



# 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](http://www.csmls.org)

# Working as a Technologist

- You must register with the CMLTO to obtain a license to work in Ontario [www.cmlto.com](http://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

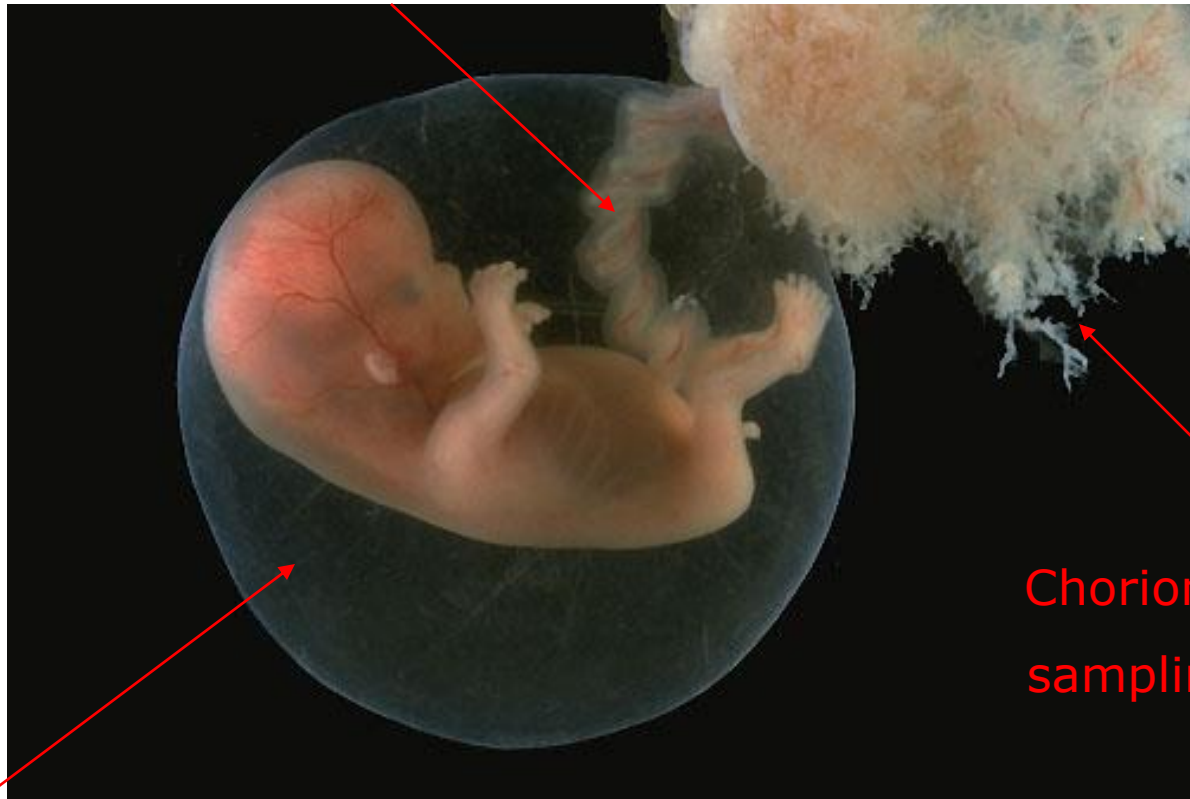
- Blood
- Amniotic fluid
- Chorionic villus sampling (CVS)
- Bone marrow
- Tissue
- Tumours
- Products of conception from miscarried or terminated pregnancies

# 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**

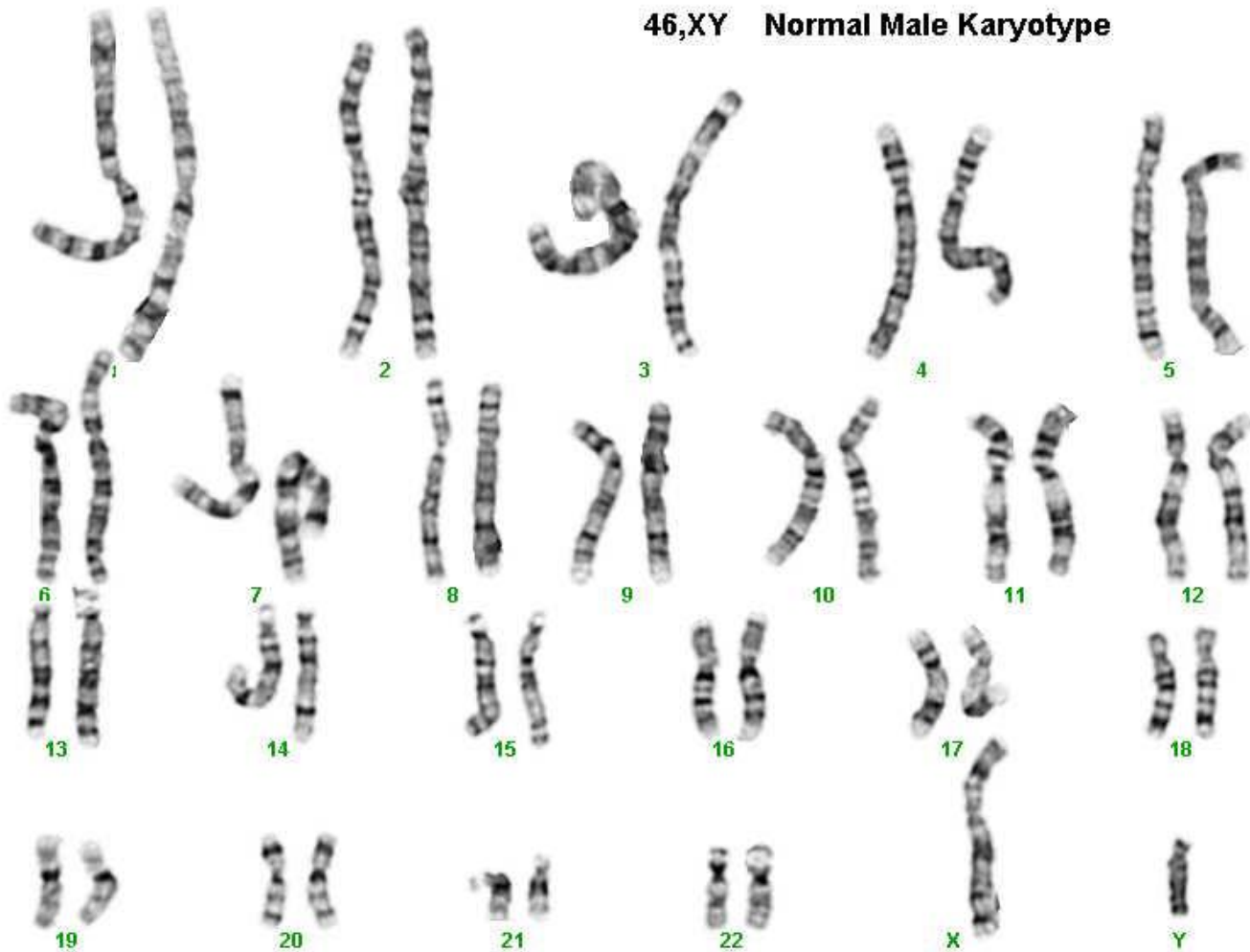
- Microscope analysis is a large part of the technologist's work day
- Chromosomes that are visualized at the microscope are then imaged using a computer imaging system
- Cases are checked by an experienced technologist and the report is generated by the Cytogeneticist (Lab Director)
- Report is sent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

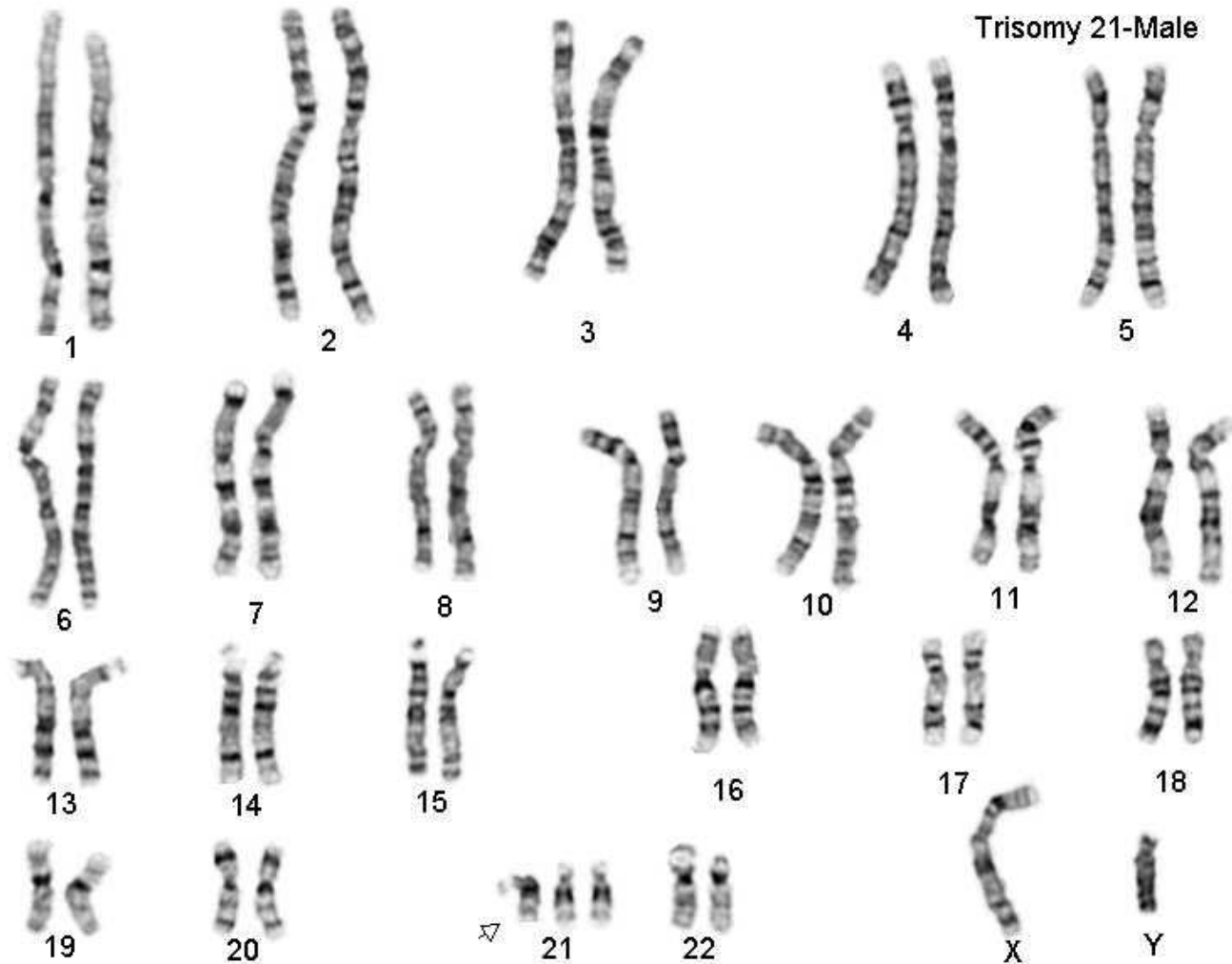
# What you see under the microscope:



# Karyotype



# Karyotype – Down Syndrome



# Cytogenetics – FISH

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

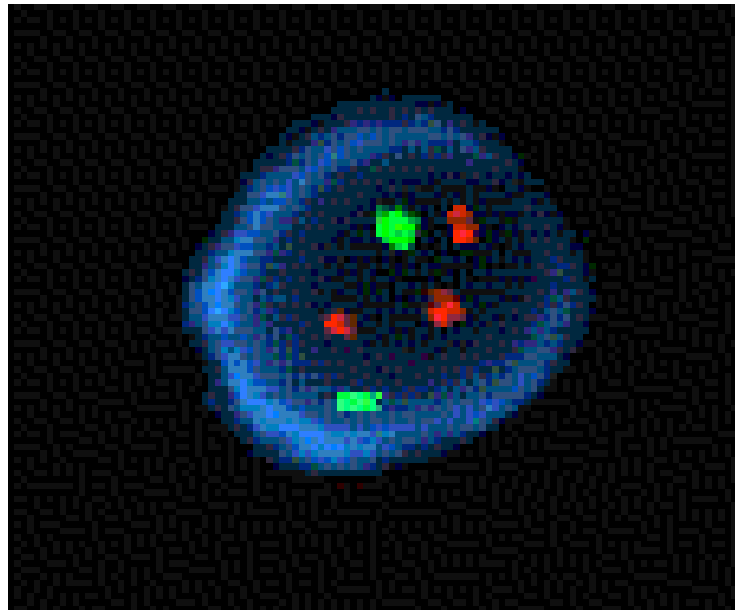
## Interphase FISH

- 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

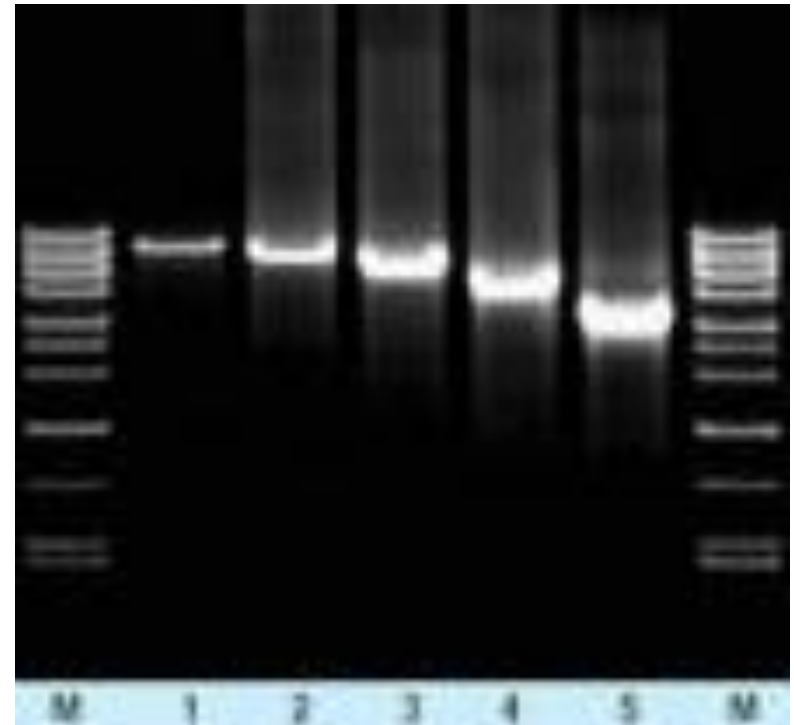
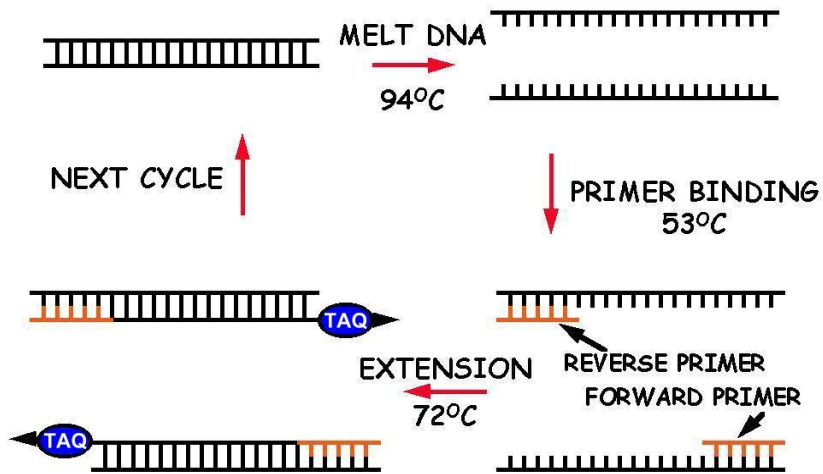
- Each lab tests for different disorders:
  - e.g. HD, BRCA, CF, Thalassemia, Thrombophilia, CML
- Samples for testing include:
  - any bodily fluid or tissue
- Unlike in cytogenetics, samples are batched together for analysis
  - have to take care not to mix up samples



# Techniques in Molecular Genetics

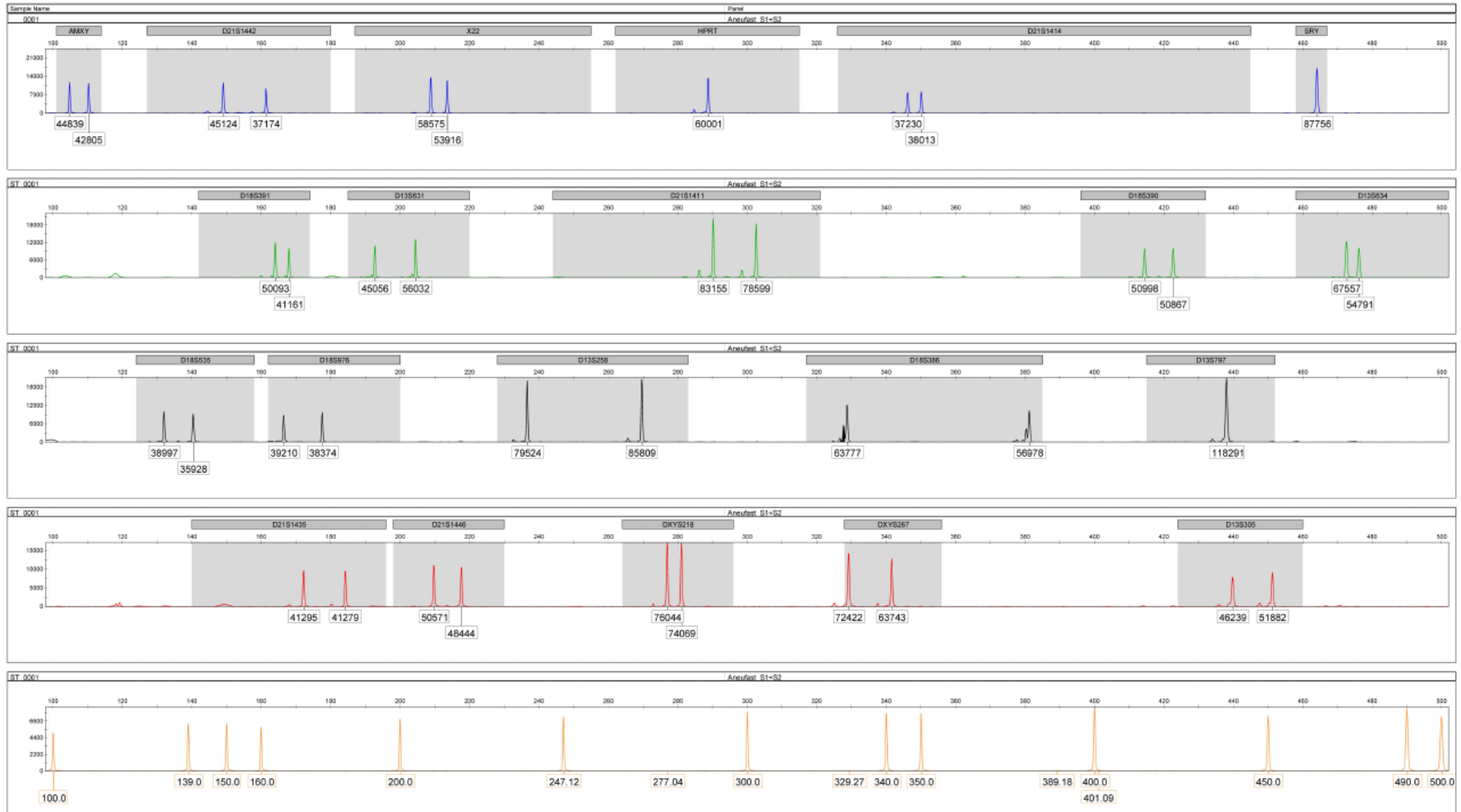
- Extraction for DNA and RNA
- PCR
- Fluorescent PCR
- Real-time PCR
- QF-PCR
- RT-PCR
- Fluorescent Sequencing
- Next Generation Sequencing
- MLPA
- Microarray

# PCR



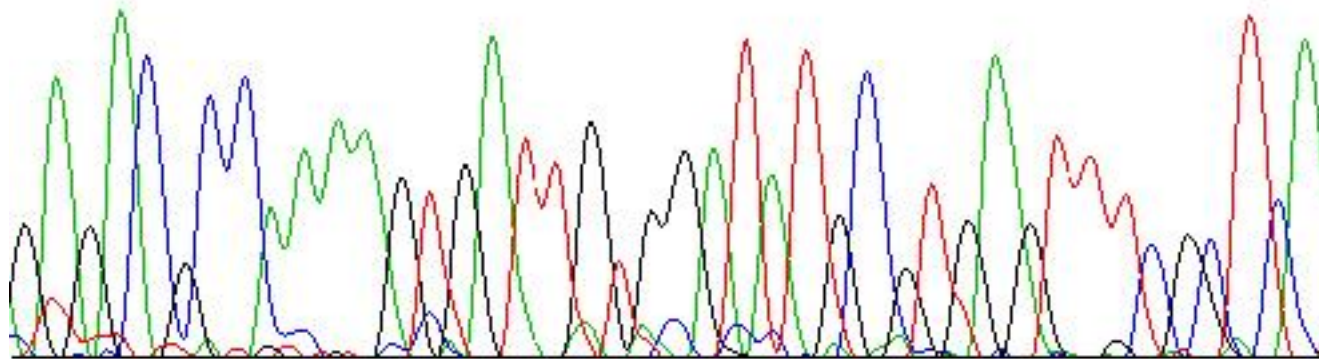
# QF-PCR

Applied Biosystems  
GeneMapper Software 5

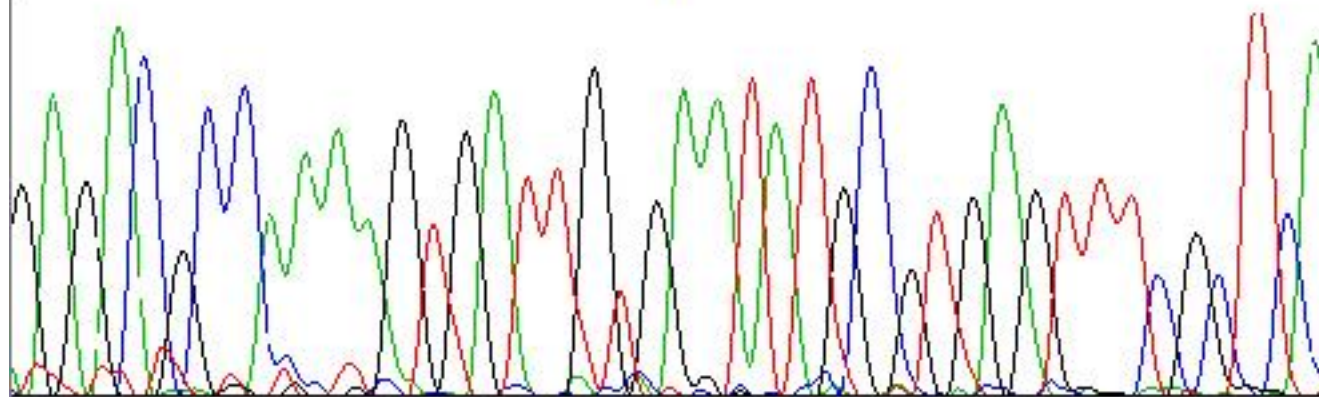


# Fluorescent Sequencing

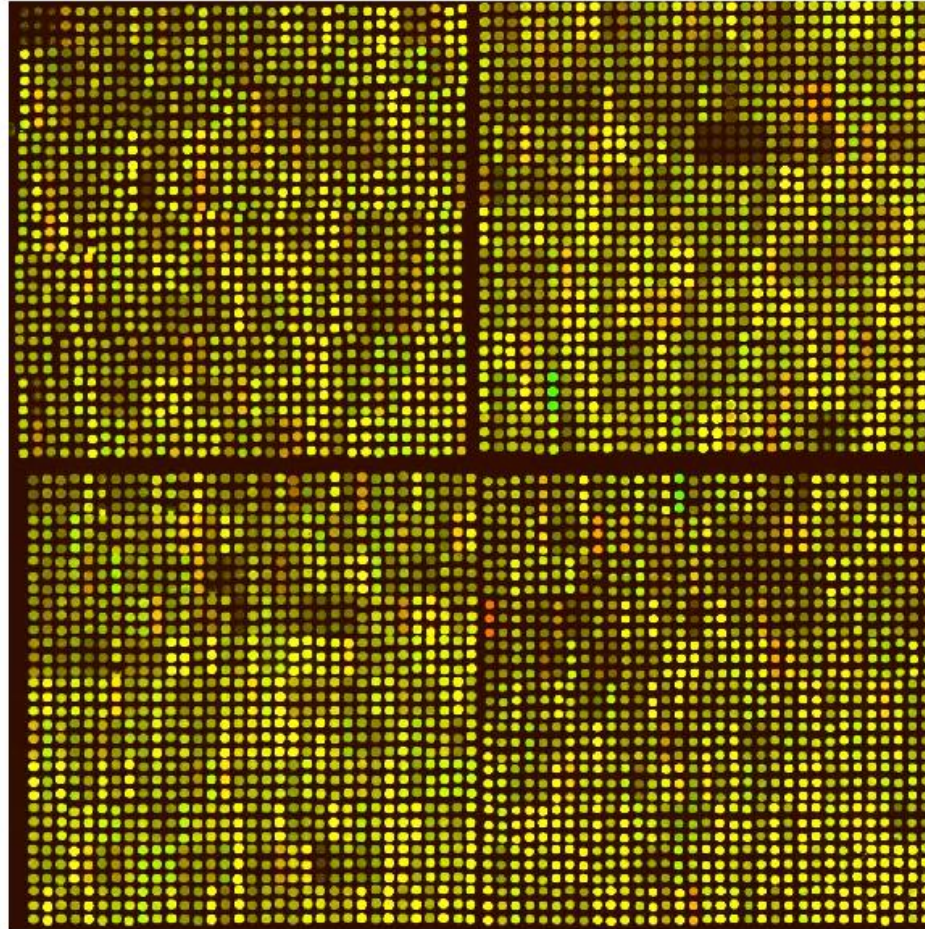
G A G A C G C C A A A A G T G A T T G T G G A T A T G C G T G A G T T T C G C T C A  
E T P K V I V D M R E F R S



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



# Microarray



# Genetics Technology: Important Facts

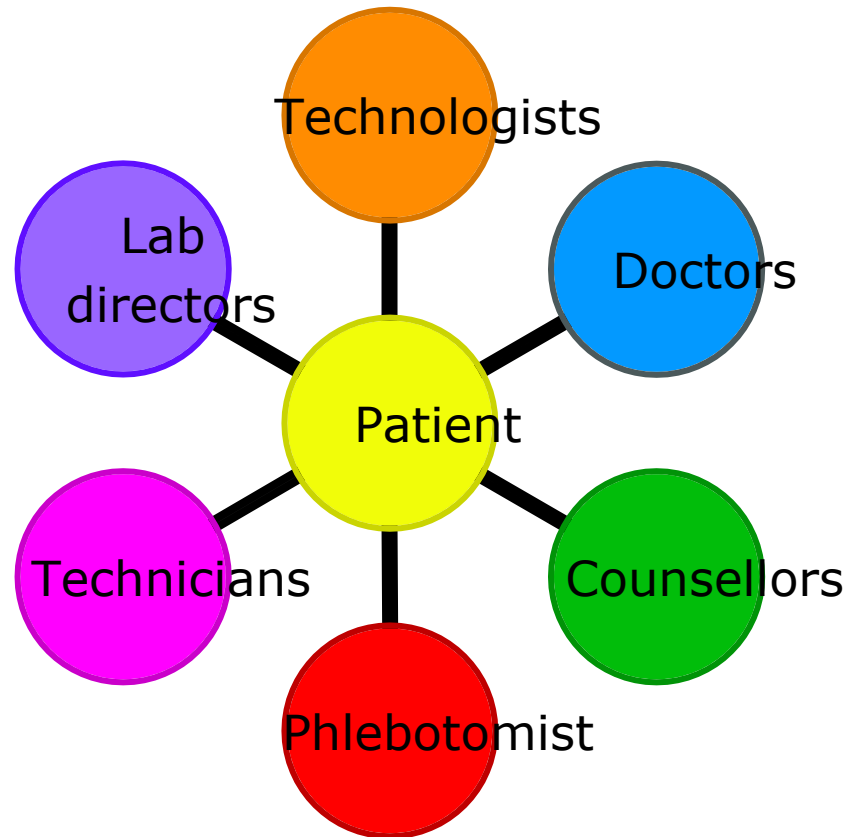
- There is almost no patient contact
  - Communication with patients is through the genetic counselors and physicians
  - As a technologist you may be present for sample procurement (e.g. bone marrow aspiration)
- There is a lot of paperwork associated with the job
  - Tracking down samples, maintaining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

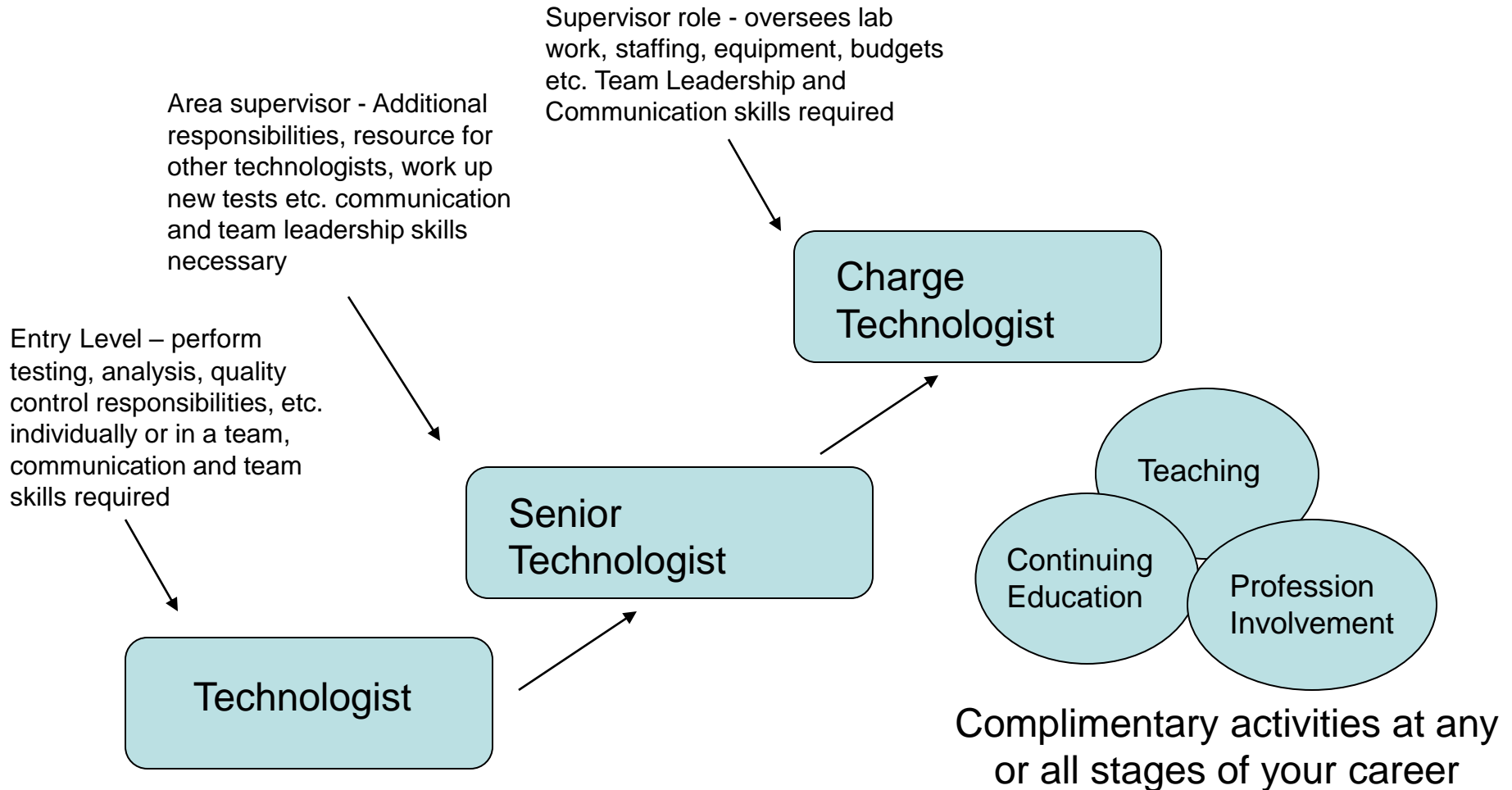
# The Genetics Team



We are all here to serve the patient!



# Career Path



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