UNIVERSITY OF JOHANNESBURG

**PROGRAM** : *BIOMEDICAL TECHNOLOGY*

**MODULE** : **Haematology III**

**CODE** : **GTH3112**

**DATE** : **SUPPLEMENTARY EXAMINATION**
15 JUNE 2019

**DURATION** : 180 MINUTES

**WEIGHT** : 50 : 50

**TOTAL MARKS** : 180

---

**EXAMINER** : MRS J PIENAAR

**MODERATOR** : MRS B XHAKAZA

**NUMBER OF PAGES** : 21 PAGES

---

**INSTRUCTIONS** : QUESTION PAPER MUST BE HANDED IN

---

**REQUIREMENTS** : EXAM SCRIPT/S AND 1 MCQ CARD

1. Do section A on the MCQ card.
2. Do section B and C in the exam script.

---

**INSTRUCTIONS TO CANDIDATES:**

1. THIS PAPER CONSISTS OF 3 SECTIONS.
2. EVERY SECTION MUST BE ANSWERED IN THE EXAMINATION ANSWER SCRIPT/S OR MCQ CARD PROVIDED.
3. THIS QUESTION PAPER MUST BE RETURNED WITH YOUR EXAMINATION ANSWER SCRIPT.
4. YOU MAY USE A CALCULATOR.

---

## SECTION A: MCQ

INSTRUCTION: CHOOSE ONLY ONE CORRECT ANSWER AND MARK ON THE MULTIPLE CHOICE (MCQ) ANSWER CARD:
(1 mark per question).

1. Which of the following leucocytes is multi-lobular, azurophilic (bactericidal myeloperoxidase), is the first to enter damaged areas, activates phagocytes at the site of inflammation, and secrets pyrogenic IL-1?

   a. Eosinophils
   b. Lymphocytes
   c. Monocytes
   d. Neutrophils
   e. Basophils

2. Tissue basophils are also known as _____ cells.

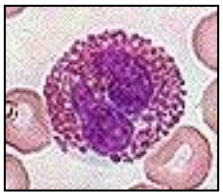
   a. Mott
   b. Plasma
   c. Mast
   d. Turk
   e. Macrophages

3. All are FALSE regarding Cytotoxic T cells *EXCEPT*:

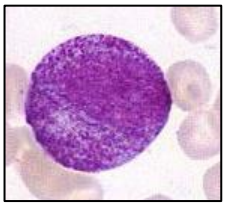
   a. They have the CD4 molecule
   b. Recognise MHC I
   c. Recognise MHC II
   d. Can activate APCs
   e. Can be broadly subdivided into two types

4. What type of cell is shown here?

   a. Neutrophil
   b. Lymphocyte
   c. Monocyte
   d. Eosinophil
   e. Basophil



5. Identify the following immature cell:



   a. Myeloblast
   b. Myelocyte
   c. Promyelocyte
   d. Monoblast
   e. Promonocyte

6. T lymphocytes are white cells that differentiate in the…?

   a. Thymus
   b. Thyroid
   c. Tonsils
   d. Tongue
   e. Bone marrow

7. Antigens which identify lymphocytes as helper cells develop from ____ lymphocytes and are known as _____.

   a. B, CD4
   b. B, CD8
   c. B, CD22
   d. T, CD4
   e. T, CD8

8. Platelet adhesion requires the presence of:

   a. von Willebrand factor
   b. Fibrinogen
   c. ADP
   d. Thrombin
   e. Fibrin

9. The activated partial thromboplastin time screens for abnormalities in which pathway(s)?

   a. Extrinsic
   b. Intrinsic
   c. Extrinsic and intrinsic
   d. Common
   e. Extrinsic, intrinsic and common

10. Alpha granules of platelets release all of the following, EXCEPT:

    a. Heparin antagonist (PF4)
    b. Platelet derived growth factor (PDGF)
    c. β-thromboglobulin, fibrinogen
    d. VWF and other clotting factors
    e. ADP

11. Fibrinogen is converted to stabilised fibrin by:

    a. Prothrombin
    b. Thrombin
    c. Factor XIIIa
    d. Anti-thrombin
    e. Factor V

12. Von Willebrand factor (vWF) is responsible for platelet adhesion, platelet-to-platelet aggregation, and acts as a carrier for what clotting factor in the plasma?

    a. Factor VIII
    b. Factor VII
    c. Factor IX
    d. Factor X
    e. Factor XI

13. Heparin inhibits the clotting of fresh whole blood by neutralizing the effect of:

    a. Thrombin
    b. Platelets
    c. Calcium
    d. Fibrinogen
    e. Fibrin

14. Which ONE of the following is NOT TRUE about neutropenia?

    a. It may be caused by acute myeloid leukaemia
    b. It occurs in aplastic anaemia
    c. It is caused by aspirin
    d. It is associated with systemic lupus erythematosus
    e. It is a cause of mouth ulcers

15. Which ONE of the following is NOT a cause of eosinophilia?

a) Eczema
b) Steroid therapy
c) Hookworm
d) Hypersplenism
e) Hodgkin's lymphoma

16. Which of the following environmental factors does not appear to influence one's predisposition for leukaemia?

a. Ionizing exposure
b. Bacterial infections
c. Toxic chemical exposure
d. Viral infections
e. Drugs

17. Which ONE of these is NOT a common genetic abnormality in the aetiology of haemopoietic malignancy?

a. Duplication of oncogene
b. Chromosomal translocation
c. Mutation in oncogenes
d. Amplification of tumour suppressor genes
e. Deletion of oncogenes

18. Which ONE of these infectious agents is associated with Hodgkin's lymphoma?

a) Human herpes virus 8 (HHV-8)
b) Helicobacter pylori
c) Epstein-Barr virus
d) Human immunodeficiency virus
e) Human papilloma virus

19. Which ONE of these is least valuable in the diagnosis of acute myeloid leukaemia?

a. Immunophenotypic analysis of a bone marrow sample
b. Cytogenetic analysis of peripheral blood
c. Microscopic analysis of the bone marrow aspirate (morphology)
d. Detection of clonal rearrangement of the immunoglobulin heavy chain gene
e. Chromosome analysis

20. Chronic leukaemias primarily affect…?

    a. Children, progress rapidly, and have mature cells in the peripheral circulation.
    b. All ages, progress slowly, and have immature cells in the peripheral circulation.
    c. Young adults, progress rapidly, and have mature cells in the peripheral circulation.
    d. Adults, progress slowly, and have mature cells in the peripheral circulation.
    e. Adults, progress rapidly, and have immature cells in the peripheral circulation.

21. Which ONE of these clinical features is commonly seen in patients who present with chronic myeloid leukaemia?

    a. Swollen cervical lymph nodes
    b. Excessive reactions to insect bites and vaccination may occur.
    c. Enlarged spleen
    d. Immune paresis
    e. Swelling of the gums

22. Which ONE of these is TRUE concerning the use of stem cell transplantation for chronic myeloid leukaemia?

    a. If the disease relapses soon after transplant then there will be no prospect of cure
    b. The five year survival rate is approximately 20% after transplantation.
    c. It does not matter if the procedure is performed during chronic phase or for accelerated or acute disease
    d. Most patients with CML eventually proceed to a stem cell transplant
    e. It is important that the donor and patient are matched at the major HLA alleles in order to reduce the risk of graft versus host disease

23. Which ONE of these statements is TRUE about pseudo (stress) polycythaemia?

    a. It is caused by a raised red cell mass
    b. It is associated with a large spleen
    c. It is treated with hydroxycarbamide (hydroxyurea)
    d. It is most common in young male adults
    e. High altitude

24. What is the approximate risk of progression to myelofibrosis or acute myeloid leukaemia in patients with polycythaemia vera?

    a. 5% and 30%, respectively
    b. 10% and 10%, respectively
    c. 20% and 20%, respectively
    d. 30% and 5%, respectively
    e. 15% and 30%, respectively

25. Which ONE of these statements regarding primary myelofibrosis is TRUE?

    a. Stem cell transplantation is not a curative option
    b. A leucoerythroblastic blood film is a characteristic feature
    c. The spleen is rarely enlarged
    d. Men are affected to a greater degree than women
    e. Uric acid levels are typically low

26. Which ONE of these is the most common finding in myelodysplastic syndromes (MDS)?

    a. Hypocellular bone marrow and reduced blood cell counts
    b. Hypocellular bone marrow and increased blood cell counts
    c. Hypercellular bone marrow and reduced blood cell counts
    d. Hypercellular bone marrow and increased blood cell counts
    e. Hypercellular bone marrow and normal blood cell counts

27. The stain(s) used to differentiate AML from ALL is (are):

    a. Myeloperoxidase
    b. Sudan black B
    c. NAP
    d. Periodic acid-Schiff
    e. Both A and B

28. Which ONE of these is the most accurate description of the pattern of incidence of acute lymphoblastic leukaemia?

    a. Peak in first year of life, secondary rise at age 10 and then gradual decline during adulthood
    b. Peak in first 3-5 years of life, less common with age but gradual rise after age 60 years
    c. Peak at age 5-10 years with secondary peak at age 60 years
    d. Stable but high incidence in first 18 years and then gradual decline in adulthood
    e. Peak at 20-30 years with secondary peak at age 70 years

29. Which ONE of the following is NOT TRUE about acute lymphoblastic leukaemia?

    a. It has a better prognosis in females than males
    b. It may be associated with the Philadelphia chromosome
    c. It causes meningeal leukaemia in 50% of cases
    d. It has a cure rate in children of more than 80%
    e. The FAB classification of ALL is as follows: L1, L2 and L3

30. Which ONE of these is TRUE concerning the translocation that leads to the Philadelphia chromosome?

    a. It leads to increased expression of the c-ABL gene as it brings a strong gene promoter close to the c-ABL gene
    b. It is present in around 60% of cases of CML
    c. It is detected on a karyotype as the t(8;21) translocation
    d. It is detected on a karyotype as the t(15;17) translocation
    e. It leads to generation of a BCR-ABL fusion protein

31. Which ONE of the following is a feature of chronic lymphocytic leukaemia?

    a. Herpes zoster infection
    b. Meningeal involvement
    c. Increased blasts in the bone marrow
    d. Bone lesions
    e. Predominance of blasts in the peripheral blood

32. Which ONE of these is a relatively common complication in multiple myeloma?

a. Acute renal failure
b. Cardiomyopathy
c. Diarrhoea
d. Pulmonary fibrosis
e. Vomiting

33. Which of the following describes Bernard-Soulier syndrome?

a. Prolonged bleeding time and giant platelets
b. Defective platelet secretion and abnormal clot retraction
c. Abnormal platelet-vessel wall interaction
d. Defects in platelet secretion
e. Megakaryocytic hyperplasia and splenomegaly

34. Which of the following statements is TRUE about von Willebrand's disease?

a. It predominantly causes deep muscle and joint haemorrhage
b. It is usually associated with a low plasma factor VIII level
c. It is usually associated with a low plasma factor X level
d. It occurs mainly in males
e. The level of von Willebrand factor in plasma is always raised

35. Which ONE of the following statements is NOT TRUE in haemophilia A?

a. Bleeding is mainly mucosal
b. Antenatal diagnosis is possible
c. Inheritance is sex-linked
d. Onset is early childhood
e. Deficiency of factor VIII

36. Which ONE of these statements is NOT TRUE concerning von Willebrand disease?

    a. There is either a reduced level or abnormal function of von Willebrand factor (vWF)
    b. Factor VIII levels may be reduced as vWF is the carrier for factor VIII protein
    c. Bleeding time is prolonged
    d. It is the most common inherited bleeding disorder and inheritance is usually autosomal dominant
    e. Plasma derived factor VIII concentrates contain vWF and are the treatment of choice in most cases

37. Which ONE of these is NOT a recognised cause of disseminated intravascular coagulation?

    a. Amniotic fluid embolism
    b. Meningococcal septicaemia
    c. Postoperative bed rest
    d. Snake bite
    e. Septic abortion

38. Which ONE of the following is NOT a risk factor for arterial thrombosis?

    a. Gout
    b. Smoking
    c. Diabetes mellitus
    d. Hypohomocysteinaemia
    e. Male sex

39. Which ONE of these is NOT an advantage of low molecular weight heparin compared to unfractionated heparin (UFH)?

    a. It can be given once or twice daily
    b. Their action is more predicable than UFH
    c. There is a reduced risk of osteoporosis
    d. It only has a half-life of 30 minutes so is easily reversed
    e. It does not need monitoring by blood tests

40. Hereditary haemorrhagic telangiectasia is associated with which of the following?

    a. Gastrointestinal haemorrhage

b. Thrombocytopenia
c. Pulmonary hypertension
d. Renal failure
e. Liver failure

**[40]**

STATE WHETHER THE FOLLOWING STATEMENTS ARE “TRUE” OR “FALSE”.

For the following questions (41-50), choose either True (**a** on the MCQ card) or False (**b** on the MCQ card).

41. *True or False:* Neutrophil precursors regularly appear in the peripheral blood.

    a) True
    b) False

42. *True or False:* Natural killer (NK) cells are cytotoxic CD8+ cells that lack the T-cell receptor (TCR).

    a) True
    b) False

43. *True or False:* A patient with myelofibrosis is not likely to develop acute leukaemia due to the high platelet count.

    a) True
    b) False

44. *True or False:* Malaria could be a cause of thrombocytopenic purpura.

    a) True
    b) False

45. *True or False:* Acute myeloid leukaemia FAB classification M5a is a monocytic leukaemia with differentiation.

    a) True
    b) False

46. *True or False:* A patient with a congenital deficiency of either antithrombin, protein C or protein S may exhibit arterial thrombosis.

    a) True
    b) False

47. *True or False:* The initiating stimulus to blood coagulation following injury to a blood vessel is the release of serotonin.

    a) True
    b) False

48. *True or False:* The identifying features in the peripheral blood firm of multiple myeloma is rouleaux formation, blueish background staining and appearance of plasma cells.

    a) True
    b) False

49. *True or False:* An elevated PT, APTT and thrombin time in a patient with DIC is caused by an inability to utilise calcium.

    a) True
    b) False

50. *True or False:* Faggot cells are typically found in the bone marrow of AML M4 blasts.

    a) True
    b) False

**[10]**

**SECTION A SUBTOTAL: 50**

## SECTION B: SHORT AND LONG QUESTIONS

**INSTRUCTION:** ANSWER THE QUESTIONS FOR SECTIONS B AND C IN AN EXAM BOOK (PLEASE MARK EACH SECTION).

## QUESTION 1

1.1. Describe the morphology, granules, and lifespan of neutrophils. (5)

1.2. Discuss normal neutrophil and monocyte function under the following heading:
*Phagocytosis* (7)

1.3. Supply the principle functions of the reticuloendothelial system (RES). (5)

**[17]**

## QUESTION 2

Describe immunoglobulin gene rearrangements in detail. **[6]**

## QUESTION 3

3.1. Describe the following benign abnormality of neutrophils:
*May-Hegglin anomaly* (3)

3.2. Describe the **defects** of phagocytic cell function under the following heading:
*Phagocytosis* (3)

3.3. What is the defect/mutation that causes Gaucher's disease? (1)

**[7]**

## QUESTION 4

Match column A with the correct answer in column B. **[5]**

| A | B |
|---|---|
| 4.1. AML M5a | a) t(15;17) |
| 4.2. Polycythaemia rubra vera | b) JAK2 mutation |
| 4.3. CML | c) Refractory anaemia with excess blasts |
| 4.4. AML M3 | d) >80% of monocytic cells are monoblasts |
| 4.5. MDS | e) <80% of monocytic cells are monoblasts |
| | f) Smudge cells |
| | g) t(9; 22) |

## QUESTION 5

Diagnose the following patients based on their lab results (be specific): **[4]**

| | Patient A | Patient B | Patient C | Patient D |
|---|---|---|---|---|
| **Sex** | Male | Female | Female | Male |
| **Age (years)** | 52 | 28 | 7 | 5 |
| **Hb (g/dl)** | 8.2 | 7.4 | 6.5 | 11.4 |
| **WCC (x $10^9$/l)** | 329 | 15.7 | 258 | 6.8 |
| **Platelets (x $10^9$/l)** | 497 | 31 | 67 | 298 |
| **MCV (fl)** | 87.9 | 88.3 | 92.6 | 84.1 |
| **MCH (pg)** | 28.2 | 28.5 | 29.3 | 29.3 |
| **MCHC (g/dl)** | 32.7 | 31.0 | 33.0 | 32.4 |
| **Bone marrow smear** | Hypercellular Granulopoietic predominance 4% blast cells | Not done | Hypercellular 77% blast cells | Not done |
| **Peripheral blood Smear** | Promyelocytes, myelocytes, metamyelocytes, stab cells, neutrophils, basophilia | Schistocytes +++. Thrombo-cytopaenia. | 37% blast cells Smudge cells | NNA |
| **Cytochemistry** | NAP: low | Not done | Sudan black: negative PAS: Positive in clusters | Not done |
| **Immuno-phenotyping** | CD13, CD15, CD33 positive CD22 negative | Not done | CD10, CD19 positive CD13 negative | Not done |
| **Chromosomal analysis** | t(9;22) | Not done | 6q- | Not done |
| **Other investigations** | LDH: increased. Vit B12: increased. Phosphate: increased. | PT: prolonged. aPTT: prolonged. Fibrinogen: decreased. D-dimer: increased | LDH: increased. UA: increased. | PT: normal aPTT: prolonged Factor VIII assay: normal Factor IX assay: decreased |

**QUESTION 6**

6.1. Concerning the mechanism of malignant transformation, altered expression of which three (3) types of genes or processes underlie the pathogenesis of haematological malignancy? (3)

6.2. Describe, in detail, three (3) clinical features of chronic lymphocytic leukaemia (CLL). (3)

**[6]**

**QUESTION 7**

Concerning the pathogenesis of CML, describe the *Philadelphia chromosome*.

**[4]**

**QUESTION 8**

8.1. List three (3) of the major components involved in haemostasis. (3)

8.2. Describe platelet aggregation. (4)

**[7]**

**QUESTION 9**

9.1. Describe, in **detail**, the extrinsic and common pathways in blood coagulation. (7)

9.2. Describe Heparin cofactor II as a coagulation factor inhibitor. (4)

**[11]**

**QUESTION 10**

List four (4) proteins that directly inhibit fibrinolysis. **[4]**

**QUESTION 11**

Describe and discuss Disseminated intravascular coagulation (DIC) under the following headings:

11.1. *Clinical features* (5)

11.2. *Laboratory findings* (5)

11.3. *Treatment (supply 1)* (1)

**[11]**

## QUESTION 12

12.1. List two (2) inherited vessel wall abnormalities. (2)

12.2. Describe antithrombin deficiency. (4)

12.3. Describe Glanzmann's thrombasthenia. (2)

**[8]**

## QUESTION 13

Three different patients present with symptoms of abnormal bleeding. Their laboratory results are given in the table below. Examine them and identify the appropriate clinical condition/cause for each of the patients. **[3]**

| | **Plt count** | **Bleeding time** | **PT** | **aPTT** | **Factor VIII** | **Factor IX** | **vWF** | **Plt aggregation with ristocetin** |
|---|---|---|---|---|---|---|---|---|
| **13.1. Patient A** | Normal | Prolonged | Normal | Prolonged | Low | Normal | Low | Abnormal |
| **13.2 Patient B** | Normal | Normal | Normal | Prolonged | Low | Normal | Normal | Normal |
| **13.3 Patient C** | Normal | Normal | Normal | Prolonged | Normal | Low | Normal | Normal |

**SECTION B SUBTOTAL: 93**

## SECTION C: CASE STUDIES

**INSTRUCTION:** ANSWER THE QUESTIONS FOR SECTIONS B AND C IN AN EXAM BOOK (PLEASE MARK EACH SECTION).

## CASE STUDY 1

**History**

A 62 year old male university professor saw his family physician because of increasing fatigue and weakness. He also reported pain in his lower back and arms when he walked.

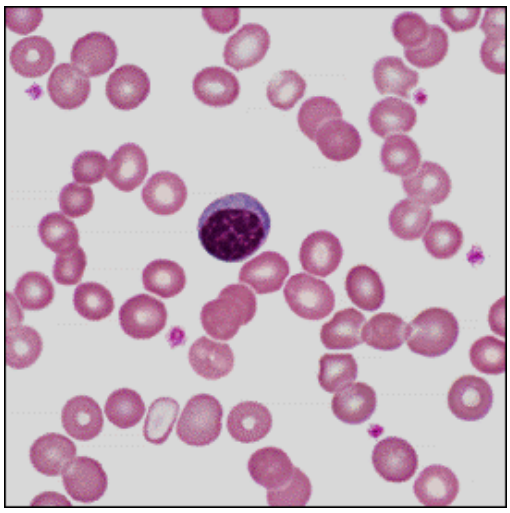
**Physical Exam**

The man had pale mucous membranes and hepatospenomegaly.

**FBC**

(with microscopic differential)

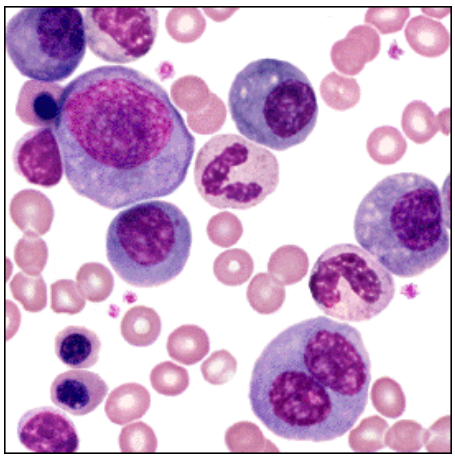
| | |
|---|---|
| RBC | 2.85 x $10^{12}$/L |
| HGB | 6.9 g/dL |
| HCT | 25.9% |
| MCV | 90.9 fL |
| MCH | 24.2 pg |
| MCHC | 26.6 g/dL |
| RDW | 16.8% |
| | |
| WBC | 15.1 x $10^{9}$/L |
| N | 58 % |
| L | 27 |
| M | 13 |
| E | 1 |
| B | 1 |
| Plasma cells | 3 |
| | |
| PLT 125 | x $10^{9}$/L |



1.1. What morphologic alterations are seen in this blood smear field above? (4)

After seeing the FBC results and peripheral slide, the doctor ordered the following tests:

**Bone marrow biopsy (see right):**



Aspirate differential (1000 cells):

- Erythroblasts 19.2%
- Myeloblasts 0.4

- N promyelocytes 0.8
- N and precursors 25.2
- L 19.2
- M 8.6
- E and precursors 3.2
- B and precursors 0.0
- Plasma cells 23.4

The plasma cells show variable morphology. Many have a normal appearance, but immature forms with prominent nucleoli are also present. Multinucleated plasma cells and occasional very large forms are noted.

**Sections:** Hypercellular with clusters of plasma cells. Immunohistochemical stains were done for kappa/lambda light chains show sheets of kappa positive cells and a few widely scattered lambda positive cells.

**Chemistry:**

- Total protein 110 g/L (RI 65-83 g/L)
- Uric acid 459 µmol/L (RI 208-428)
- U & E: All within normal limits
- Serum total calcium: 299 mmol/L (RI 2.15-250)

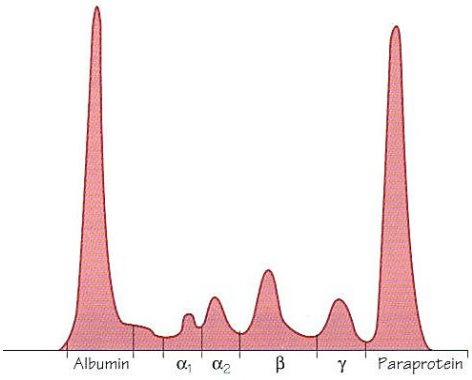
**Serum protein electrophoresis:**

- Albumin 32 g/L (RI 35-50)

<u>Globulins:</u>

- Alpha1 0.4 (RI 0.1-0.5)
- Alpha2 1.0 (RI 0.5-1.2)
- Beta 0.8 (RI 0.5-1.1)
- Gamma 5.6 (RI 0.6-1.7)

  Monoclonal protein (5.5 g/dL) seen near the gamma fraction.




**Immunoelectrophoresis:**

Immunoglobulins, quantitative:

- IgA 0.5 g/dL (RI 0.7-3.12)
- IgG 58 g/dL (RI 8-12)
- IgM 0.19 g/dL (RI 0.5-2.8)

**Radiography:**

- Multiple lytic lesions of the skull, spine, pelvis, and femurs.

1.2. What is the most likely diagnosis; and which type is present? (2)

1.3. How did you come to this conclusion? List six (6) reasons. Please explain, in detail, for each point that you list, the relevance/significance to this particular disease. (6)

1.4. A 24 hour urine electrophoresis was also performed. Name the protein that is often found in the urine of patients with this disease. (1)

1.5. Concerning the pathogenesis of this disease, describe *Multiple lytic bone lesions, hypercalcaemia and pathologic fractures*: (7)

1.6. Name one growth factor that mediates bone resorption in this disease (please give the full name). (1)

**[21]**

## CASE STUDY 2

**History:**

The mother of a six-month-old boy cannot stop his bleeding after he hits his mouth on the kitchen floor.

The child had just turned 6 months old. He had recently discovered the freedom of being mobile and was attempting to follow his 3 year old sister up the stairs. He had almost mastered crawling up the first step when he slipped and fell, hitting his mouth on the linoleum floor of the kitchen. The screaming brought his mother running who initially thought the baby must have split his head open because of the amount of blood that was everywhere. As she cleaned the injury, she realized that the blood was coming from the baby's mouth. After applying cold compresses for 15 minutes, the bleeding eventually stopped. Five minutes later, the bleeding started up again. She decided to call the pediatrician.

The baby had stopped bleeding by the time the mother arrived at the pediatrician's office.

During a thorough checkup of the baby, the pediatrician noticed bruises on the legs and arms. He noted that the baby had not been circumcised. Upon examination of the injured gum area, bleeding started again.

The pediatrician asked the mother if there was any history of bleeding disorders on the maternal side of her family. The mother was not sure, although she thought she may have had a great uncle who died when he was young of a blood disorder.

**Laboratory Test Results:**

| | Patient | Normal Range |
|---|---|---|
| **Platelet Count** | 220 x $10^9$/l | 150 - 400 x $10^9$/l |
| **Bleeding Time** | 8.5 min | 1-9 min |
| **PT** | 11 sec | 10-12 sec |
| **APTT** | 67 sec | 28-35 sec |

2.1. Interpret the laboratory results: *briefly mention whether the patient's results are within the normal range or not, and if not what the status is, and describe the significance of the patient's results*. (5)

Based on the coagulation study results, the pediatrician ordered factor assays on factors VIII, IX, and XI and XII.

***Factor Assay Results***

| | | |
|---|---|---|
| **Plasma Factor VIII Assay** | Patient: <1% | Normal Range: 50-150% |
| **Plasma Factor IX Assay** | Patient: 80% | Normal Range: 50-150% |
| **Plasma Factor XI Assay** | Patient: 95% | Normal Range: 50-150% |
| **Plasma Factor XII Assay** | Patient: 93% | Normal Range: 50-150% |

2.2. From the testing results, what is your final diagnosis for this patient?(1)

2.3. How did you come to this conclusion? List five (5) reasons. Please explain, in detail, for each point that you list, the relevance/significance to this particular disease. (5)

2.4. Describe three (3) possible treatment modalities for this patient. (3)

2.5. What sex carries this disease's gene? What sex can inherit that gene? (2)

**[16]**

**SECTION C SUBTOTAL: 37**

**TOTAL MARKS: 180**