

Haematopoiesis located in bone marrow section biology essay



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Haemopoiesis also known as haematopoiesis located in bone marrow section of an adults and lymphatic tissue is the process of production of blood cells and platelets which continues throughout life, replacing aged cells which are removed from the circulation by which immature precursor cells expand to mature blood cells. This process thesis and how it works is known as monophyletic theory. The cellular blood components are precursor to haematopoietic stem cells (HSC) that forms blood cells and immune cells. Blood cells (BC) are significant in maintenance of immune system in all types of cells in the body which prompt the BC to constantly maintain self renewal. Haemapoiesis stem cells therefore can proliferate, differentiate and even undergo cell death called apoptosis in various types of specialized cells in the body.

The morphology and growth of BC sometimes occurs outside the bone marrow cells called extramedullary haemopoiesis. This is abnormal condition associated with Myelofibrosis caused by disorder in the bone marrow due to abnormal stem cell results or replacement by collagenous connective tissues. The sources of HSC are bone marrow, peripheral blood, umbilical cord blood, Foetal Hematopoietic, Embryonic Stem Cells and Embryonic Germ Cells. The vascular compartment of bone marrow is used to supplied nutrient artery and open into sinuses. The sinus carries the blood from the bone marrow to the body.

HSCs have two kinds and include long term stem cells which incorporate transplantation of a new marrow cells to lethally cancerous patients and restore its haemopoietic system for longer periods and short term progenitor which are unable to renew themselves for longer period but immediately

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regenerate all types of blood cells. The success of been able to inject healthy cells from compatible donor to patients receiving chemotherapy successfully and recipient recover by regaining full functioning healthy blood cells is deemed to have completed stem cells.

Large amount of new blood cells are constantly been produced in the blood circulation ensuring steady flow in the peripheral circulation. This type of stem cells is known as pluripotential stem cell (PSC). Pluripotent stem cell however differentiates into other stem cells known as unipotential stem cells: erythropoiesis, monocytes, granulopoiesis, thrombopoiesis and lymphopoiesis are specially multiplied into precursor specifically to individual mature blood cells.

Erythropoiesis is the process used to describe red blood cells (erythrocytes) formation exclusively in the red bone marrow involving matured nucleated precursor into erythrocytes. The yellow bone marrow initially composed of fats and subsequently changed to red bone marrow from greater affinity of red blood cells needs. Haemocytoblasts is the precursor of erythrocytes lasting for few days and involved around four mitotic divisions of cells given rise to 8 to 16 more cells.

The kidney initiates RBC production in mature cell by responding to lack of oxygen in the blood and secret special hormone called erythropoietin. This hormone is then transferred to red bone marrow and begins production of red blood cell. The RBC fills up the blood capillaries for distribution in the body. After few days the RBC is strong enough to serve oxygen to the body and consequently subsided after few months and loses its affinity to continue

oxygen distribution and rupture. The ruptured RBC is then taken up by the spleen for recycled to form new RBC.

Monocytes is a type of white blood cells that mature to much larger cells called macrophages and plays major role in immune system of the body that destroy dead cells or tissues damaged and cancer cells. Produced in the bone marrow and develop from nucleated precursors, the monoblast and promonocyte and then goes through the bloodstream for circulation to the spleen, lymph nodes, liver, bone marrow and lungs. Mature cells in monocytes life span is around 3-8 hours with full antigenic stimulation of T and B lymphocytes.

Thrombopoiesis is a Platelets formed in the cytoplasm cell called megakaryocyte inside bone marrow with maturity within 10 days from much larger stem cells, megakaryoblast . The platelets formation penetrates into the blood vessels to prevent bleeding, assist clots formation to prevent bleeding and repair damages to blood vessels. Macrophages eventually destroy the platelets in the spleen and liver.

Granulopoiesis are formed in the red bone marrow (RBM) called granulocytes and subdivided into three types of white blood cells (WBC); eosinophils, neutrophils and basophils and are grouped in the same stem cells called myeloblast.

Granulocytes are produced by the continuous lobulation and condensation of the nucleus, loss of RNA cytoplasmic granules development. A developed cell goes through sinus endothelium where half of the granulocytes circulate to the internal surface of blood vessels and the other half circulates in the blood

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vessels for exchange. Half of the granulocytes eventually disperse from the circulation in response to requirement in the tissues.

Lymphopoieses are precursor to lymphoblasts and prolymphocytes produced in bone marrow. Immature cells are transferred to the lymphoid tissues and thymus, with further division with similar antigens to T cells, B cells and NK cells. They mediate composite and immune effectors.

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regenerate all types of blood cells. The success of been able to inject healthy cells from compatible donor to patients receiving chemotherapy successfully and recipient recover by regaining full functioning healthy blood cells is deemed to have completed stem cells.

Leukemia and Lymphoma are some of the cancer of the blood associated with treatment by HSCs. The process relates to the patient's defective white blood cells causes by cancer having been destroyed using chemotherapy and replaced with bone marrow transplant matched with donor. Donor are usually from patients family with similar leukocytes antigens. Cancer of the blood are acute or chronic myeloblastics leukemia, multiple myeloma, non-Hodgkin's lymphoma and Hodgkins diseases.

Name the systems used to classify acute lymphoblastic leukaemia(ALL) and acute myeloid leukaemia (AML). (word limit: 20 words) (2 MARKS)

French-American-British (FAB) classification and the World Health

Organization (WHO) classifications are two subtypes used in classification of AML and ALL.

Define leucocytosis and thrombocytopenia. (word limit: 75 words)(5 MARKS)

Leucocytes is a conditions of an abnormal increase of white cells in the blood due to infections. Total white blood cells is approximately 4400 to 11, 000 cells/microL. Excess to the value of 50, 000/microL, attributed to leukemia is called leukemoid reaction.

Thrombocytopenia is a condition where there is abnormal decrease in platelets counts, rendering inability for clot formation resulting in excessive bleeding. Causes can be due to low platelets in bone marrow, intravascular and extravascular.

Define leukaemia and state the four main divisions of the disease. (word limit: 70 words) (10 MARKS)

Leukaemia is a malignant (cancer) of the bone marrow characterized by uninhibited proliferation of abnormal white blood cells. Symptoms include enlargement of liver, lymph nodes and spleen, anaemia, blood clotting retardation.

Four major types of leukaemia are; Acute lymphoblastic leukaemia (ALL) and Chronic lymphocytic leukaemia (CLL) classified as Lymphocytic or lymphoblastic, Acute myeloid leukaemia (AML) and Chronic myeloid leukaemia (CML) classified as Myelogenous leukemia

State the typical manifestation of someone presenting with acute leukaemia including the blood film morphology. (word limit: 200 words) (5 MARKS)

Most common symptoms includes abnormal bruising and bleeding (thrombocytopenia), anemia, bleeding gums or irregularity in menstrual period and infections. Anaemia and hypermetabolic state are attributed to fatigue, malaise, weight loss, chest pain and tachycardia. Granulocytopenia can progressively lead to potential life threatening bacterial infections. Developing infection frequently in eyes, nose and mouth known as neutropenia, trace of blood in urine, fine rash dark red spots called purpura.

Sign of fever, abnormal haemostasis are mostly common. Patients may sometimes show lesion in soft tissues, spine, dura and cranial representing tumour of leukaemia cells called granulocytic sarcoma or chroma. Periosteal infiltration and bone marrow may initiate joint pain (Arthralgia) in children with ALL. Meningitis causing vomiting, seizure, papilloedema and headache is rare.

Blood film morphology diagnosis of AML shows presence of more than 20% myeloblasts in blood cell. Cells appear to be smudge with decrease in thrombocytes. Elevated count of leucocytes $135.3 \times 10^9 /L$ and thrombocytopenia of $26 \times 10^9 /L$ indicates signs of acute leukaemia.

In AML, Auer rods appear smaller in size, absent of granules, lower RBC counts and appear smaller in morphology. Also ALL contains no granules

State the typical manifestation of someone with chronic leukaemia including the blood film morphology. (word limit: 200 words) (5 MARKS) (word limit: 230 words) (15 MARKS)

Chronic leukaemia from mature cells is a slow progressive symptom that goes unnoticed for months. Disease is normally noticed during normal routine blood test. Immediate treatment is not imminent and may involve chemotherapy treatment in tablet form. Two types of chronic leukaemia: Chronic myeloid leukaemia (CML), cancer of the myeloid cells, and chronic lymphocytic leukaemia (CLL), cancer of the lymphocytes.

Chronic lymphocytic leukaemia (CLL) is the most common type characterised by an increased number of lymphocytes (WBC). The lymphocytes are unable

to perform normal process of responding to infections by producing antibodies needed to destroy bacteria.

Symptoms may be tiredness (anaemia) due to lack of RBC, continuous infections due to WBC's healthy shortages in fighting infections, abnormal lymphocytes in lymph glands causing swelling in neck and arm pits or groin, also swelling in spleen, Low platelets in blood leading to bruising or bleeding without injury, weight loss, fevers and night sweat.

Test in blood film morphology indicates nuclei appearance is rounded and condensed chromatin. High level of beta-2-macroglobulin protein in the blood indicates advance CLL. Appearance and large amount of lymphocytosis in the blood more than 10, 000 lymphocytes/mm³ of blood shows presence of the disease. Patient with CLL often have low red blood cells and blood platelets in the body.

Explain the following techniques and give one example for each, of application in the diagnosis or monitoring of leukaemia: (word limit: 230) (15 marks).

Cytochemistry

Is the staining methods use to study, identify and localization of various chemical compounds within living cells and activities of acute leukaemia.

The most simplify cytochemistry method of diagnosing leukaemia is Myeloperoxidase (MPO) staining which can be completed within minutes. Its main function is to differentiate AML and ALL. Lysosomal enzyme stored azurophilic granules of neutrophils and monocytes. Used in basophils and

eosinophils demonstration. A heme pigmentation react to its green colour secretion found in neutrophils.

Immunophenotyping

Immunophenotyping is use to analyze heterogeneous populations of cells based on the antigens phenotype according to their resemblance of interest. Example is leukocytes from peripheral blood extract from lymph nodes, leukaemia and lymphoma specific to differentiate cancer cells to normal of immune system. Immunophenotyping is used on a daily basis by pathologist from normal biopsies to bone marrow biopsies from various patients.

Method mostly used to analyze and sort T-lymphocytes into subsets based on CD antigens is flow cytometry techniques. Samples of cells are analyzed in a multi-well plate with aid of fluorescence or scatter laser light to sort out population by immunophenotypic markers type.

Cytogenetics

The branch of genetics specialized in the studies of relationships between the structure of cell division and chromosomes relating to variation in phenotype and genotype. Test are carried out in blood samples and bone marrow from leukaemia patients to analyse abnormalities in chromosomal link with certain disease.

Fluorescent in situ hybridization (FISH) is one of the methods use in routine analysis of cytogenetic band, molecular cytogenetic and G-Banded chromosomes in leukemia against normal chromosome.

What is the Philadelphia chromosome? Give an example of where this is commonly found. (word limit: 120 words) (5 MARKS)

Philadelphia chromosome (PH) or Philadelphia translocation is a specific chromosomal abnormality that causes chronic myelogenous leukemia (CML). It is an abnormally chromosome 22 involved in an exchange with chromosome 9 which occur at the site of single bone marrow cell and can also be located in form of acute lymphoblastic leukemia (ALL).

The clonal process expands to the leukaemia and was the first major mutant cell found in malignancy which led to the CML cells combination of BCR-ABL gene protein. These genes belong to chromosome 22 and 9 respectively. The activities of both PH chromosome fused together causing uncontrolled malignant in the cell is a strong indication of pathogenic disease. The drug mesylate (Gleevec) was introduced through understanding of this mechanism to aid in cancer treatment.

State the difference between stem cell and bone marrow transplants. (word limit: 100 words) (4 MARKS)

Stem cell transplantation is a method where the stem cells are obtained from the peripheral blood using aphaeresis method. Aphaeresis assists in stem cells filtrations and avoids unwanted blood. When stem cells are obtained from the outpatient donor from the blood stream, they are less invasive and patient can recover very quickly at home.

Stem cell harvested from the bone marrow using fine needle inseted into the hip joint however required critical method from in patient to be hospitalized and put under general anesthesia for continue monitoring.

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Stem cells collected from the bone marrow are much richer in stems compare with stem collected from the peripheral blood.

State the difference between autologous and allogenic transplants. (word limit: 50 words) (4 MARKS)

Difference between an autologous transplant is when patient's own blood forming cell are collected for use in transplataion later, while an allogenic transplant relies on cells collected from volunteer's bone marrow.

The donor's tissue type must be compatible to the recipient to avoid miss match.