

**Training Syllabus**  
**CLINICAL SYLLABUS**



**SYLLABUS FOR TRAINING IN CLINICAL PAEDIATRIC METABOLIC MEDICINE**

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Paediatrics is an independent medical specialty based on the knowledge and skills required for the prevention, diagnosis and management of all aspects of illness and injury affecting children of all age groups from birth to the end of adolescence, up to the age of 18 years. It is not just about the recognition and treatment of illness in babies and children. It also encompasses child health, which covers all aspects of growth and development and the prevention of disease. The influence of the family and other environmental factors also play a large role in the development of the child, and many conditions require life-long management and follow-up before a smooth transition of care to adult services.

For these reasons we believe that all doctors practising Paediatric Metabolic Medicine require a solid basic training in General Paediatrics, as set out by many National Training Authorities (NTAs), and in the recommended European Common Trunk Syllabus, approved by the EAP-UEMS. This training, which should be of 3 years minimum duration, can either act as a prelude to specialist training, or may take place alongside it, and will underpin many of the principles set out in this specialist syllabus.

This document sets out the minimum requirements for training in Tertiary Care Paediatric Metabolic Medicine. Metabolic Medicine is a subsection of the Tertiary Care Group of the European Academy of Paediatrics, itself a section of the European Union of Medical Specialists (Union Europeenne des Mediciens Specialistes (UEMS)) through the European Board of Paediatrics (EBP).

The subspecialty of Paediatric Metabolic Medicine concerns inherited disorders that affect the body's biochemical reactions. There are many rare metabolic diseases that can affect the function of any organ system and can present at any age. Metabolic Paediatricians require detailed knowledge of normal biochemistry and the impact of disorders and they use this knowledge for diagnosis and management. They strive to improve the early recognition of metabolic disorders, including through newborn screening. They participate in research and work closely with laboratory scientists, dietitians, pharmacists and nurses.

This syllabus is intended as a guide. Whilst the training should be comprehensive, it is recognized that not all subjects can be covered in the same detail. Changes may also be necessary to meet local needs.

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### C.1 KNOWLEDGE

#### C.1.1 Physiology and Biochemistry

The normal physiology and biochemistry, including changes during childhood, of:

- fluid and electrolyte balance.
- acid - base regulation
- intermediary metabolism including blood glucose and metabolic response to fasting, lactate, ammonia, aminoacids, organic acids and fatty acid metabolism.
- oxidative phosphorylation and the respiratory chain
- lipids and lipoproteins
- cholesterol and other sterols
- lysosome and peroxisome metabolism
- purines and pyrimidines
- porphyrins
- calcium metabolism
- bilirubin
- trace metal metabolism
- relevant aspects of brain metabolism including neurotransmitters. The role of the blood brain barrier
- Golgi and ER metabolism with a focus on protein glycosylation
- enzyme biochemistry and tissue expression

### C.1.2 Paediatric Metabolic Disease

- The pathological and biochemical changes, clinical symptoms, investigations and management in metabolic disorders of these pathways and organelles, as listed in the appendix.
- Specific Drug management. An understanding and experience of the drugs used for the treatment of metabolic disorders.
- Transplantation. The metabolic indications for and long term follow up of liver transplantation
- haematopoietic stem cell transplantation
- renal transplantation
- Principles of *ex vivo* and *in vivo* gene transfer and its relevance to IEM
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### C.1.3 Nutrition

- The normal nutritional requirements of protein, energy, vitamins and minerals for normal growth and development.
- The principles of dietary therapy including the consequences of changes in the intakes of nutrients. Consequences of under-nutrition and specific nutritional deficiencies.

### C.1.4 Genetics

- Mechanisms of inheritance and an understanding of molecular genetics including mitochondrial DNA
- Understanding of principles of prenatal diagnosis

### C.1.5 Development

- Normal intellectual and psychological development
- Methods of assessment of DQ, IQ, behaviour and neuropsychological function

### C.1.6 Research

- Principles of Good Clinical Practice (GCP) in Clinical Trials

## C.2. SKILLS

### C.2.1 Clinical skills

1. Assessment and investigation of metabolic causes of :
  - Acute encephalopathy
  - Neurological disease to include retardation, regression, seizures,
  - Liver disease including acute liver failure
  - Hepatosplenomegaly
  - Cardiomyopathy
  - Ophthalmological disease
  - Skeletal disorders
  - Skin disorders
  - Renal disorders including the Fanconi syndrome

- Nutritional status and growth
  - Muscle disease
2. Emergency management and indications for and the use of:
    - assisted ventilation
    - peritoneal dialysis
    - haemodialysis, haemofiltration and related techniques
    - intracranial pressure monitoring
  3. Genetic counselling and counselling prior to prenatal diagnosis

### C.2.2 Technical Skills

1. Interpretation of the investigations including understanding analytical, physiological and nutritional factors that influence the results. The use of investigations for long term monitoring of metabolic disorders.
  - Aminoacids
  - Ammonia
  - Organic acids (including interpretation of GC/MS data)
  - Intermediary metabolites: glucose, FFA, lactate, ketones
  - Acylcarnitines
  - Glycosaminoglycans
  - Lipids and lipoproteins
  - Peroxisomal enzymes and metabolites (VLCFA, pristanoate, phytanate, etc)
  - Purines and pyrimidines

Neurotransmitter and biogenic amine metabolites in CSF and other fluids  
 Vitamin, mineral and other nutrient analyses including copper and caeruloplasmin

  - Cholesterol and other sterols
  - Porphyrins, bilirubin and related compounds
2. Indications and interpretation of:
  - fasting test for disorders of intermediary metabolism
  - glucagon test
  - tests for co-factor responsive disorders (such as B12 test for MMA, BH4 for hyperphenylalaninemia )
  - loading tests ( protein, amino acid...)
  - newborn screening methods
  - enzymatic studies: specific and non specific assays
3. Biopsies -indications for, planning and interpretation of:
  - skin biopsy (for fibroblast culture)
  - liver biopsy
  - muscle biopsy (needle and open)
  - and other biopsies
4. Experience of the use and interpretation of molecular genetic techniques including NGS, WES etc....
5. Practical aspects of dietary management:
  - evaluation of nutritional intake and requirements
  - low protein diets and those with controlled aminoacid intake (e.g. MSUD, PKU including the management in pregnancy)
  - low and very low fat diets
  - galactose and fructose free diets
  - dietary management of glycogen storage disease
  - emergency /metabolic crisis regimens

- electrolyte replacement regimens (for treatment of Fanconi syndrome)

#### 6. Interpretation of psychological and neuropsychometric testing

#### C.2.3 Management skills

- Understanding of management skills required for development and use of resources in the metabolic unit, including budget control, contracting, strategic planning and writing a business plan.
- Experience of day-to-day running of a paediatric metabolic service including management of admission policies within the medical directorate system.
- Importance of and involvement in clinical audit structure and function of local, regional and national NHS organisation

#### C.2.4 Academic skills

- Critical evaluation of clinical results from literature review and audit
- Manuscript preparation
- Oral presentation skills

#### C.2.5 Teaching skills

- Formal and informal teaching skills at undergraduate and postgraduate level
- Development of core teaching material to enable participation in teaching programmes on a regular basis
- Organization of a postgraduate teaching programme

#### C.2.6 Organizational skills

- Routine departmental tasks including duty rotas, teaching programmes and postgraduate meetings

#### C.2.7 Research skills

- Design of clinical trials including medical statistics
- Data organization and presentation
- Computer literacy

### C.3. ATTITUDES

#### C.3.1 Clinical

- Appreciate the patient and families' understanding of metabolic disease
- Understanding of psychological stress of diagnosis of metabolic disorders
- Understanding of ethnic and cultural differences in attitudes to metabolic disorders.
- Understanding of the problems for the patient and family of progressive disorders and disorders in which the natural history is very difficult to predict such as Leigh's disease.
- Working in partnership with others who care for the children to include multidisciplinary teams, education authorities, etc.

#### C.3.2 Communication

- Effective communication and appropriate approach to parents, children, colleagues primary care physicians and community health care staff, research and laboratory staff and managers

### **C.3.3 Education**

- Commitment to continuing self-education and to teaching others

### **C.3.4 Support and leadership**

- Supportive and sympathetic approach to handling families which can be maintained under difficult circumstances
- Understanding and positive approach to the supervision of junior medical staff
- Recognition of and coping with stress in self and others
- Effective leadership of clinical teams

### **C.3.5 Academic/Research**

- Innovative attitude to clinical problems
- supportive to / active in research
- Collaborative attitude to local and national colleagues

### **C.3.6 Managerial**

- Interest in the overall organisation of departmental activities
- Understanding approach to local management structure
- Constructive attitude to the process of decision making
- Acceptance of shared responsibility for the use of resources
- Ability to respond effectively to clinical complaints

## APPENDIX

### INBORN ERRORS OF METABOLISM

- Disorders of aminoacid and peptide metabolism: Phenylketonuria including the management in pregnancy, homocystinuria, MSUD, etc)
- Disorders of organic acid metabolism (propionic acidaemia, methylmalonic acidaemia, etc)
- Hyperammonaemia and urea cycle disorders including transporter defects (triple-H, lysinuric protein intolerance)
- Disorders of carbohydrate metabolism including transport (GLUT-1, GLUT-2 etc...)  
(Glycogen storage disease, galactosaemia, fructosaemia, etc)
- Disorders of fatty acid oxidation
- Disorders of ketone body metabolism
- Lysosomal storage disorders
- Disorders of lipoproteins and lipid metabolism
- Peroxisomal disorders
- Disorders of purine and pyrimidine metabolism
- Disorders of calcium metabolism
- Disorders of metal metabolism (Wilson's disease, Menkes syndrome, etc)
- Respiratory Chain Defects and Congenital lactic acidoses (PDH, PC, TCA defects)
- Porphyrrias
- Disorders of cholesterol, sterol and bile acid metabolism
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- Disorders of vitamin metabolism (biotin, cobalamin, etc)
- Defects of membrane transport (lysinuric protein intolerance, etc)
- Defects of glycosylation
- Defects of creatine synthesis and transport
- Defects of neurotransmitter synthesis and metabolism
- Defects of phospholipid and sphingolipid synthesis
- Defects of connective tissue