**Background:**

**Karyotype Lab**

Chromosome mutations (changes in the number or parts of chromosomes) are the cause of several human genetic disorders. A common technique for detecting these disorders is to create a **Karyotype**. A karyotype is an arrangement of homologous chromosomes. **Homologous chromosomes** are chromosomes which are the same length, the same shape, have the same location of their centromere and have the same banding pattern.

Karyotypes can be used to find several different types of information. One of them is the gender of a subject. Female humans have twenty three pairs of homologous chromosomes. Male humans have twenty two pairs of homologous chromosomes and one non-homologous pair. This means that in males, the twenty third pair does not match. Females are said to have two “X” chromosomes while males have an “X” chromosome and a “Y” chromosome.

**Objectives:**

In this exercise you will prepare a karyotype. You will arrange the chromosomes in the sample to help determine the disorder that is affecting the patient. Then you will write up a full lab report to help inform the patients and their families if there is a genetic abnormality.

**Procedure:**

1. Find the sample of chromosomes that has been given to your lab.
2. Arrange the chromosomes that you have in your sample. Match the chromosomes based on the banding patterns and centromeres. You may also use the sample reference sheet that is included in your packet. Arrange the chromosomes side by side and paste them onto the sample sheet.
3. Once the chromosomes are arranged correctly, identify the genetic abnormality that is present in your sample. Be sure to circle the genetic abnormality that you have found.
4. Fill out the Cytotechnician Report that is attached in your packet. Be sure to include all information that is needed.

**List of Diseases:**

1. **Down’s Syndrome** (Trisomy 21) – Occurs in about 1 in every 660 births of both sexes. 40% of Down’s individuals are female. The frequency of Down’s appears to increase with the age of the mother because females are born with all of their eggs on hold in prophase 1 of meiosis. Environmental factors can then act on the eggs of the lifetime of the mother. In 50% of the Down Syndrome births, the mother is over 40 years of age.

Physically, Down’s individuals have a small round face with a flat profile, flat nasal bridge, small ears, epicanthic eyelid folds and their tongue protrudes because the mouth can often be small. Other physical features include short stature, broad hands, curved pinky, stubbed fingers and toes, double jointedness, rough and highly elastic skin and an abnormally small pelvis.

Intellectually the IQ tends to decrease with age. An average IQ for a 5 year old is 50 and the average IQ for a 38 year old is 15. With proper care and guidance the IQ can exceed 80. The

The life expectancy of a 1 year old diagnosed with this disorder is 23 years. But 25% die before the age of 1. However 15% do survive past 40. However, recent medical advances are increasing the life expectancy for those with Down’s Syndrome.

1. **Edward’s Syndrome** (Trisomy 18) – occurs in about 1 in every 8,000 births of both sexes. 80% of Edward’s individuals are female. The average age of parents is 32.5 for mothers and 34.9 for fathers.

Physically, Edward’s individuals have an elongated skull, a small mouth, with small teeth, a high arched palate and mouth, a harelip, a cleft palate and deformed ears. Other physical traits are their feet can have reversed arches, they have mottle skin a narrow pelvis and deformed sternum. Heart, kidney and brain defects are all very common, leaving many patients physically and mentally handicapped.

During pregnancy there is low fetal activity and many fetuses die before they are born. Those that are born have a life expectancy of around 10 weeks. Of those that survive until birth, 50% die within one week and 5% - 10% die within one year.

1. **Klinefelter’s Syndrome** (XXY) – occurs in about 1 in 500 to 1 in 1000 male births. The average age of the mother is 31.7 and the father is 35.5. Klinefelter’s individuals have a normal life expectancy and all are males.

Physically, Klinefelter’s males have a scares beard, an arm span that exceeds their height (as opposed to equal to their height), delicate skin with tendency to acne, poor musculature and female secondary sex characteristics. They are sterile because they have small testes and thus low testosterone levels. They can have broad female like hips.

Klinefelter’s individuals have low mental ability and many have psychotic disorders and social difficulties. Individuals have difficulty with reading and spelling. They also have difficulty forming peer relationships. The mean IQ is 85 to 90 and special education classes are often necessary to help with reading and spelling. Testosterone replacement therapy beginning at age 11 or 12 can help individuals develop during puberty.

1. **Patau Syndrome** (Trisomy 13) – occurs in about 1 in 5000 births of both sexes. The average age of the mother is 31.6 and of the father is 34.5.

Physically, patau individuals have small heads, small or missing eyes, low set ears, a broad nose and a cleft lip/palate. They are polydactyl (extra fingers), have hearth defects and have cystic kidneys.

The brain has no olfactory bulbs so they have no sense of smell. Patau individuals are mentally retarded. The median survival age is about 2.5 days. Eighty percent die within the first month. Five percent survive the first six months

1. **Jacobsen Syndrome** – With only 20 cases since 1973, this is a very rare disorder. It is due to a deletion in a long segment of chromosome 11. Symptoms include stunted growth, moderate to severe mental deficiencies, a short nose with an upturned lip, a large carp shaped mouth, a small jaw, low set or malformed ears and cardiac defects. All affected individuals are mentally handicapped but generally live long healthy lives. Early death often is related to their cardiac defects.
2. **Cri-du-chat** (Cat Cry Syndrome) – Occurs in an estimated 1 in 50,000 births. It is associated with deletion in a short arm of chromosome 5. The syndrome gets its name from the distinctive high pitched cry from affected infants.

Other symptoms include a low birth weight, small head, wide set eyes, a small jaw, low set ears, skin tags, partial webbing or fusion of fingers and toes and a single line in the palm of the hand. Life expectancy is normal but individuals with the syndrome are usually severely mentally handicapped. Half of the afflicted individuals over the age of 10 have adequate vocabulary and sentence structure to communicate. With special schooling and a supportive home environment, social and psychomotor skills of a normal 5 or 6 year old may be achieved.

1. **Jacobs Syndrome** (XYY Syndrome) – Occurs in 1 in 1000 men. Males with the disorder appear to be normal but mature to be much taller than XY males. Large teeth are common. Individuals tend to be weak and have poor motor coordination. Pectoral and shoulder muscle development is also poor. They are also prone to excessive acne (due to excess testosterone).

They general have a reduced mental capacity. There have also been reports that link them to increased aggression and crime rates. The IQ of Jacobs individuals are usually below the normal IQ for males but can be well below or well above (80 – 140). Jacobs males tend to lead a normal life and produce offspring.

1. **Feingold Syndrome** (Trisomy 9) – is another rare disorder however there is no confirmed incidence rate. Symptoms include growth deficiency, a sloping forehead, deep set eyes, a prominent upper lip covering the lower lip, a bulbous nose with slit like nostrils, a small jaw, low set ears, a narrow chest and abnormal position or function of joints. Most individuals die in the period shortly after birth. Survivors have sever motor and mental handicaps. Some remain bedridden throughout life with others can walk and become capable of minimal speech.
2. **Turner Syndrome** (Monosomy X) – occurs in 1 in 2000 births. The age of the mother is not a factor and the age of the father is not a factor. The syndrome is characterized by short stature and the lack of sexual development at puberty. Sexual development is impeded by the incomplete development of the ovaries resulting in low estrogen levels. Other physical features may include a webbed neck, heart defects, kidney abnormalities and/or various other malformations. Individuals also tend to have poor coordination.

The mean IQ is 90. Social development is impeded by a lack of ability to appreciate subtle social cues. Life expectancy is normal if there are no life threatening deformities. Estrogen replacement therapy can help to normalize sexual development and plastic surgery can help offset physical deformities. It is recommended that corrective surgery be completed before school age.

1. **Triple X Syndrome** (Super Females) – occurs in 1 of 1000 births. Women with triple X are usually fertile but they sometimes enter menopause earlier than double X females. There are no physical deformities or characteristics associated with the syndrome but triple X females are often passive as infants and less assertive later. Triple X females tend to be tall with an average height of 172cm.

Triple x females frequently have a delayed development in motor function, speech and maturation but no special treatment or therapy is needed. A speech therapist may help as will exposure to social situations such as quality day care at an early age. The average IQ of triple X females is just below normal at 90.

1. **Philadelphia Chromosome** (Translocation 9 and 22) – Occurs in 1-2 out of 100,000 births. The chromosome is associated with chronic myogenic leukemia. The chromosome abnormality is present in 95% of the cases of this leukemia. CML is a malignant disorder of the stem cells that produce erythroid cells and platelets in blood. The median age of the leukemia is 53 years but all age groups including children are affected. Typical symptoms are fatigue, anorexia and weight loss but about 40% patients show no symptoms. They cannot be diagnosed without a blood count. This disease progresses from a benign disorder to a rapidly fatal disorder within 3 to 5 years.
2. **Trisomy 8** (Warkany syndrome 2) – is a rare disorder with around 100 episodes reported since 1963. Full trisomy 8 can be lethal in early development and only mosaic individuals survive at birth.

Affected individuals vary in height form short to tall. Each has a prominent forehead, deep set eyes, prominent nostrils, full lips, abnormal fingernails, abnormal shoulder blades, a slender trunk, a narrow pelvis, prominent ears, deep creases in palms and soles of the feet, cardiac defects and a short or webbed neck.

Their life span is normal if life threatening disorders are absent. IQ averages in the low seventies. Mental development depends on the severity of mental deficiency. Individuals should have disorders tended to as they arise.

1. **Ver Jaal Syndrome** (no other name) –is due to a deletion of part of the short arm of chromosome 3. The syndrome is rare with 15 cases reported since 1978. Symptoms include growth deficiency, microcephaly, epicanthal folds, prominent nasal bridge, a long philtrum, malformed ears, down turned corners of the moth and a small jaw.

Patients are sever to profoundly mentally handicapped. Deaths in early childhood result from either a heart defect or pneumonia. Individuals who survive the first year may be blind and deaf. As a result of these deficiencies individuals will interact minimally with the environment even though they may have a normal life expectancy.

**Analysis Questions:**

1. How many chromosomes are present in a normal human karyotype? How many chromosomes are present in your karyotype?
2. What is the sex of your patient? How can you tell?
3. Karyotyping is usually performed in the first trimester of pregnancy if an abnormality is suspected due to family history or parental age. If you were a physician, what would you tell the parents of the patient that you just karyotyped to expect in 6 months. (assume the Ka