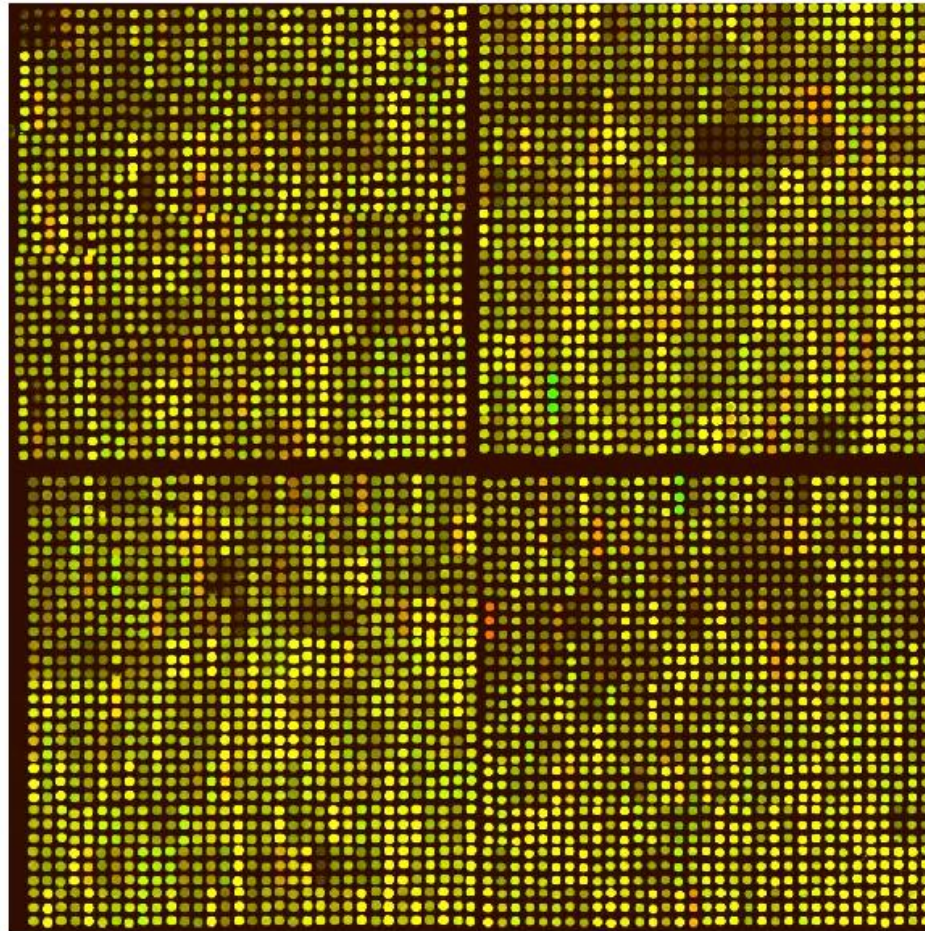
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E T P K V I V D M R E F R S



G A G A C G C C A A A A G T G A T T G T G A A T A T G C G T G A G T T T C G C T C A
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Microarray



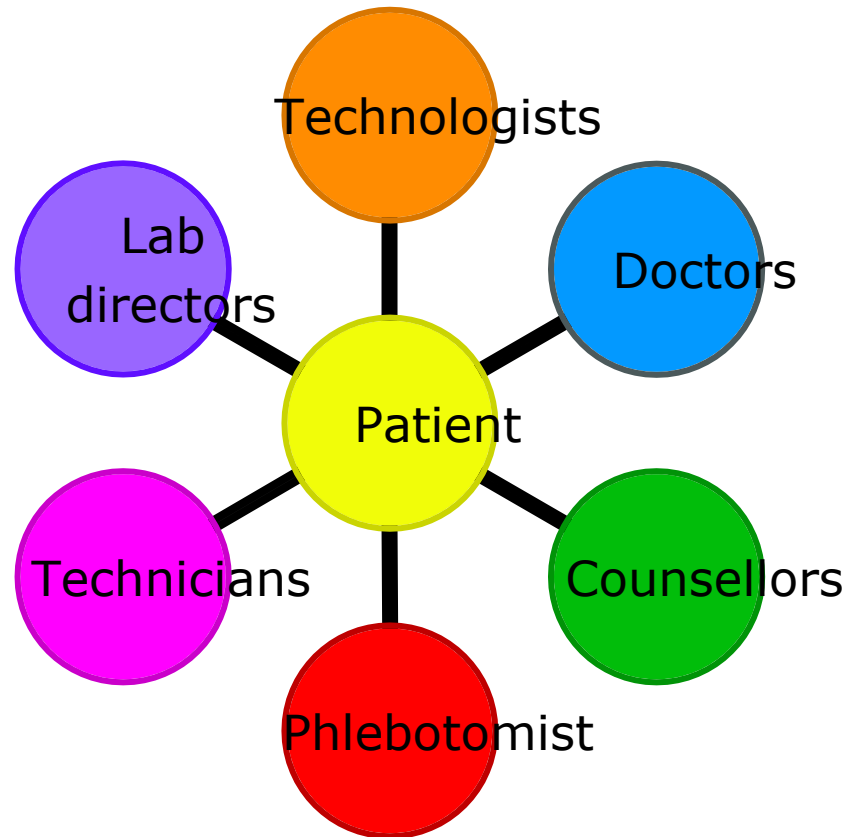
Genetics Technology: Important Facts

- There is almost no patient contact
 - Communication with patients is through the genetic counselors and physicians
 - As a technologist you may be present for sample procurement (e.g. bone marrow aspiration)
- There is a lot of paperwork associated with the job
 - Tracking down samples, maintaining quality control documentation, transcribing information, accurate reporting of results are some examples

Genetics Technology: Important Facts

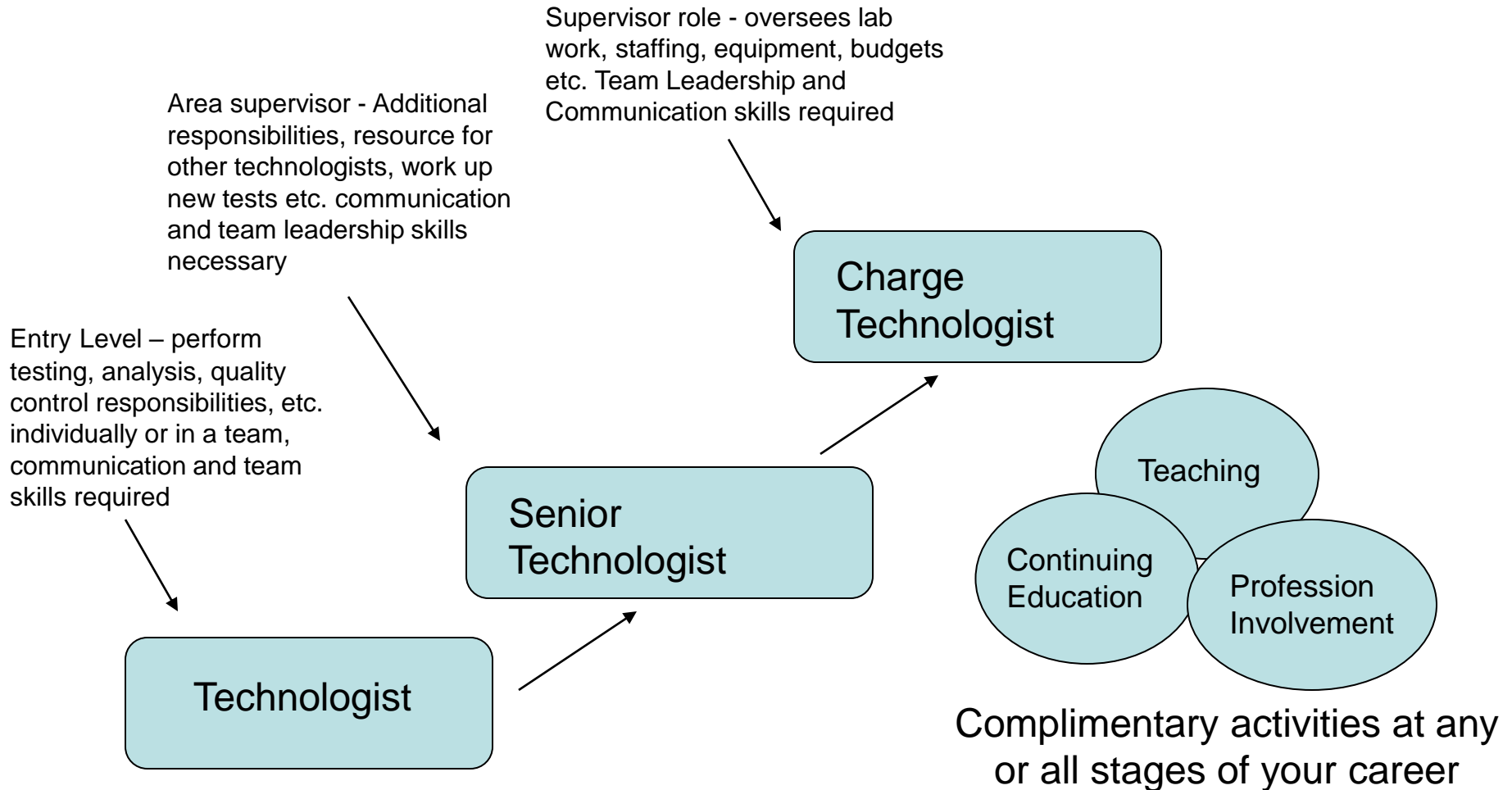
- Working under time pressures while maintaining accuracy is critical e.g. Prenatal cases, STAT cases
- Multitasking is an essential skill
- Molecular analysis involves significant use of different computer software
- Cytogenetics involves hours of microscope work
 - May lead to eye strain, headaches, neck or back strain
- You will encounter many hazards
 - Biological ~ HIV, AIDS, Hepatitis
 - Chemical ~ Acids, bases, carcinogens, etc ...
 - UV light

The Genetics Team



We are all here to serve the patient!

Career Path



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