

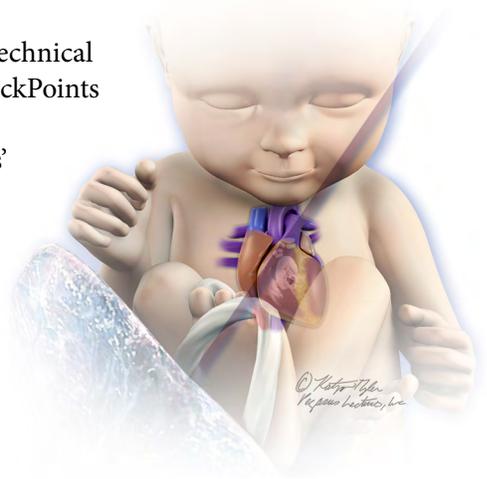
# FUNDAMENTALS OF FETAL ECHOCARDIOGRAPHY

## EOURSE

### SUMMARY

The Fetal Echocardiography series provides a comprehensive resource for physicians, sonographers and healthcare professionals interested in learning more about or integrating fetal echocardiography into their practice. Beginning with a review of the fetal cardiac anatomy, interactive didactic lectures cover a plethora of fetal cardiac pathologies as well as focusing on how to recognize the sick fetus, how to implement a multi-disciplinary approach to perinatal management and, when applicable, surgical options to consider. Since the ability to recognize pathology is based on a solid understanding of normal anatomy and physiology, we have included a ScanLab which demonstrates the normal fetal cardiac anatomy and physiology, including color and spectral Doppler.

In addition to scanning techniques and protocols, Dr. Gardiner provides technical tips throughout the ScanLab to aid in image optimization. Interactive CheckPoints are integrated throughout the series to reinforce key concepts, aiding in maximum retention of the content presented. As with all Pegasus Lectures' online courses, the participant is able to create a customized review.



### FACULTY



**Dr. Helena Gardiner, M.D., Ph.D.**

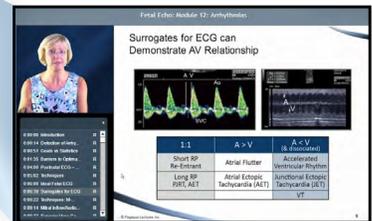
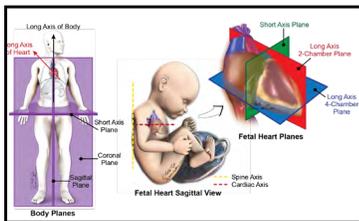
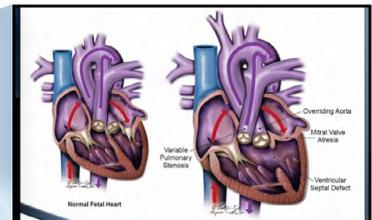
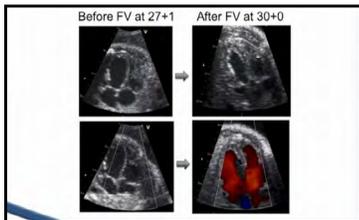
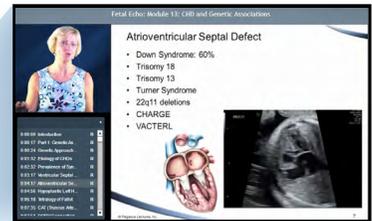
*Fetal Cardiologist  
London, United Kingdom*

Dr. Gardiner has worked in fetal cardiovascular medicine for the last twenty years. She initially trained in pediatrics and neonatal medicine in the United Kingdom and then went on to specialize in Pediatric Cardiology. She was awarded a MRC Research Fellowship, resulting in a PhD thesis on Cardiovascular Programming in the Fetus at the University of Lund, Sweden.

Her clinical/academic appointments include Senior Lecturer/ Reader in Perinatal Cardiology at Imperial College London with appointments at the Royal Brompton and Queen Charlotte's Hospitals, London, UK (1997-2013) and Director of the Fetal Cardiovascular Program, The Fetal Center, McGovern Medical School at UTHealth, Houston, Texas USA (2013-2018). Dr. Gardiner established the Tiny Tickers Charity in the UK to improve awareness of congenital heart disease and improve its prenatal detection and served as Medical Advisor (1999-2013). She was appointed Cardiac Editor for Ultrasound in Obstetrics and Gynecology in 2015.

Dr. Gardiner's clinical and research interests include fetal vascular programming in monochorionic twins, fetal growth restriction and the use of percutaneous fetal valvuloplasty. She is first or senior author of more than 130 peer-reviewed publications, editorials and book chapters.

# FETAL ECHOCARDIOGRAPHY E-COURSE FEATURES & MODULE OVERVIEW



- Flexible 24/7 Viewing
- Dual Video Streaming
- ScanLabs

- Interactive CheckPoints
- Bookmarking Capability
- Modular Delivery

- Customized Review
- Integrated Note-Taking
- Printable PowerPoints



**MODULE 1:**  
Cardiac  
Screening



**MODULE 2:**  
ScanLab



**MODULE 3:**  
Left Heart  
Obstruction



**MODULE 4:**  
Right Heart  
Obstruction



**MODULE 5:**  
Shunts



**MODULE 6:**  
Conotruncal  
Defects Part I



**MODULE 7:**  
Conotruncal  
Defects Part II



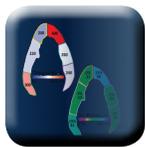
**MODULE 8:**  
Fetal Arches  
& 3VT View



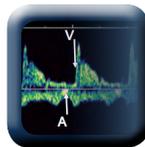
**MODULE 9:**  
Single  
Ventricle



**MODULE 10:**  
Atrial  
Isomerism



**MODULE 11:**  
Recognizing  
the Sick Fetus



**MODULE 12:**  
Fetal  
Arrhythmias



**MODULE 13:**  
Genetic  
Associations



**MODULE 14:**  
Systemic Venous  
Anomalies

## MODULE DESCRIPTIONS



### Module 1: Cardiac Anatomical Screening & Basic Circulation

Beginning with a discussion of body planes vs. heart planes, Helena Gardiner, MD, PhD, presents the American Institute of Ultrasound in Medicine (AIUM) and International Society of Ultrasound in Obstetrics and Gynecology (ISUOG) practice guidelines for sonographic screening of the fetal heart. An in-depth review of each of the positions in the 5 transverse view protocol follows with Dr. Gardiner presenting alternative views as well as the sagittal views of the AIUM guidelines. In the second portion of the module, we review the morphology of the 4-chamber view and recognize the identifying characteristics between the right and left atria, ventricles, aortic and ductal arches. The module concludes with a presentation of the fetal circulation and postnatal changes, including the paths of oxygenated and deoxygenated blood prior to birth, the transition at delivery, and the manifestations post-birth.

**Core Concepts: 1 hour 3 min**  
**Focused Review: 48 min**



### Module 2: ScanLab

This ScanLab is performed in real-time and shows how to obtain diagnostic images in a realistic setting with fetal movement and shadowing. We base our screening and diagnosis on a consistent protocol, the 5 transverse views, augmented by coronal and sagittal views as needed. Objectives of this module include assessing how to optimize images, integrating the use of color Doppler to demonstrate direction of flow as a clue to abnormality, and evaluating spectral Doppler to measure flow velocities through valves to provide physiological information. Understanding the cardiac morphology, connections and relationships is fundamental to improving interpretation of images and to distinguish normal from abnormal.

**Core Concepts: 58 min**  
**Focused Review: 44 min**



### Module 3: Left Heart Obstruction

Module 3 begins by providing an overview of the spectrum of left heart abnormalities. Beginning with aortic stenosis (AoS), Dr. Gardiner covers the characteristics, spectrum, and natural history of fetal aortic stenosis. Fetal valvuloplasty (FV) is discussed as prenatal therapy for fetal AoS with a review of the selection criteria for FV and considerations for fetal intervention. The module also covers hypoplastic left heart syndrome (HLHS), addressing the underlying anatomical changes and the significance of prenatal diagnosis in this ductal dependent lesion. The diagnostic presentation of the 4-chamber view and significance of the color Doppler and spectral Doppler findings in risk stratification of HLHS are discussed. This module concludes with considerations for fetal intervention, associated fetal factors, counseling, surgical considerations, and expected outcomes after surgery.

**Core Concepts: 1 hour**  
**Focused Review: 45 min**



## Module 4: Right Heart Obstruction

The spectrum of right heart abnormalities is discussed, with tips on how to best assess morphology. The first right heart obstruction covered is critical pulmonary stenosis (PS). Morphological specimens provide insight into pulmonary valve pathology with ultrasound images helping to differentiate between mild, moderate, and critical (ductal dependent) PS. Doppler criteria which aids in differentiating levels of pathology are presented. The next section covers Pulmonary Atresia Intact Septum (PAIVS), beginning with characteristics of this pathology, 2D and Doppler findings, occurrence of RV fistula, and concludes by discussing the natural history of fetal PAIVS and rationale for intervention. More rare right heart obstructive lesions presented include Ebstein's malformation, Uhl's malformation and unguarded tricuspid valve (TV). The physiology, 2D and Doppler measurements of right heart obstructions are discussed with an overview of how the right atrial pressure score can help predict the fetal outcome. The module concludes with the rationale for fetal valvuloplasty and the prediction of circulation in the fetus with right heart obstruction.

**Core Concepts: 1 hour 6 min**

**Focused Review: 50 min**



## Module 5: Shunts

The first type of pathology discussed in this module is atrioventricular septal defect (AVSD) with an overview of the characteristics of AVSD (also known as endocardial cushion defect or AV canal defect). The 5 transverse view protocol is presented with tips on how to best recognize this type of pathology. The second portion of this module focuses on the characteristics and types of ventricular septal defects (VSD). Following a review of the regions of the ventricular septum, Dr. Gardiner discusses ventricular malformations including ventricular septal defect, Tetralogy of Fallot, double outlet right ventricle, common arterial trunk, and atrioventricular septal defects. Additionally, technical tips are presented on how to best visualize ventricular septal defects. This module concludes with a discussion of the characteristics and types of atrial septal defects and scanning approaches to best detect atrial septal defects.

**Core Concepts: 57 min**

**Focused Review: 45 min**

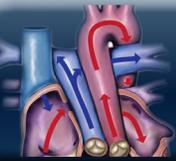


## Module 6: Conotruncal Defects, Part I (VSD Type / Shunt Physiology)

The first of the two modules on Conotruncal Defects, covers malformations of the outflow tracts with ventricular septal defect (VSD) resulting in shunt physiology. Dr. Gardiner presents the sonographic characteristics and physiology of Tetralogy of Fallot (ToF), double outlet right ventricle with normally related great arteries (DORV-VSD type) and common arterial trunk (truncus). For each lesion, she demonstrates the use of the 5 transverse view protocol to highlight the spectrum of morphological features. In particular, the use of the 3 vessel and tracheal view (3VT) checklist, enables detection of ductal dependency, important in prenatal counseling, monitoring and delivery. The benefits of a multi-disciplinary team in developing a prenatal plan and determining the best approach to delivering a baby with a Conotruncal defect are discussed.

**Core Concepts: 39 min**

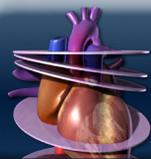
**Focused Review: 30 min**



## Module 7: Conotruncal Defects, Part II (Transposition Physiology)

The second of the two modules on Conotruncal Defects, covers transposition physiology and presents the sonographic characteristics and physiology of complete transposition (d-TGA), congenitally corrected TGA (I-TGA/double discordancy), and double outlet right ventricle with malposed great arteries (DORV-TGA type). Dr. Gardiner discusses the optimum views to recognize the characteristic pathology of d-TGA. Counselling for surgical options is covered with a review of the risk stratification of d-TGA based on its variable features. These contribute to the hidden mortality associated with d-TGA and this module emphasizes the importance of fetal monitoring of the foramen ovale (size and Doppler flow) and recognition of abnormal flow patterns in the arterial duct. The Children's National Level of Care Protocol is presented along with best practices for delivery plans. L-Transposition, commonly called double discordancy, is reviewed next with the diagnostic components of its pathology presented. This module concludes with a discussion of the range of double outlet right ventricles with malposed great arteries leading to transposition physiology using diagnostic ultrasound features to aid in detection, surgical options, and post-surgical outcomes.

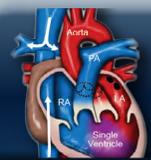
**Core Concepts: 1 hour 7 min**  
**Focused Review: 51 min**



## Module 8: Fetal Arches and the Three Vessel/Trachea View (3VT)

Aortic arch malformations may be isolated or combined with left heart obstruction. Dr. Gardiner begins this module by reviewing the 5 transverse protocol and how it is used to detect these abnormalities. In particular, the three vessel and tracheal (3VT) checklist provides clues to the detection of isolated aortic arch malformations. Reversal of color Doppler flow in left and right heart obstructions and the steal phenomena detected in the transverse arch are discussed. The module continues with characteristics of coarctation (CoA), diagnostic views, quantitative measurements, counseling, and the lifelong risk of generalized arteriopathy. Dr. Gardiner also discusses the various types of interrupted aortic arch (IAA), comparing findings of the aortic, ductal, and azygous arches and reviewing Doppler findings to aid in refining the diagnosis.

**Core Concepts: 56 min**  
**Focused Review: 42 min**



## Module 9: Single Ventricle

In this module, Dr. Gardiner discusses the spectrum of abnormal AV connections. Specific single ventricle pathologies covered include tricuspid atresia (TA), double inlet left ventricle (DILV), and double outlet right ventricle with mitral atresia (DORV-MA). The characteristics of each pathology are illustrated using diagnostic ultrasound views. The wide spectrum of possible connections is discussed as well as counseling and treatment plans.

**Core Concepts: 35 min**  
**Focused Review: 27 min**

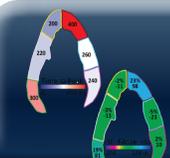


## Module 10: Atrial Isomerism

Module 10 in the Fetal Echocardiography series discusses atrial isomerism, variously known as heterotaxy, isomerism, polysplenia and asplenia. This module covers a wide and variable spectrum of malformation and associated non-cardiac findings. Beginning with a review of right and left sidedness, Dr. Gardiner presents the features of atrial appendages and the variability of atrial isomerism. Multiple ultrasound images reveal the extent of the variability and the importance of becoming familiar with the different component of pathology. This module concludes with a discussion of biventricular and univentricular AV connections, abnormalities of the great arteries, pulmonary veins, conduction tissue, and the importance of accurate prenatal diagnosis in informing counseling and postnatal management.

**Core Concepts: 55 min**

**Focused Review: 45 min**

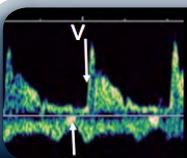


## Module 11: Recognizing the Sick Fetus

Beginning with a discussion of fetal hydrops, tricuspid valve abnormalities, and changes in the systemic veins, Dr. Gardiner reviews how to assess fetal cardiac function using Doppler to estimate pressure and volume flow measurements, as well as changes in the peripheral resistance. She discusses individual measurements of cardiac function, including Doppler assessment of afterload and preload, ventricular filling time, myocardial performance (Tei Index), tissue Doppler velocity and M-Mode assessment of long axis function and cardiac contractility. The module concludes with a review of advanced techniques, such as strain analysis, speckle tracking, color Doppler myocardial images, and a comparison of speckle tracking with tissue Doppler.

**Core Concepts: 41 min**

**Focused Review: 31 min**



## Module 12: Fetal Arrhythmias

This module begins with a discussion of fetal arrhythmias, barriers to optimal management, and the “ideal” modality, fetal ECG. The techniques of M-mode and spectral Doppler findings are described, along with their clinical interpretation. The next segment describes fetal tachycardia and includes specific findings of supraventricular tachycardia, atrial flutter, and ventricular tachycardia and how to distinguish between long and short VA tachycardia. Hemodynamic changes occurring during fetal tachycardia and timing of their resolution following successful fetal treatment are discussed. The first section concludes with management and clinical outcomes, with an emphasis on therapeutic options, treatment routes, and the state of tachycardia treatment today.

The second part of this module discusses fetal bradycardia including blocked atrial bigeminy, second degree heart block, and complete heart block detected in the fetus with a normal heart and in the presence of congenital heart disease. The module concludes with therapeutic options and outcomes for fetal bradycardia.

**Core Concepts: 51 min**

**Focused Review: 40 min**



## Module 13: Genetic Associations

The first part of this module presents the genetic approach, etiology of, and the prevalence of congenital heart disease. Common cardiac malformations and structures considered to be normal variants, are discussed including VSD, AVSD, HLHS, Tetralogy, truncus, DORV, pulmonary and aortic stenosis, aortic arch anomalies, and hypertrophic cardiomyopathy. Genetic abnormalities presented include Down syndrome (trisomy 21), trisomy 18, trisomy 13, Turner syndrome, 22q11.2 deletion, single gene disorders, Noonan syndrome, CHARGE syndrome, Cornelia de Lange, Adams-Oliver syndrome, Smith Lemli Opitz, tuberous sclerosis and VACTERL.

The second part of this module focuses on perinatal management and surgical options. Beginning with an overview of circulation after birth, Dr Gardiner discusses which types of anomalies require early management to maintain the systemic or pulmonary circulation after birth, how to assess the severity of morphological variants and their effect on surgical risks.

**Core Concepts: 49 min**

**Focused Review: 37 min**



## Module 14: Systemic Venous Anomalies

This module focuses on systemic venous anomalies and begins with a developmental overview of the venous and portal systems. The normal findings and abnormalities of the umbilical, cardinal, and vitelline venous systems are discussed, along with recognized variants and a summary of associated findings. Dr. Gardiner presents the sonographic findings and clinical importance of systemic venous abnormalities, guiding the participant in how to best distinguish between normal and abnormal findings

**Core Concepts: 32 min**

**Focused Review: 24 min**

### FETAL ECHOCARDIOGRAPHY ECOURSE SUMMARY

#### Viewing Time

Core Concepts: 12.5 hours

Focused Review Sessions (optional): 9.5 hours

#### Continuing Medical Education Credits

This activity is approved for 16.5 SDMS CME credits

### FOR MORE INFORMATION

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