Guidelines
For
Competency Based Training Programme
in
DrNB- Clinical Haematology
2021

NATIONAL BOARD OF EXAMINATIONS IN MEDICAL SCIENCES
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CONTENTS

I. INTRODUCTION

Haematology over the past two decades has seen phenomenal growth. The change has been both in the laboratory and clinical aspects. In India, a Haematology laboratory provides rapid, accurate, and reproducible results for large numbers of samples with automation.

Cytogenetics and molecular techniques are no longer research tools but necessary for clinical decision-making. Blood banking has come a long way with component therapy and single donor apheresis. Haematological disease management has been evolving with multiple targeted therapies, and small molecules added to the armamentarium each year. Haematopoietic Stem Cell Transplantation (HSCT) now provides a cure for many, hitherto, incurable diseases, and a haematologist should be able to offer this type of treatment. Gene therapy and CAR-T cells therapy is on the horizon for clinical use in the near future.

India must produce specialists in Haematology who can integrate the laboratory aspects and clinical management of the patient with haematologic disorders. The doctor who undergoes training in Haematology should possess the necessary clinical and laboratory skills to manage patients with primary haematological problems and interact as a consultant for Haematology problems from other specialties.

II. OBJECTIVE OF THE PROGRAMME

1. Programme Goal

i. Community based Haematology practice.

ii. Develop a team approach involving radiation and surgical oncologist, nuclear Provide specialized training in Clinical Haematology, including hospital and medicine specialist, transfusion medicine specialist, microbiologist, biochemist and pathologist, molecular pathology, cytogeneticist and allied imaging department to manage patients and conduct other departmental activities as & when necessary.

2. Programme objectives

At the end of training in Clinical Haematology, it is expected that the qualified Haematologist will be able to:

i. Diagnose and manage all patients with non-malignant and malignant haematological disorders. Recognize and manage haematological complications of non-haematological diseases.

ii. Perform independently different clinical procedures like bone marrow aspiration and biopsy, central venous catheter insertion, lumbar puncture, etc.

iii. Interpret laboratory test results, including cytogenetic, molecular genetic including measurable residual disease data, and synthesize laboratory and clinical data to provide rational solutions for patients with haematological problems.

iv. Perform independently the different basic laboratory haematological investigations used to diagnose haematological disorders.

v. To provide the state of art therapy to patients with haematological disorders.

vi. To have knowledge and expertise to perform HSCT.

vii. To be able to prepare and perform protocol based therapies for various malignant and non-malignant haematological disorders, including the following.

a. **Basic Scientific Principles** -The trainee should have clear concepts regarding the basic principles of the biology of normal cells, cell cycle expression and regulation, basics of haematopoiesis, haemostasis, and coagulation pathway. The trainee must also have an understanding of the genetic basis of both malignant and non-malignant haematological diseases.

b. **Principles in the Management and Treatment of Haematological Diseases** The trainee at the end of the training program should be thorough with the basic principles of management of all non-malignant (acquired and inherited) and malignant haematological diseases, including the clinical, radiological, and laboratory approach to the diagnosis, its treatment, response assessment and post-treatment follow up.

c. **Psychosocial Aspects of inherited, non-malignant and malignant haematological diseases** The trainee should become skillful in handling cultural issues, spiritual conflicts, adaptive behavior, and coping mechanisms.

d. **Patient Education** – The trainee should be able to know how to **break** bad news e.g. a diagnosis of cancer, counsel the patient and family in an empathetic manner and guide the family on all treatment options available. They should be able to counsel families with genetic blood disorders like Haemoglobinopathies and haemophilia, and educate the patients as well as relatives about health maintenance, long-term complications, risk of treatment-induced cancer, endocrine dysfunctions and genetic counseling (screening and assessment of risk).

e. **Legal and Economic Issues** – The trainee should be fully proficient in taking informed consent for research activities and ethical **conduct** of medical research. The trainee should be well versed with legal issues (life support and withdrawal) and cost issues about the disease treatment.

f. **Skills** – During the training period, the trainee should imbibe and develop the skills of administration of chemotherapy, immunotherapy, targeted therapy, and biologics (prescribing, administering, handling, and disposal of chemotherapeutic and biologic agents), and to independently perform clinical procedures like bone marrow aspiration, biopsy, lumbar punctures, central venous catheter insertion and care of a CVC, abdominal and thoracic paracentesis. Should have comprehensive knowledge of blood transfusion indications and practices and be competent in management of complications.

g. **Community responsibilities** – The trainee should be well versed with community aspects of screening for the prevention of inherited haematological diseases as well as haematological malignancies.

h. **Constant development** – The trainee should be aware of the **recent developments** in the field of haematology, chemotherapeutics, preventive medicine, and molecular biology. Trainees should be able to communicate this to the patient and their family. They should be able to break bad news with patience and compassion. Trainees should learn to communicate and work together with other health professionals in the team.

i. **Clinical research including statistics**: Trainees must be provided **education** in the design and conduct of clinical trials. They must have exposure to the development and conduct of these trials. Trainee must understand the basics of statistics, sample size calculation in designing studies, proper interpretation of data, toxicity assessment and grading, role, and functioning of the Institutional Ethical Committees/Review Board. They should have experience in obtaining informed consent from the patients and be aware of the government regulatory mechanisms. They should have knowledge about making proposals for obtaining research grant and about mechanisms of support for clinical research, instruction in preparing abstracts, or a land visual presentations, and writing research articles. They should be able to critically evaluate the scientific value of published articles and their influence on daily clinical practice.

j. **Professionalism– Ethics and Professionalism must be fostered during Haematology** training. In addition to mastering the comprehensive clinical and technical skills of the consultant, trainees are expected to maintain the values of professionalism.

III. TEACHING AND TRAINING ACTIVITIES

1. The fundamental components of the teaching program should include:

   i. Case presentations & discussion- once a week.
   ii. Seminar- Once a week.
   iii. Journal club activities including journal club and journal scan- Once every fortnight.
   iv. Grand round presentation (by rotation departments and subspecialties) Haematopathology or radiology Conferences-once a week.
   v. Faculty lecture teaching- once a month.
   vi. Clinical Audit/Mortality meet-Once a month.
   vii. One poster and one oral presentation during their training period in a recognized National/ International conference is mandatory.

2. Daily ward rounds will be an essential component of training. This should include a review of case history, clinical examination, investigations, and management plan. There should be bedside teaching sessions on all inpatients. The documentation of all patients should be appropriately managed by the residents and reviewed by the consultants.

3. The training program would focus on knowledge, skills, attitudes, behavior, and other essential education components. It should be divided into theoretical, clinical, practical, rehabilitative care, research and teaching methodology.

   i. **Theoretical:** Basic knowledge on disease pathogenesis, its diagnosis, staging and prognostication, evolution of management and supportive care should be acquired from standard textbooks. Further theoretical knowledge should be acquired through discussions, journal clubs, symposia, and seminars. The students are exposed to recent advances through discussions in journal clubs.

   ii. **Symposia:** Trainees would be required to present a minimum of 20 topics based on the curriculum during three years of training. A free discussion would be encouraged in these symposia. The topics of the symposia would be given to the trainees with the dates for the presentation.

   iii. **Clinical:** The trainee would be attached to faculty members to be able to pick up methods of history taking, examination, prescription writing, and management.

iv. **Bedside:** The trainee would work up cases and learn the management after discussion with the faculty of the department.

v. **Journal Club Activities:** This would be a fortnightly academic exercise and will include journal club and journal scan. A list of suggested Journals is given towards the end of this document. The candidate would summarize and discuss the scientific article critically. A faculty member will suggest the article and moderate the discussion. The contributions made by the article in furtherance of the scientific knowledge and limitations, if any, has to be highlighted.

vi. **Research:** The student would carry out the research project and write a thesis dissertation following NBE guidelines. Trainees should also participate in the ongoing research projects in the departments to learn their planning, methodology and execution to learn various aspects of research.

IV. SYLLABUS

1. **THEORY SYLLABUS:** Departments involved in the training programme:

   i. Clinical Haematology (Adult and Pediatric) and HSCT
   ii. Laboratory Haematology including Haematopathology, Cytogenetics and Molecular genetics
   iii. Transfusion Medicine
   iv. Microbiology
   v. Biochemistry
   vi. Pathology
   vii. Nuclear Medicine
   viii. Radiotherapy
   ix. HLA/transplant immunology

2. **CLINICAL HAEMATOLOGY TRAINING:** Under the faculty's guidance and supervision, the postdoctoral student will be responsible for the acquisition of knowledge in all areas of Haematology (clinical and laboratory) and Transfusion Medicine. Such knowledge will be acquired through bedside teaching, seminars, case presentations, journal clubs, tutorials, proper use of the library, and formal reviews of selected major topics. Faculty should be present at various exercises to provide appropriate input. The trainee will acquire clinical experience by day-to-day management of all patients admitted to the Haematology service under the faculty's supervision.

   i. **Basic Haematology:**
      a. Cell Cycle and haematopoiesis, iron, vitamin B12 and folate metabolism, concepts of coagulation and natural anticoagulant, structure, and functions of all types of blood cells.
      b. Principles of chemotherapy, concepts of combination chemotherapy, their toxicities.
      c. Monoclonal antibodies, immunotherapy and small molecules in Haematology, their use and toxicities.
      d. Immunology: principles of innate and adaptive immunity and transplant immunology.

ii. **Disorders of Red Cell:** Clinical evaluation of a patient with anemia, adequate history taking, clinical examination, appropriate laboratory investigations, and management.

a. Iron deficiency anemia: Iron metabolism and its regulation, pathophysiology of iron deficiency, epidemiology, iron deficiency as a community health program, causes in the population, control strategies in the population. Interpretation of serum iron, TIBC, transferrin, ferritin to diagnose iron deficiency. Relevant test to establish the cause of the iron deficiency. Management, including iron replacement and treatment of the underlying cause. Epidemiological significance of iron deficiency anemia in the population and preventive strategies.

b. Vitamin B12 and folate deficiency: Understanding the role of Vitamin B12 and folate in cellular metabolism and the interaction of disease and drugs with B12 and folate metabolism. Clinical and laboratory evaluation of the deficiency and management of vitamin B12 and folate deficiency.

iii. **Haemolyticanaemia:**

a. Thalassemia and Haemoglobinopathies: Genetic basis and pathophysiology of the disorder, clinical and laboratory evaluation of the patient, with their management, and long-term follow-up. Adequate knowledge on transfusion regimes, chelation, thalassemia complications, the role of splenectomy, and HSCT. Principles of control of the thalassemia syndromes in the population, screening strategies, antenatal diagnosis, genetic counseling and monitoring of complications due to iron overload.

b. Sickle cell disease: Pathophysiology, evaluation, management of the steady-state as well as various sickle cell crises and management of chronic complications. Clinical and haematological features of the various sickle cell diseases. Therapeutic role of HSCT.

c. Inherited enzymopathies (Red cell G6PD deficiency & others) and membrane opathies: evaluation, planning and interpretation of investigations (like Osmotic Fragility Test and Eosin-5'-Maleimide dye binding test) to ascertain the diagnosis, and management. The precise role of splenectomy in the present era and emphasis on genetic counseling.

d. Acquired Haemolytic disorders: evaluation and management of acquired haemolytic anemia, the role of immunosuppression, intravenous immunoglobulin, plasmapheresis and role of splenectomy.

e. Management of rare congenital and acquired red cell disorders like porphyria, congenital dyserythropoietic anemia, pure red cell aplasia (inherited and acquired), side roblastic anemias, and non-spherocytichaemolytic anemia etc.

iv. **Disorder of White Cell**:

a. Neutropaenia: Clinical evaluation of the neutropenic patient, role of surveillance microbiology, antimicrobial therapy in neutropenia with emphasis on the multidrug-resistant organism, role of growth factors, barrier nursing, and principles of providing a sterile environment for the neutropenic patient. Evaluation and management of inherited neutrophil disorders.

b. Functional disorders of neutrophils: laboratory tests for evaluating neutrophil dysfunction, and the role of growth factors, antimicrobial prophylaxis, and HSCT in its management.

c. Leukemia (acute and chronic): Clinical evaluation, diagnostic confirmation by morphology, immunopheno typing, special stains, cytogenetics, and molecular genetics. They should know the algorithmic approach in immunopheno typing for diagnosis of leukemia's. The trainee must be familiar with the principles of leukemia management and standard protocols available. They should understand the pharmacology of chemotherapeutic drugs, their mode of administration, toxicity and complications such as extravasation. They should have knowledge of supportive care, including transfusion support in managing patients with all types of leukemia. The trainee should be familiar with the management of complications like hyper leukocytosis, tumor lysis syndrome and drug toxicities.

d. Myeloproliferative neoplasms (MPN): Classification, systematic diagnostic evaluation of MPNs, risk stratification, and current management strategies, including the role of HSCT.

e. Myelodysplastic syndrome (MDS): Clinical evaluation, diagnosis, risk stratification, and management, including the role of supportive care and HSCT.

f. Lymphoma: WHO classification of lymphomas, clinical evaluation, principles of diagnosis, and staging. Immunophenotypic (flow cytometry and immunohistochemistry) approach to diagnosis of lymphoproliferative disorders, role of cytogenetic and molecular tests in diagnosis and prognostication of lymphomas. Management of the different types of

lymphomas including chemotherapy, HSCT, maintenance therapy and follow-up.

g. Multiple Myeloma and other Para protein disorders: Clinical, laboratory and radiological evaluation of a patient with plasma cell disorders. Interpretation of electrophoresis and imaging reports, assessment of end-organ damage, role of flow cytometry, cytogenetics and risk stratification in diagnosis and management. Treatment algorithm of plasma cell dyscrasia and response assessment. Role of HSCT, post-transplant consolidation, maintenance therapy, and follow-up. Management of complications like anaemia, renal failure, hypercalcemia, infections, bone disease and hyper viscosity. Concepts of monoclonal gammopathy of undetermined/renal/clinical significance. Evaluation and treatment of Waldenstrom's macroglobulinemia and other rare para proteinemias.
h. Immunodeficiency disorders: Trainees must be able to investigate and manage primary immunodeficiency disorder systematically. They should have adequate knowledge of immunoglobulin replacement principles, interferons, growth factors, antibiotic prophylaxis, and role HSCT. They should have adequate knowledge on the haematological manifestations of acquired immunodeficiency disorders and its management.
i. Disorders of histiocytic: Evaluation and management of Haemophago cyticlympho histiocytosis and histiocytic malignancies, Langerhans cell history to is and storage disorders.

v. **Pancytopenia:**

a. Aplasticanaemia: Etiology, pathophysiology, evaluation, and management, including immune suppression (anti-thymocyte globulin, cyclosporine), eltrombopag, and supportive therapy. Role of HSCT including the role of haploidentical transplant. Management of a relapsed case of aplastic anaemia.
b. Bone marrow failure syndrome (BMFS): Etiology, classification, pathophysiology, clinical features of various bone marrow failure syndromes. Clinical evaluation and investigations including the role of cytogenetics, stress cytogenetics and relevant molecular workup for confirmation of the diagnosis. Knowledge of telomeropathies and ribosomopathies and their management. Therapeutic strategies for various BMFS with curative treatment options of HSCT and role of supportive care.

c. Evaluation and management of pancytopenia due to other systemic disorders, drugs, autoimmune disorders and sepsis.

vi. **Haemostasis and thrombosis:**

a. Trainees should be thorough with the clinical and laboratory approach to a patient with a bleeding tendency.

b. Thrombocytopaenia: Evaluation and investigation of the cause of thrombocytopaenia and its management.

c. Inherited platelet function disorders: Clinical evaluation, laboratory diagnostic strategies, and management. Interpretation of platelet aggregation studies, flow cytometry and viscoelastic tests for platelet defects.

d. Inherited coagulation factor deficiencies: Clinical evaluation and laboratory diagnosis of haemophilia, principles of factor replacement, prophylaxis strategies and on-demand therapy, replacement schedule in a person with haemophilia who needs surgery, in the event of major bleed or trauma, and management of complications of haemophilia including arthropathies. Concepts of development of inhibitor and interpretation of inhibitor assay. Principles of managing patients with inhibitors including management of breakthrough bleeds.

e. Acquired bleeding disorders: Evaluation and management of DIC, haemorrhagic complications of liver disease, renal failure, acquired coagulation factor deficiency and drug related platelet disorder. Management of thrombocytopenia in pregnancy.

f. Thrombotic disorders: Classification and laboratory diagnosis of inherited thrombotic disorders, evaluation of acquired thrombotic disorders with emphasis on cancer related thrombosis, the clinical use of anticoagulants, duration of therapy, and monitoring emphasizing the upcoming role of DOACs.

vii. **Haematopoietic stem cell transplantation (HSCT):**

a. Indication sand outcome of HSCT in various diseases. Role of autologous and allogenic transplant in different diseases. Indications and outcome of HLA matched sibling donor, matched unrelated donor, cord blood and haploidentical transplant in different diseases.

b. Thorough knowledge on donor selection.

c. Conditioning regimens used for different disease. Strategies for GvHD prevention.
d. Peripheral blood and bone marrow harvest of stem cell and its manipulation, cryopreservation.
e. Supportive care and management of complications in the post-transplant period.
f. Monitoring and management of the long-term complications in post-transplant patients.
g. Post-transplant vaccination.
h. Post-transplant immune reconstitution and interpretation of chimerism studies.

viii. **Consultation Haematology:**

a. Haematological complications of pregnancy.
b. Haematological complications of systemic disease.
c. Haematological problems of the intensive care patient.
d. Drugs-related haematological issues.
e. Haematological problems in the newborn.
f. Consults in rheumatology – APS/ HLH/ MAS/ CAPS
g. Haematological consults in geriatric medicine
h. Haematological manifestations in solid malignancies e.g. myelopthisic anemia, cancer related thrombosis.

ix. **Supportive care:**

a. Management of nausea, vomiting, diarrhoea.
b. Pain management.
c. Management of cytopaenia and its complications like infections, bleeding, and anaemia.
d. Gonad preservation.
e. Parenteral and enteral nutritional support, diet.
f. Infection control, environmental measures, hygiene.

x. **Recent Advances in Haematology:**

a. Recent concepts on iron metabolism, coagulation, and other basic aspects of Haematology.
b. Recent advances in molecular biology in Haematology.
c. Modern diagnostic tools in Haematology.

d. Recent advances in the understanding of haematological diseases.
e. New drugs in Haematology, including monoclonal antibodies, targeted therapy, and small molecules
f. Management of multidrug resistant organisms and newer antimicrobials.
g. New developments and upcoming role of imaging in Haematology
h. Advances in HSCT, CAR-T cell therapy, and gene therapy.
i. New developments in Haematology as discussed in yearly international conferences and webinars.

xi. **Transfusion Medicine:**

a. Blood component preparation and clinical use: Blood collection, knowledge on anticoagulants used in storage and their effect on storage. Component preparation and storage. Quality assurance in transfusion medicine.
b. A thorough understanding of the clinical indications for the proper use of specific blood components.
c. Diagnosis and management of transfusion associated complications.
d. Concepts and indication of leucodepletion and irradiation of blood components. Knowledge on the performance of the same.
e. Screening and management of allo-immunisation concerning transfusion.
f. Principles of the plasmapheresis. Principles of the machine, continuous versus intermittent flow techniques, replacement fluids for plasmapheresis, current status, and indication in various diseases should also be known and understood.

xii. **Bioethics:**

a. Respect human life and the dignity of every individual.
b. Refrain from supporting or committing crimes against humanity and condemn all such acts.
c. Treat the sick and injured with competence and compassion and without prejudice and apply the knowledge and skills when needed.
d. Protect the privacy and confidentiality of those for whom we care and breach that confidence only when keeping it would seriously threaten their health and safety or that of others.
e. Work freely with colleagues to discover, develop, and promote advances in medicine and public health that ameliorate suffering and contribute to human well being

f. Educate the public about the present and future threats to the health of humanity.
g. Advocate for social, economic, educational, and political changes that ameliorate suffering and contribute to human wellbeing.
h. Teach and mentor those who follow us, for they are the future of our caring profession.

xiii. **Research and biostatistics:** Clinical trial protocol designing, Clinical epidemiology, Biostatistics, Bioethics, and Medico-legal issues pertaining to study patients.

3. LABORATORY HAEMATOLOGY:

i. **Laboratory Equipment's and organization:**

a. Proper use and care of common laboratory instruments such as the light microscope, centrifuge, water baths, freezers, etc.
b. Trainee must have adequate knowledge of all laboratory equipment's essential maintenance, including their calibration procedure and frequency.
c. Knowledge on setting up a Haematology laboratory, its workflow procedures, handling, storage, and sample disposal.
d. Technical and non-technical personnel requirements, their periodic training, and safety.
e. Maintenance of record, data preservation, and generation of laboratory statistics.
f. Quality assurance (Internal and External) measures and assessment of pre-analytical, analytical, and post-analytical variables. Period audits to ensure precision and accuracy of lab results.

ii. **Basics of Laboratory Haematology**

a. Blood collection of samples by venipuncture and finger prick methods.
b. Knowledge about the types of vacutainers and anticoagulants used for sample collection, the ratio of sample to the anticoagulant, the effects of delay in sample processing, and proper temperature of sample storage.
c. Determination of blood counts (haemoglobin, haematocrit and other red cell indices, total and differential WBC counts andplatelet count) manually.
d. Use of automated electronic blood cell counters, including principles and practice. Interpretation of the parameters of advanced cell counters.
e. Preparation, staining, and interpretation of peripheral blood smears.

f. Review of normal and abnormal blood smears with emphasis on:
   - Morphology of red cells, white cells, and platelets.
   - Performance of WBC differential count.
   - Subjective assessment of platelet count.
   - Interpretation of abnormal smear to ascertain approach to diagnosis.

g. Supravitally staining of reticulocytes: manual and automated techniques and interpretation of the results.

h. Performance of bone marrow aspiration and trephine needle biopsy.

i. Preparation of smears of bone marrow aspirates and biopsy imprints (touch preparations) and their staining by Romano sky stain as well as special stains like Perl's stain, PAS, Sudan Black B, Myeloperoxidase, Specific, on-specific and Dual esterase.

j. Performance and interpretation of HbS (sickle hemoglobin) solubility test, screening for red cell G6PD activity and its interpretation.

iii. **Laboratory Investigation of HaemolyticAnaemias:**

Red cell membrane disorders and Immune Haemolyticanaemias:

a. Quantitation of normal HbA, HbF, HbA2 and abnormal HbS, HbD,HbE,HbC, etc., by electrophoresis and chromatography.

b. Screening for unstable haemoglobin (heat instability and Isopropanol tests).

c. Supravital staining for HbH inclusions.

d. Standard hypotonic saline osmotic fragility test, incubated osmotic fragility test and Eosin-5'-Maleimide binding test by flow cytometry.

e. Heinz body preparation.

f. Screening for red cell G6PD deficiency and quantitative estimation of red cellG6PD activity.

g. Screening for red cell pyruvate kinase (PK) deficiency and assay of red cell pyruvate kinase activity.

h. Screening for other red cell enzymopathies.

i. PNH flow cytometry and FLAER for PNH, Urine haemosiderin.

j. Direct and indirect anti globulin (Coombs) tests, warm and cold autoantibody (Cold agglutinin) titre, determination of thermal amplitude of cold agglutinin.

k. Role of flow cytometry in the evaluation of Haemolyticanaemia.

l. Role of molecular techniques including NGS in the diagnosis of Haemolyticanaemia.

m. Sickling test.

Miscellaneous biochemical tests on Red cells, Plasma, and Urine:

a. Examination of urine red cells, haemosiderin, haemoglobin, urobilinogen, and bilirubin.
b. Principles of estimation and significance of serum ferritin, iron, TIBC, serum cobalamin, red cell folate, serum folate, cry globulin.

iv. **Laboratory Investigation of Bleeding Disorders:**

Investigation of platelets disorders:

a. Performance of platelet count and morphology, ivy bleeding time, and template bleeding time. Interpretation of MPV and IPF in patients with low platelet counts.
b. Principles, practice, and interpretation of platelet aggregation study and thromboelastographic.
c. Understand the technique and use of flow cytometry in the diagnosis of platelet disorders.
d. Laboratory evaluation of suspected heparin-induced thrombocytopenia (HIT).

Screening and diagnosis of coagulation factor abnormalities:

a. Prothrombin time (PT), activated partial thromboplastin time (APTT), thrombin time (TT).
b. Plasma fibrinogen assay, differentiation of afibrinogenaemia, and dysfibrinogenemia.
c. FDP and D- Dimers
d. Correction studies (Mixing studies) with normal plasma, and factor deficient plasma. APTT based inhibitor screen assay for both immediate acting inhibitor and time dependent inhibitors.
e. Assays of clotting factors with particular emphasis on factors VIII and IX.
f. Urea solubility test and an assay of factor XIII
g. Screening for inhibitors against coagulation factor, especially factor VIII and IX, titration of inhibitor by Bethesda assay.

Relevant tests of fibrinolytic activity:

a. Laboratory Investigation of Thrombotic disorders:
    - Assays of plasma Antithrombin, protein C, protein Sand Activated Protein C resistance for factor V Leiden.

- Principles of screening tests and interpretation of results for lupus anticoagulant by dRVVT as well as anticardiolipin and anti-β2glycoprotein-1 antibodies.
- Laboratory monitoring of anticoagulant (heparin and direct oral anti-coagulant) therapy: Anti-Xa activity diluted Thrombin Time, and Ecarin clotting time. Diagnosis of Heparin induced thrombocytopenia.
- Molecular tests for diagnosis of thrombophilia like Factor V Leiden, Prothrombin P20210A, MTHFR mutation etc.

b. Flow Cytometry: The trainee should be well versed with the principle of flow cytometry and- flow cytometer's functioning. They must be thorough with the procedure's sample requirements, processing, and analysis of the results. They should be well-versed in the interpretation of flow cytometry results for the diagnosis of haematological malignancies. They must also understand the role of a flow cytometer in evaluating red cell and platelet disorders.

c. Cytogenetics: Understanding the principle and technique of cytogenetics (particularly conventional karyotype and fluorescence in-situ hybridization), relevance, and significance of chromosomal studies in the context of various diseases.

d. Molecular Biology: Understanding the principle involved in the molecular diagnosis of hematological disorders:
   - DNA and RNA extraction.
   - RT-PCR and RQ-PCR.
   - RFLP and other techniques to evaluate polymorphisms.
   - Difference methods of mutation detection, their principle, and technique.
   - DNA Sequencing and fragment length analysis for monitoring response to therapy.

e. Transfusion Medicine:
   - Basic laboratory aspect of transfusion medicine:
   - ABO blood grouping (forward and reverse), Rh typing Wof donors and recipient's indirect ant globulin test), antibody identification following elution by various techniques.
   - Blood group compatibility (cross-matching).
   - Investigation of ABO, Rh, and another immune-Haemolytic disease of the newborn.

- Investigations of platelet refractoriness and heparin-induced thrombocytopenia.
- Donor recruitment, their clinical and laboratory evaluation before phlebotomy.
- Principles of phlebotomy.
- Blood component preparation and storage.
- Practical and documentation procedures involved in issuing and transfusing blood and cellular components.
- Principles and mechanics of blood component preparation.
- Principles of apheresis and performance of the procedure concerning the collection of platelets, granulocyte, and stem cells.
- Principle and performance of plasmapheresis.
- Practical steps in the laboratory investigation of transfusion reactions.

f. Histopathology: Practical laboratory training and related theory should cover the following areas:
   - Tissue processing (particularly trephine biopsy and lymph nodes)
   - Techniques of cytology, including cytosine concerning body fluid, CSF in particular.

g. Knowledge in anatomic pathology and immunohistochemistry relevant to the diagnosis of the hematological disorder.

h. Biochemistry: Knowledge of the principle, technique, and interpretation of immunoassays, electrophoresis, nephelometry, etc. The role of proper and adequate sample collection and transport for the tests.

i. HLA module: understanding the principles of:
   - Separation of lymphocytes using density gradient centrifugation.
   - The micro-lymph cytotoxicity test and its application in HLA typing, cross-matching, and antibody screening.
   - DNA-based HLA typing, including high-resolution HLA typing using next-generation sequencing.
   - HLA antibody identification.

j. Nuclear Medicine: Principle of PET scan and its role in diagnosis, response assessment, and monitoring of haematological disorders

k. Radiation Oncology: The students should be encouraged to learn about radiotherapy basics and have hands-on training on linear accelerator, IGRT, IMRT, TBI, CRRT in haemato-oncological practice and blood components radiation.

V. COMPETENCIES

1. **Haematology Ward and Ancillary rotations:** The candidate works in the department of haematology as follows:

2. **Inpatient posting** (12 months): the candidate will be allotted beds, and they are required to work up patients admitted on those beds. The trainee will assume complete responsibility for the patients during their hospitalization and plan the diagnostic workup and treatment, discusses it with the concerned consultants, presents it on the grand rounds. Trainee should work in harmony with the support staff of the ward, including the nursing team.

3. **Out-patient department (OPD) posting** (12 months): the candidate will be posted to haematology OPD where he learns the nuances of evaluation of malignant and non-malignant haematology and HSCT follow-ups. Trainee will be involved in managing specialized leukemia's, myeloma, bleeding & clotting disorders, Hemolytic anemias, and cancer survivor clinics. The candidates posted to these clinics work under the supervision of consultants. They are expected to see new and follow-up patients, plan out the management and assess the therapeutic responses.

4. **Daycare posting**(4months): during this posting, the candidate is expected to learn skills in introducing and managing central venous catheters and PICC lines. They must be familiar with the care of central venous access device. They have to acquire adequate skills in procedures like bone marrow aspiration and biopsy, lumbar puncture, intrathecal chemotherapy administration, and aspiration of fluids. They must manage daycare chemotherapy, manage acute adverse reactions, plan, and supervise transfusion therapy, especially in chronic disorders like thalassemia, managing bleeding episodes in haemophilia with factor replacement, etc.

5. **BMT posting** (2 months): The candidate works under the supervision of concerned consultants and assumes the responsibility of managing the patients undergoing HSCT.

6. **Laboratory Haematology including cytogenetics and molecular genetics** (4 months): the candidate is expected the learn and sign out complete blood count and peripheral smear report. The candidate should be thorough with slide preparation and reporting of bone marrow aspiration and biopsy, work-up of haemolytic anemia, bleeding, coagulation and thrombotic disorders. The candidate should have basic understanding of flow cytometry, FISH, cytogenetics and molecular genetic techniques

that are essential in diagnosing patients. The trainee should also have a thorough knowledge of lymph node histology and IHC reporting.

7. **Ancillary posting:**
   i. **Transfusion medicine and laboratory immunology** (2 weeks): The trainee should learn the basis of blood compatibility, the principles and methods of screening and cross-matching, procurement and preservation of blood and blood components, and clinical use for specific component therapy. Trainee should also learn the quality control and quality assurance program with the blood bank. Trainee should learn the principles of immune-haematology and various other tests being conducted in the blood bank.
   ii. **Radiotherapy (2 weeks):** The trainee should learn the principles of radiotherapy, the use of various radioisotopes. Radiotherapy in the management of NHL, Hodgkin's disease, multiple myeloma, CNS prophylaxis in acute leukemia's. They will also familiarize themselves with various radiotherapy equipment.
   iii. **Nuclear medicine and radiology (2 weeks):** The trainee is expected to acquire the basic knowledge of imaging modalities including PET/CT scan, and their interpretation in diagnosing haematological disorders and complication arising during treatment.
   iv. **Microbiology and Biochemistry (2 weeks):** The candidate should have knowledge on the staining and culture techniques used in microbiology including the emerging use of molecular techniques in diagnosis and monitoring of infections. They should have knowledge on the principles and techniques of basic biochemistry test. They should be able to perform and interpret serum and urine protein electrophoresis and immune fixation.

8. **RESEARCH TRAINING:** The candidate is introduced to the field of research in haematology, both at the clinical and laboratory level.

9. **PRACTICAL HAND ON TRAINING:**
   i. **Anti-cancer drug administration.** The trainee should know how to prescribe and safely administer anticancer agents, including chemotherapeutic and biological agents.
   ii. **The trainee should be well conversant with the care of indwelling venous catheters**—insertion of PICC line and another central venous access device, including tunneled catheter and chemo port placement.

iii. **Bone Marrow Aspiration, Biopsy**: Trainees should be able to perform a marrow aspiration and biopsy. They should have experience in the interpretation of marrow aspirations and biopsies.

iv. Lumbar Puncture Training must demonstrate an ability to perform a lumbar puncture, perform and interpret a CSF analysis report, and administer chemotherapy by that route.

v. **Paracentesis**: ascetic fluid tapping, indications, fluid analysis, and interpretation

   a. Thoracentesis and chest tube placement

   b. Interpretation of the graphs and plots of a report of an automated cell counter.

   c. Interpretation of flow cytometry for acute leukemia, CLPD and MRD

   d. Interpretation of Bethesda assay and viscoelastic testing

   e. Interpretation of HPLC chromatograms

VI. LOGBOOK

1. A candidate shall maintain a logbook of operations (assisted/performed) during the training period, certified by the concerned postgraduate teacher / Head of the department / senior consultant. This logbook shall be made available to the board of examiners for their perusal at the time of final examination. The candidate will maintain the record of all academic activities undertaken by the trainee in the logbook. It should be duly certified by the supervisor countersigned by the administrative head of the Institution. In the absence of production of the logbook, the result will not be declared.

2. The logbook should have the following records:

    i. Personal profile of the candidate
    ii. Educational qualification/Professional data
    iii. Record of case seen, management plan, and outcome
    iv. Procedures learnt and performed
    v. Record of laboratory tests performed

VII. RECOMMENDED TEXT-BOOKS AND JOURNALS

Haematology specific journal

Journal name	Impact factor as on January 2021
Blood	17.543
The Lancet Haematology	10.406
Leukemia	8.665
Haematologica	7.116
Critical Reviews in Oncology/Haematology	5.833
British Journal of Haematology	5.518
American Journal of Haematology	5.303
Blood Advances	4.91
Journal of Thrombosis and Haemostasis	4.662
Seminars in Haematology	4.379
Journal of Leukocyte Biology	4.289
Biology of Blood & HSCT	3.853
HSCT	3.57
Therapeutic Advances in Haematology	3.456
Journal of Haematology& Oncology	3.231
Journal of Transfusion Medicine	2.159
Clinical Lymphoma, Myeloma and Leukemia Journal	2.02
Mediterranean Journal of Haematology and Infectious Diseases	1.6
BMC Haematology	1.22
Indian Journal of Haematology and Blood Transfusion	0.925
BMC Blood disorders	0.91
Advances in Haematology	0.516
Blood research	0.39

Other Journal

Journal name	Impact factor as on January 2021
The Lancet	60.392
Science	41.845
New England Journal of Medicine	74.699
Nature	42.778
British Medical Journal	30.223

BOOKS FOR READING (LATEST EDITION)

1. William's Haematology [Beutler, Lichtman, Coller & Kipps]
2. Wintrobe's Clinical Haematology [Greer et al]
3. Haematology– Basic Principles & Practice [Hoffman, Benz, Shattil, Furie, Cohen & Silberstein]
4. Postgraduate Haematology [Victor Hoff brand et al]
5. Practical Haematology [Dacie & Lewis]
6. WHO manual of classification of haematolymphoid malignancies.
7. HSCT. [Forman, Blume & Thomas]
8. Clinical bone marrow and blood HSCT [Atkinson et al]
9. The molecular basis of Blood Diseases [Stamatoyannopoulos, Neinhuis, Leder& Majerus].
10. Pediatrics Haematology by [Nathan & Ozaskie]
11. Cancer Chemotherapy Handbook, BAQUIRANJ DELIA
12. The Lymphomas, CANELLOS,G.P.et al
13. Chemotherapy source book, PERRY, M.C
14. Leukaemia, HENDERSON,E.S.et al
15. Atlas of clinical Haematology, BEGEMANN
16. Text book of Malignant Haematology, Degos.L et al
17. Clinical Haematology, ROCHARD Lee. et al
18. Magrath, I. The Non-Hodgkin's Lymphoma,
19. American Society of Haematology-self assessment program (two yearly publication)
20. American Society of Haematology- education book (yearly publication)
21. Leukemia Diagnosis (Barbara J Bain)
22. Bone marrow pathology (Barbara J Bain)
23. De Gruchy's Clinical Haematology in Medical Practices (De Gruchy)