Cardiovascular Principles – CCI Registry Review

The CCI adult echocardiography board examination consists of 170 multiple choice questions (150 are graded – approximately 25 questions are test questions for future examinations).

Below is the CCI knowledge list. The list describes general areas of knowledge which can be presented as cardiovascular principles and may appear on the CCI adult echocardiography board examination. Test information including the adult echocardiography complete test outline is available at the CCI website - https://cci-online.org

Knowledge List

- Basic Life Support (BLS)
- Basic math skills (formulas, exponents, decimals, scientific notation)
- Basic pharmacology
- Cardiac abnormalities
- Cardiac embryology
- Cardiovascular anatomy
- Electrophysiology
- General anatomy
- Hemodynamics
- HIPAA (Health Insurance Portability and Accountability Act)
- History and physical
- Medical ethics
- Medical terminology
- Pathophysiology
- Physiologic maneuvers
- Physiology
- QA procedures
- Recognize basic cardiac anatomy obtained using other imaging modalities
- Safety practices for patients and staff
- Ultrasound instrumentation
- Ultrasound physics
- Ultrasound modalities:
  - 3-D
  - Doppler (spectral, tissue, and color)
  - Contrast
  - M-mode
  - Stress testing (pharmacological and physiologic)
  - TEE
- Universal precautions/infection control

The course below presents the cardiovascular principles required to prepare for the cardiovascular principles portion of the CCI adult echocardiography board examination. The reader is encouraged to review the lists provided in each section and test whether the required knowledge for each term can be identified. Multiple choice questions which will prepare the reader for the CCI's multiple choice questions are provided for each section. If you have any questions, please contact me at reynoldsterry58@gmail.com

Cardiac Anatomy

Right Atrium (RA) - Left Atrium (LA)

1. Two components of the atria?
2. Eustachian valve? – Location?
3. Network of Chiari? – Location?
4. Crista terminalis?- Location?
5. Superior vena cava (SVC), Inferior vena cava (IVC), Coronary sinus drain into the RA? or LA?
6. Flap of the foramen ovale - Location?
7. Pectinate muscles: muscle bundles of the atria or muscle bundles of the ventricles?
8. How many pulmonary veins are there? Names?
9. Most common location of LA atrial thrombus: principal (main) cavity or appendage?
10. Atrial systole occurs at ventricular end-diastole or ventricular end-systole?

Right Ventricle (RV) - Left Ventricle (LV)

11. Trabeculae carneae (trabeculations): muscle bundles of the atria or muscle bundles of the ventricles?
12. Moderator band (Septal band, Parietal band): RV or LV?
13. RV morphology: Triangular or Prolate ellipse?, Thin or Thick walled?, Heavily or Lightly trabeculated?, Top normal wall thickness? Top normal dimension as compared to the LV?
14. Infundibulum – RVOT internal or RVOT external?
15. Conus arteriosus? – RVOT internal or RVOT external?
16. LV: Shape: Prolate ellipse or Triangular?, Lightly or Heavily trabeculated?,. Thick or Thin walled?, Top normal wall thickness?, Top normal dimension?
17. Name of the two LV papillary muscle groups of the LV?

Layers of the heart

18. Inner layer?
19. Middle layer?
20. Outer layer?
21. Thickest layer and contractile layer?
22. Two layers of the pericardium?
23. Normal volume of fluid in the pericardial sac is?
24. Clear space on an echocardiogram during ventricular systole **only** is: Normal (physiologic) or Pericardial effusion?
25. Clear space only anterior and speckled in appearance is: Pericardial effusion or Adipose tissue?
26. Clear space during systole and diastole on an echocardiogram: Physiologic (normal) or Pericardial effusion?
27. Small pericardial effusion: less than: _____ cm; Moderate pericardial effusion: _____ cm; Large pericardial effusion: _____ cm.
28. When should the size of pericardial effusion be measured: end-diastole or end-systole?
29. Which layer is the serous layer?
30. Potential space located posterior to the atria?
31. Potential space located between the great arteries of the heart?
32. Is cardiac tamponade an echo diagnosis or clinical diagnosis?
33. The name of the triad of hypotension, jugular venous distention and quiet heart used to determine the presence of cardiac tamponade clinically?
34. List the three 2-D findings and cardiac Doppler finding for cardiac tamponade.

Cardiac Valves

Atrioventricular Valves (AV): Mitral valve (MV) – Tricuspid Valve (TV) –

Semilunar Valves: Aortic valve (AoV) – Pulmonary valve (PV)

35. Name of the two mitral valve leaflets?
36. Name of the three tricuspid valve leaflets?
37. Valve apparatus for the MV and TV? (annulus, leaflets, chordae tendineae, papillary muscles, myocardium)
38. Name of the three aortic valve leaflets?
39. Name of the three pulmonary valve leaflets (cusps)?: Anterior, Right leaflet, Left leaflet
40. Valve apparatus for the semilunar valves? (annulus, leaflets, sinuses, lunules, nodules)
41. Most superior located cardiac valve?
42. Most inferior located cardiac valve?
43. Coronary arteries originate from which section of the aorta?
44. MV and TV open?/close? during ventricular diastole; open?/close? _____during ventricular systole?
45. AoV and PV open?/close? during ventricular systole; open?/close? _____ during ventricular diastole?
46. Valves open and close due to a change in? pressure? or volume?

Aorta (Ao)

47. Identify the following sections of the aorta: annulus, sinuses of Valsalva, aortic root, sino-tubular junction, ascending aorta, aortic arch (transverse aorta), aortic isthmus, descending thoracic aorta (DTA), abdominal aorta (AA)
48. Structure which is the dividing line between the DTA and AA?
49. Three branches of the aortic arch (transverse aorta)?
50. Two branches of the brachiocephalic (innominate) artery?
51. Definition of aortic root? Anatomic? (annulus to the sino-tubular junction) and Virtual?
52. Definition of aortic isthmus?
53. Definition of ligamentum arteriosum?
54. Most common location of aortic aneurysm?
55. Most common location for aortic dissection?
56. Most common location for aortic coarctation?
57. Two most common defects associated with coarctation of the aorta (aortic coarctation)?

Coronary Arteries

58. Two primary coronary arteries?
59. The two main coronary arteries originate?
60. Coronary artery which supplies the anterior interventricular septum (IVS)? Anterior wall LV? Cardiac apex? Left anterior descending (LAD) or Circumflex (Cx) or Right coronary artery (RCA)?
61. Coronary artery which supplies the anterolateral LV wall? Inferolateral LV wall? Left anterior descending (LAD) or Circumflex (Cx) or Right coronary artery (RCA)?
62. Coronary artery which supplies the inferior IVS? Inferior LV? Inferior RV? Left anterior descending (LAD) or Circumflex (Cx) or Right coronary artery (RCA)?
63. Importance of significant left main disease? (Hint: “Widow maker”)
64. Coronary artery blood flow occurs primarily during ventricular diastole or ventricular systole?
65. Coronary blood flows from endocardium to epicardium? Epicardium to endocardium?
66. Narrowing of a coronary artery will result in a reduction of blood flow to the heart muscle – this is called?
67. Total occlusion of a coronary artery will result in?
68. 2-D echocardiographic finding for ischemia in coronary artery disease (CAD)?

69. Thin, bright, akinetic segmental wall motion abnormality (SWMA) as seen on two-dimensional echocardiography suggests acute myocardial infarction (MI)? or chronic (old) MI?
70. Segmental wall motion score (1-4) for: Normal or hyperkinetic (>40%)? Hypokinetic (10 to 40%)? Akinetic (<10%)? Dyskinetic (paradoxical – e.g.; LV apical aneurysm)?
71. Which valvular regurgitation is associated with coronary artery disease (CAD)?
72. Cardiac catheterization test used to identify and quantify coronary artery disease (CAD)?
73. Surgical treatment for coronary artery disease (CAD)?
74. Catheter and catheter-based treatments for CAD (2)?
75. Vein which lies between the LA and LV and collects myocardial deoxygenated coronary artery blood and delivers this deoxygenated coronary blood to the RA?
76. Three veins which make up the coronary sinus system?

Cardiac Conduction

77. List the components of the cardiac conduction system.
78. In what order does the electrical impulse travel in the cardiac conduction system?
79. Where is the Sino-atrial (SA) node located?
80. Where is the atrioventricular (AV) node located?
81. Which component of the cardiac conduction system carries the electrical impulse from the atria to the ventricles?
82. The electrical impulse travels in the ventricles: Epicardium to endocardium? Endocardium to Epicardium?
83. The normal heart rate: ____ to ____ bpm. Sinus bradycardia? _____bpm? Sinus tachycardia? ____ bpm.
84. Intrinsic rate of the SA node: ____ bpm? AV node: ____ bpm? Purkinje fibers: ____ bpm?
85. Pacemaker of the heart? Why?
86. Which portion of the cardiac conduction system depolarizes the ventricles?
87. The electrocardiogram (EKG) (ECG) P wave represents?
88. The EKG QRS complex represents?
89. The T wave represents?
90. The first positive deflection on the EKG tracing is the ___ wave.
91. The first negative deflection after the P wave is the ____ wave.
92. The first positive wave after the P wave is the ___ wave.
93. The first negative deflection after the R wave is the : _____ wave.
94. The onset of the P wave to the onset of the QRS complex is the ____ interval.
95. The normal duration of the PR interval is:____ sec.
96. The normal duration of the QRS complex is: ____ sec.
97. From the end of the S wave to the onset of the T wave is called the ____ segment.
98. ST segment depression suggests: _____.
99. ST segment elevation suggests: ____.
100. The onset of the Q wave to the end of the T wave is called the ____ interval.
101. How many leads are used to acquire a standard 12 lead EKG?
102. The precordial leads are called V_____ to V: _____. (6)
103. The limb leads are used to acquire _____(6)
104. Yes or No: The P wave represents atrial depolarization – atrial systole?
105. Yes or No: The QRS complex represents ventricular depolarization – ventricular systole?
106. Yes or No: The T wave represents ventricular repolarization?
107. Yes or No: The PR interval represents the time it takes for the electrical impulse to travel from the SA node to the Purkinje fibers.

Miscellaneous

108. The pulmonary valve lies _____, _____ and to the ____ of the aortic valve. (think PSAX – AoV)

109. Review the structures demonstrated in the standard two-dimensional views especially the in the PSAX of the AoV!

Cardiac Anatomy – Multiple Choice Questions

1. Which of the following structures is **NOT** located in the right atrium?
    A. Eustachian valve
    B. Network of Chiari
    C. Crista terminalis
    D. Moderator band
2. The flap of the foramen ovale is located in the:
    A. RA
    B. LA
    C. RV
    D. LV
3. The muscle bundles of the atria and atrial appendages are:
    A. Pectinate muscle
    B. Moderator band
    C. Parietal band
    D. Septal band
4. The most common location for LA thrombus is (the)
    A. MV
    B. Interatrial septum (IAS)
    C. Appendage
    D. Principal cavity
5. The muscle bundles of the ventricles are (the):
    A. Pectinate
    B. Moderator
    C. Parietal
    D. Trabeculae carneae (trabeculations)
6. The moderator band, septal band and parietal band are located in the:
    A. RA
    B. RV
    C. LA
    D. LV
7. Which is **INCORRECT** concerning the RV?
    A. Prolate ellipse in shape
    B. Heavily trabeculated especially at the RV apex
    C. Thin wall
    D. Top normal thickness is 0.5 cm
8. The external portion of the RVOT is the:
    A. Conus arteriosus
    B. Infundibulum
    C. Crista terminalis
    D. Moderator band

9. The internal RVOT is called the:
    A. Conus arteriosus
    B. Infundibulum
    C. Crista terminalis
    D. Moderator band
10. Which is **INCORRECT** concerning the LV?
    A. Triangular shaped
    B. Lightly trabeculated
    C. Thick
    D. Top normal thickness (Male): 1.0 cm; (Woman): 0.9 cm
11. The name of the two papillary muscles of the LV are:
    A. Anterior; Posterior
    B. Lateral; Medial
    C. Anterolateral; Posteromedial
    D. Superior; Inferior
12. The top normal dimension of the LV is: ___ cm.
    A. 2.0
    B. 3.0
    C. 4.0
    D. 6.0
13. The contractile and thickest wall of the heart is the:
    A. Endocardium
    B. Myocardium
    C. Epicardium
    D. Parietal pericardium
14. The two layers of the pericardium are:
    A. Endocardium; Myocardium
    B. Myocardium; Epicardium
    C. Endocardium; Epicardium
    D. Visceral pericardium; Parietal pericardium
15. The normal volume contained in the pericardial sac is: ____ mL.
    A. 20 to 50
    B. 50 to 100
    C. 100 to 500
    D. Greater than 500
16. Which of the following is **NOT** a branch of the aortic arch (transverse aorta)?
    A. Left main
    B. Brachiocephalic (Innominate)
    C. Left common carotid
    D. Left subclavian
17. The segment of the aorta located between the end of the left subclavian to the insertion of the ligamentum arteriosum is the:
    A. Aortic root
    B. Ascending aorta
    C. Transverse aorta
    D. Aortic isthmus

18. The most common location for coarctation of the aorta is the:
    A. Ascending aorta
    B. Transverse aorta
    C. Aortic isthmus
    D. Descending thoracic aorta
19. The most common congenital heart defect associated with aortic coarctation (50 to 70%) is:
    A. Bicuspid aortic valve
    B. Mitral valve prolapse (MVP)
    C. Mitral stenosis (MS)
    D. Persistent left superior vena cava (PLSVC)
20. The **MOST** common location for aortic aneurysm is the:
    A. Aortic root
    B. Ascending aorta
    C. Descending thoracic aorta
    D. Abdominal aorta (infrarenal)
21. An aneurysm which involves the entire circumference of the artery is:
    A. Saccular
    B. Fusiform
    C. Dissected
    D. Ruptured
22. Which coronary artery supplies blood to the anterior interventricular septum (IVS), anterior wall of the LV and cardiac apex?
    A. Left anterior descending
    B. Circumflex
    C. Right coronary artery
    D. Acute marginal
23. Which coronary artery supplies blood to the anterolateral and inferolateral wall of the LV?
    A. Left anterior descending
    B. Circumflex
    C. Right coronary artery
    D. Acute marginal
24. Which coronary artery supplies blood to the RV, inferior wall of the LV, inferior IVS?
    A. Left anterior descending
    B. Circumflex
    C. Right coronary
    D. Oblique marginal
25. Which vessel drains deoxygenated myocardial blood and delivers the blood to the RA?
    A. Left main
    B. LAD
    C. Coronary sinus
    D. Pulmonary veins
26. Coronary artery blood flow occurs primarily during:
    A. Ventricular diastole
    B. Ventricular systole
    C. Isovolumic contraction
    D. Dichrotic notch

27. Coronary artery blood flow travels from:
    A. Endocardium to epicardium
    B. Endocardium to myocardium
    C. Epicardium to endocardium
    D. Visceral pericardium to parietal pericardium
28. Coronary blood flow occurs during:
    A. Ventricular diastole
    B. Ventricular systole
    C. Isovolumic contraction
    D. Throughout the cardiac cycle
29. The coronary arteries originate from the:
    A. Aortic root
    B. Ascending aorta
    C. Transverse aorta
    D. Sinuses of Valsalva
30. The correct sequence of cardiac conduction system is:
    A. AV node-SA node-His bundle-Bundle branches-Purkinje fibers-Intra-atrial pathways
    B. SA node-Intra-atrial pathways-AV node-His bundle-Bundle branches-Purkinje fibers
    C. Purkinje fibers-Bundle branches-His bundle-AV node-Intra-atrial pathways-SA node
    D. Intra-atrial pathways-SA node-His Bundle-AV node-Purkinje fibers-Purkinje fibers
31. The intrinsic rate of the SA node is:
    A. 60 to 100 bpm
    B. 40 to 60 bpm
    C. 20 to 40 bpm
    D. 0 bpm
32. The normal heart rate is:__ bpm.
    A. 60 to 100
    B. 40 to 60
    C. 20 to 40
    D. 0
33. Which component of the cardiac conduction system depolarizes the ventricles?
    A. SA node
    B. AV node
    C. Bundle branches
    D. Purkinje fibers
34. The cardiac electrical impulse travels:
    A. Endocardium to Myocardium
    B. Endocardium to Epicardium
    C. Visceral pericardium to Parietal pericardium
    D. Endocardium to Parietal pericardium
35. The pulmonary valve lies _____ to the aortic valve.
    A. Anterior-Posterior-Right
    B. Posterior-Anterior-Left
    C. Anterior-Superior-Left
    D. Right-Left-Posterior

36. The coronary arteries originate from the:
    A. Oblique sinus
    B. Sinus venosus
    C. Transverse aorta
    D. Sinuses of Valsalva
37. The most superior located cardiac valve is the:
    A. Aortic
    B. Mitral
    C. Pulmonary
    D. Tricuspid
38. The most inferiorly located cardiac valve is the:
    A. Tricuspid
    B. Pulmonary
    C. Mitral
    D. Aortic
39. Valves open and close due to a change in:
    A. Volume
    B. Pressure
    C. Heart rate
    D. Vascular resistance

Answers: 1.D; 2.B; 3.A; 4.C; 5.D; 6.B; 7A; 8.A; 9;B; 10.A; 11.C; 12.D; 13.B; 14.D; 15.A; 16.A; 17.D; 18.C; 19.A; 20.D 21.B; 22.A; 23.B; 24.C; 25.C; 26.A; 27.C; 28.A; 29.D; 30.B; 31.A; 32.A; 33.D; 34.B; 35.C; 36.D; 37.C; 38.A; 39.B

Cardiac Embryology

1. When does the heart tube first appear: 3 weeks? or 8 weeks?
2. When is the heart tube completely formed: 3 weeks? or 8 weeks?
3. When do most of the structures of the heart appear and be formed?
4. The heart tube loops _____ and to the _____ (places the RV anterior and to the right)
5. The direction of the shunt across the foramen ovale during fetal circulation: Right to Left? or Left to Right?
6. The foramen ovale becomes the _____ in the adult.
7. Percentage of patients with patent foramen ovale (PFO) in the adult population: 10%?25%?50%?99%?
8. This vessel carries blood away from the lungs in fetal circulation?
9. The direction of the shunt during fetal circulation for the ductus arteriosus: Right to Left? or Left to Right?
10. The ductus arteriosus becomes the ___ in the adult
11. Which closes first: foramen ovale or ductus arteriosus?
12. The two components of the IAS are septum primum and septum secundum – which one closes the foramen ovale?
13. Endocardial cushions contribute to the formation of:
14. Situs solitus?
15. Situs inversus?
16. Situs ambiguus? (Heterotaxy)

17. Know the sections of the heart tube and what each contributes to the formation of:
    Sinus venosus:
    Primitive atria:
    Atrioventricular canal:
    Endocardial cushions
    Primitive ventricle:
    Bulbus cordis:
    Conus arteriosus (conus cordis):
    Infundibulum:
    Truncus arteriosus:
    Aortic Sac: 3rd; 4th; 6th

Cardiac Embryology – Multiple Choice Questions

1. The heart tube first appears day:
    A. 1
    B. 23
    C. 56
    D. 270
2. The heart tube is completely formed by day:
    A. 1
    B. 23
    C. 56
    D. 270
3. The heart tube loops:
    A. Anterior and to the right
    B. Anterior and to the left
    C. Superior
    D. Inferior
4. Which cardiac chamber is the most anterior chamber?
    A. RA
    B. RV
    C. LA
    D. LV
5. The foramen ovale becomes the ____ in the adult.
    A. Fossa ovalis
    B. Ligamentum arteriosum
    C. Septum secundum
    D. Truncus arteriosus
6. The percentage of adults with patent foramen ovale is:____%
    A. 1
    B. 25
    C. 50
    D. 100
7. The vessel which carries blood away from the heart in fetal circulation is the:
    A. Ductus venosus
    B. Ductus arteriosus
    C. Foramen ovale
    D. Pulmonary veins

8. The direction of the foramen ovale and ductus arteriosus shunt in fetal circulation is:
    A. Right to left
    B. Left to right
    C. Bidirectional
    D. Cannot be predicted
9. Which septum closes the foramen ovale?
    A. Membranous septum
    B. Septum primum
    C. Septum secundum
    D. Muscular septum
10. The ductus arteriosus becomes the:
    A. Sinus venosum
    B. Ductus venosum
    C. Ligamentum arteriosum
    D. Aortic isthmus
11. The sinus venosus will **NOT** contribute to the formation of (the):
    A. Superior vena cava (SVC)
    B. Inferior vena cava (IVC)
    C. Coronary sinus
    D. Pulmonary veins
12. The atrioventricular canal is the communication between the atria and ventricles and contains the:
    A. Aortic sac
    B. Truncus arteriosus
    C. Infundibulum
    D. Endocardial cushions
13. The endocardial cushions do **NOT** contribute to the formation of:
    A. MV
    B. TV
    C. AoV
    D. Inlet IVS
14. The bulbus cordis contributes to the formation of the:
    A. RA
    B. RV
    C. LA
    D. LV
15. The conus arteriosus is the:
    A. RV
    B. RVOT (external)
    C. LV
    D. LVOT
16. The infundibulum is the:
    A. RV
    B. RVOT (internal)
    C. LV
    D. LVOT

17. The truncus arteriosus contributes to the formation of the:
    A. MV, TV
    B. Aorta, Main pulmonary artery (MPA)
    C. LA, RA
    D. RV, LV
18. The 3rd aortic arch of the aortic sac contributes to the formation of the:
    A. Common carotid
    B. Arch
    C. Ductus arteriosus
    D. MPA
19. The 4th arch of the aortic sac contributes to the formation of the:
    A. Common carotid arteries
    B. Arch
    C. Ductus arteriosus
    D. MPA
20. The 6th aortic arch of the aortic sac contributes to the formation of the:
    A. Common carotid
    B. Arch
    C. Ductus arteriosus
    D. Ascending aorta

Answers: 1.B; 2.C; 3.A; 4.B; 5.A; 6.B; 7.B; 8.A; 9.C; 10.C; 11.D; 12.D; 13.C; 14.B; 15.B; 16.B; 17.B; 18.A; 19.B; 20.C

Fetal Circulation

1. Placenta?
2. Umbilical vein?
3. Ductus venosus?
4. Ligamentum venosum?
5. Foramen ovale?
6. Fossa ovalis?
7. Ductus arteriosus?
8. Ligamentum arteriosum?
9. Umbilical arteries?
10. Umbilical cord?

Fetal Circulation – Multiple Choice Questions

1. The ___ provides nutrients, gas exchange, waste exchange for the fetus.
    A. Placenta
    B. Umbilical vein
    C. Umbilical arteries
    D. Ductus venosus
2. The _____ is made up of one umbilical vein and two umbilical arteries.
    A. Placenta
    B. Umbilical cord
    C. Ductus venosus
    D. Foramen ovale

3. The _____ carries oxygenated blood from the placenta to the fetus.
    A. Umbilical vein
    B. Umbilical arteries
    C. Foramen ovale
    D. Ductus arteriosus
4. The _____ allows oxygenated blood from the umbilical vein to bypass the liver and flow into the inferior vena cava.
    A. Ligamentum teres
    B. Ductus arteriosus
    C. Fossa ovalis
    D. Ductus venosus
5. The valve at the mouth of the inferior vena cava which guides the oxygenated towards the foramen ovale is the: _____.
    A. Thebesian
    B. Eustachian
    C. Tricuspid
    D. Pulmonary
6. An extension of the eustachian valve is the: _____.
    A. Chiari network
    B. Thebesian valve
    C. Sulcus terminalis
    D. Crista terminalis
7. The _____ allows oxygenated blood to travel from the right atrium to the left atrium in fetal circulation.
    A. Foramen ovale
    B. Fossa ovalis
    C. Ductus arteriosus
    D. Ligamentum arteriosum
8. The foramen ovale closes due to a change in:
    A. Volume
    B. Pressure
    C. Heart rate
    D. Oxygen level
9. Which structure closes the foramen ovale?
    A. Eustachian valve
    B. Chiari network
    C. Septum primum
    D. Septum secundum
10. The foramen ovale may stay open or potentially be able to be open due to increased right atrial pressure in approximately _____% of adults?
    A. 10
    B. 25
    C. 45
    D. 75

11. The shunt direction of the foramen ovale in fetal circulation is predominantly: _____.
    A. Left to right
    B. Right to left
    C. Bidirectional
    D. Dependent on heart rate
12. The foramen ovale becomes the _____ after birth.
    A. Ligamentum teres
    B. Ligamentum venosum
    C. Fossa ovalis
    D. Remains open
13. The _____ carries oxygenated blood directly from the main pulmonary artery to the aorta bypassing the deflated fetal lungs.
    A. Fossa ovalis
    B. Ductus arteriosus
    C. Ligamentum arteriosum
    D. Ligamentum venosum
14. The shunt direction of the ductus arteriosus in fetal circulation is:
    A. Left to right
    B. Right to left
    C. Bidirectional
    D. Dependent on heart rate
15. Approximately when does the ductus arteriosus close after birth?
    A. 12 to 24 minutes
    B. 12 to 24 hours
    C. 12 to 24 days
    D. 12 to 24 months
16. The ductus arteriosus becomes the _____ after birth.
    A. Ligamentum arteriosum
    B. Ligamentum venosum
    C. Ligamentum teres
    D. Fossa ovalis
17. The _____ carry deoxygenated blood from the fetus to the placenta.
    A. Umbilical vein
    B. Umbilical arteries
    C. Ductus venosus
    D. Ductus arteriosus

Answers: 1.A; 2.B; 3.A; 4.D; 5.B; 6.A; 7.A; 8.B; 9.D; 10.B; 11.B; 12.C; 13.B; 14.B; 15.B; 16.A; 17.B

Congenital Heart Defects in the Adult

1. The most common type of atrial septal defect (ASD): Ostium Secundum? Ostium primum? Sinus venosus?
2. ASD most associated finding with cleft MV: Ostium Secundum? Ostium Primum? Sinus Venosus?
3. ASD most associated finding with partial anomalous pulmonary venous return (PAPVR)?
4. Mitral valve prolapse (MVP) is associated with___ ASD: Ostium Secundum? Ostium Primum? Sinus Venosus?
5. The components of the interventricular septum (IVS) (4): Membranous? Inlet? Outlet? Trabecular?

6. Most common type of ventricular septal defect (VSD) in adults? Perimembranous? Inlet? Outlet? Trabecular?
7. Restrictive vs Non-restrictive VSD: Which would create a high peak velocity?
8. Components of complete (atrioventricular) (AV) canal?
9. Syndrome associated with canal defects?
10. Associated with machinery-like continuous murmur?
11. Narrowing of the aorta in the region of the aortic isthmus is:
12. Coarctation of the aorta is strongly associated with? Second most common finding?
13. The four defects of tetralogy of Fallot?
14. Is tetralogy of Fallot is most often a cyanotic lesion? or acyanotic lesion?
15. Which cardiac valve differentiates tetralogy of Fallot from truncus arteriosus?
16. Patent foramen ovale (PFO): Common or Uncommon?
17. Abnormal displacement of the TV downward towards the cardiac apex with RV dysplasia (atrialization of the RV) is:
18. Thin membrane located beneath the aortic valve-attached to the left side of the IVS to the anterior MV leaflet:
19. Thin membrane located in the left atrium:
20. Reversal of a shunt due to increased pulmonary vascular resistance (severe pulmonary hypertension):
21. Both shunts in fetal circulation (Foramen ovale and Ductus arteriosus) are right to left or left to right? In the adult (assuming normal intracardiac pressures)?

Congenital Heart Disease – Multiple Choice Questions

1. The most common type of ASD is:
    A. Ostium secundum
    B. Ostium primum
    C. Sinus venosus
    D. Coronary sinus
2. Ostium primum ASD is strongly associated with:
    A. Bicuspid aortic valve
    B. RV dysplasia
    C. Cleft MV
    D. Tricuspid valve atresia
3. Sinus venosus ASD is strongly associated with:
    A. Bicuspid aortic valve
    B. Cleft MV
    C. Perimembranous VSD
    D. Partial anomalous pulmonary venous return
4. The most common type of VSD in adults is:
    A. Perimembranous
    B. Inlet
    C. Outlet
    D. Trabecular
    E. Malalignment

5. Narrowing of the aorta in the area of the aortic isthmus is aortic:
    A. Dissection
    B. Coarctation
    C. Aneurysm
    D. Atherosclerosis
6. Which of the following defects is **MOST** strongly associated with aortic coarctation? (50 to 70%)
    A. Bicuspid aortic valve
    B. VSD
    C. RV dysplasia
    D. Ostium secundum ASD
7. Which of the following is **NOT** considered a component of tetralogy of Fallot?
    A. RVH
    B. Over-riding aorta
    C. Mal-alignment VSD
    D. Cleft MV
    E. RVOT obstruction (PS)
8. The presence of which cardiac valve differentiates tetralogy of Fallot from truncus arteriosus?
    A. AoV
    B. MV
    C. PV
    D. TV
9. How common is patent foramen ovale (PFO) in adults?___%
    A. 1
    B. 25
    C. 50
    D. 100
10. Abnormal displacement of the TV towards the apex with RV dysplasia (atrialization of the RV) is:
    A. Ebsteins
    B. Uhls (RV dysplasia)
    C. Tetralogy
    D. Truncus
11. A membrane located beneath the aortic valve is:
    A. Hypertrophic cardiomyopathy (HCM)
    B. Mitral valve prolapse (MVP)
    C. Discrete subaortic stenosis (DSS)
    D. Sigmoid septum
12. Reversal of a shunt due to increased pulmonary vascular resistance (severe pulmonary hypertension) is:
    A. Doppler
    B. Libman-Sacks
    C. Eisenmengers
    D. Carvallo

13. The shunt direction during fetal circulation for the foramen ovale and ductus arteriosus is:
    A. Left to right
    B. Right to left
    C. Bidirectional
    D. Cannot be predicted

Answers: 1.A; 2.C; 3.D; 4.A; 5.B; 6.A; 7.D; 8.C; 9.B; 10.A; 11.C; 12.C; 13.B

Cardiac Physiology

1. Action potential curve – 5 phases –
   0 to 1 Depolarization – sodium moves into the cardiac cell due to electrical stimulus – coincides with the QRS complex of the EKG
   1 – Brief repolarization – Potassium moves out of the cardiac cell
   2 – Plateau phase – Calcium moves into the cell resulting in contraction – coincides with the ST segment of the EKG
   3 – Repolarization – Potassium and calcium leave the cell – coincides with the T wave of the EKG
   4 – Resting state (diastole) coincides with the end of the T wave to the onset of the QRS complex (includes atrial systole (P wave)
   Absolute refractory period – cardiac cell will not respond to another electrical stimulus – Phase 0 to 3 (onset of the QRS complex to the onset of the T wave)
   Relative refractory period – cardiac cell may respond to another electrical stimulus – (R on T phenomenon) – (T wave of EKG)
2. When does ventricular diastole occur on the EKG?
3. When does atrial systole occur in relation to the EKG?
4. When does ventricular systole occur in relation to the EKG?
5. Yes or No: During ventricular systole, the ventricles contract and deliver blood to the great arteries (e.g.; aorta and main pulmonary artery).
6. Yes or No: During ventricular diastole, the ventricles relax and fill.
7. Atrial systole is considered a part of ventricular diastole or ventricular systole?
8. The atrioventricular valves (MV, TV) are ____ during ventricular diastole and ____ during ventricular systole.
9. The semilunar valves are _____ during ventricular diastole and _____ during ventricular systole.
10. Cardiac valves open and close due to a change in: _____.
11. Four factors which determine cardiac performance (e.g.; EF, SV, CO) Preload, Afterload, Myocardial contractility, Heart rate
12. Preload – the amount of diastolic filling – Measured by end-diastolic volume (EDV) or end-diastolic pressure (EDP) or both?
13. Frank-Starlings Law (Law of the Heart) ("Rubber band" law): Increase EDV (EDP) (Increase preload) - Increase myocardial fiber length-Improve cardiac performance (e.g.; EF, SV) - To a certain physiologic limit. True or False?
14. Preload: Can be measured by EDV? or EDP or Both?
15. Preload is the amount of diastolic filling Yes or No?
16. Increase preload-Increase EDV-Increase EDP-Increase myocardial fiber length-Improve cardiac performance-To a certain physiologic limit? True or False?
17. Increase preload increases or decreases chamber dimension?
18. Resistance to the ejection of blood? Preload or Afterload
19. Afterload Enhances? or Reduces? cardiac performance?
20. Increase in preload increases or decreases chamber dimension?

21. Increase in afterload results in chamber dilatation or chamber (wall) hypertrophy?
22. EDV – ESV =?
23. EDV – ESV x HR =?
24. Cross-sectional area (CSA) x velocity time integral (VTI) = ?
25. CSA x VTI x HR=?
26. CSA = ?
27. .785 x Diameter^2 =?
28. Stroke volume (SV) x heart rate (HR) =?
29. .785 x D^2 x VTI x HR =?
30. CSA_1 x VTI_1 = CSA_2 x VTI_2 = ?
31. CSA_1 x VTI_1 ÷ VTI_2 = ?
32. EDV-ESV/EDV x 100=?
33. The method used to determine 2-D echocardiography volumes?
34. Normal range for SV?
35. Normal range for cardiac output (CO)?
36. Normal range for cardiac index (CI)?
37. Normal range for ejection fraction (EF)? Male: _____%; Female: _____%
38. Normal right atrial pressure (RAP): 5 mmHg? 10 mm Hg? 15 mm Hg? 20 mm Hg?
39. Normal right ventricular systolic pressure (RVSP): 5 mm Hg? 10 mm Hg? 25 mm Hg? 120 mm Hg?
40. Normal systolic pulmonary artery pressure (SPAP): 5 mm Hg; 10 mm Hg? 25 mm Hg? 120 mm Hg?
41. Normal pulmonary artery end-diastolic pressure (PAEDP): 5 mm Hg? 10 mm Hg? 25 mm Hg? 120 mm Hg?
42. Normal left ventricular systolic pressure (LVSP): 5 mm Hg? 10 mm Hg? 25 mm Hg? 120 mm Hg?
43. Normal left ventricular end-diastolic pressure (LVEDP): 5 mm Hg? 10 mm Hg? 25 mm Hg; 120 mm Hg?
44. Normal blood pressure (BP)?
45. Pulmonary wedge pressure (PWP) represents the ____ and _____ pressure and is acquired with a with right heart or left heart (Swan-Ganz) catheter?
46. The pressure gradient between the LV and LA during ventricular systole?
47. Pressure gradient between the Ao and LV during diastole?
48. 4 x V_2^2 = ?
49. 4 x TR^2 + RAP = ?
50. 4 x $PREDV_2$ + RAP = ?
51. 4 x PR peak velocity^2 + RAP = ?
52. SBP – 4 x MR^2 = ?
53. SBP – 4 x VSD peak velocity^2 = ?
54. Which has the longer duration of flow: MR or AS?
55. O2 saturation for the coronary sinus: 98% or 60%?
56. O2 saturation for the pulmonary veins: 60% or 98%?
57. Valsalva – Strain phase: Increases or Decreases venous return?
58. Valsalva strain phase useful in diastolic function Grade 2, Grade 3, HOCM? True or False?
59. Valsalva – Release phase: Increases or Decreases venous return?
60. Valsalva release useful in evaluation of PFO or ASD with agitated saline contrast? Yes or No?
61. Inspiration: Increases or Decreases venous return?
62. Expiration: Increases or Decreases venous return?
63. The two normal heart sounds: S____ and S ___
64. Abnormal early diastolic heart sound due to increased early diastolic filling: S___
65. Late diastolic heart sound due to reduced ventricular compliance: S____

Cardiac Physiology Multiple Choice Questions

1. Of the following ions listed, which one is **LEAST** involved in cardiac cell depolarization and repolarization?
    A. Sodium
    B. Potassium
    C. Calcium
    D. Chloride
2. When does actual mechanical contraction occur - Phase
    A. 0 to 1
    B. 2
    C. 3
    D. 4
3. Actual mechanical contraction coincides with the EKG:
    A. P wave
    B. QRS complex
    C. T wave
    D. UST segment
4. The cardiac cell will **NOT** respond to an electrical stimulus during the:
    A. Absolute refractory period
    B. Relative refractory period
5. A cardiac cell may respond to another electrical stimulus during the:
    A. Absolute refractory period
    B. Relative refractory period
6. Electrical ventricular systole occurs during the:
    A. P wave
    B. T wave
    C. Onset of the QRS complex to the end of the T wave
    D. U wave
7. Electrical ventricular diastole occurs during the:
    A. Onset of the QRS complex to the end of the T wave
    B. End of the T wave to the onset of the P wave
    C. End of the T wave to the onset of the QRS complex
    D. U wave
8. The ventricles relax and fill during ventricular:
    A. Diastole
    B. Systole
9. The ventricles contract and deliver blood to the great arteries during ventricular:
    A. Diastole
    B. Systole
10. Increase preload-Increase end-diastolic volume (EDV) - Increase cardiac performance-To a certain physiologic limit is:
    A. Frank-Starling law of the heart
    B. Doppler
    C. Bernoulli
    D. Continuity

11. End-diastolic (EDV) or End-diastolic pressure (EDP) is:
    A. Preload
    B. Afterload
    C. EF
    D. CO
12. The resistance to the ejection of blood is:
    A. Preload
    B. Afterload
    C. CO
    D. EF
13. An increase in preload results in chamber:
    A. Dilatation
    B. Hypertrophy
    C. Dysplasia
    D. Hypoplasia
14. An increase in afterload results in chamber:
    A. Dilatation
    B. Hypertrophy
    C. Dysplasia
    D. Hypoplasia
15. EDV – ESV =
    A. SV
    B. CO
    C. CI
    D. EF
16. Stroke volume (SV) x (heart rate) HR =
    A. SV
    B. CO
    C. CI
    D. EF
17. EDV –ESV x HR =
    A. SV
    B. CO
    C. CI
    D. EF
18. Cardiac output (CO) + Body surface area (BSA) =
    A. SV
    B. CO
    C. CI
    D. EF
19. EDV – ESV / EDV x 100 =
    A. SV
    B. CO
    C. CI
    D. EF

20. The method used to determine volumes by 2-D is:
    A. Simpson's method of discs (MOD)
    B. Teichholz
    C. Bernoulli
    D. Doppler
21. Cross-sectional area (CSA) x Velocity time integral (VTI) =
    A. Stroke Volume (SV)
    B. Cardiac output (CO)
    C. Cardiac index (CI)
    D. Ejection fraction (EF)
22. .785 x Diameter^2 =
    A. SV
    B. CO
    C. CI
    D. CSA
23. CSA x VTI x HR =
    A. SV
    B. CO
    C. CI
    D. EF
24. .785 x Diameter^2 x VTI =
    A. SV
    B. CO
    C. CI
    D. EF
25. .785 x Diameter^2 x VTI x HR =
    A. SV
    B. CO
    C. CI
    D. EF
26. Which intracardiac pressure is **INCORRECT**?
    A. RAP: 0 to 8 mm Hg
    B. RVSP: 18 to 25 mm Hg
    C. SPAP: 18 to 25 mm Hg
    D. LV: 120/80 mm Hg
27. The normal blood pressure (BP) is: ____ mm Hg.
    A. 0 to 8
    B. 120/80
    C. 120/10
    D. 18 to 25
28. The pulmonary wedge pressure (PWP) obtained with the Swan-Ganz catheter is the:
    A. LAP and LVEDP
    B. RAP and RVEDP
    C. RVSP
    D. SPAP

29. The normal pressure gradient between LV and LA during ventricular systole is:
    A. 10
    B. 50
    C. 70
    D. 110
30. The normal pressure gradient between the Ao and LV during ventricular diastole is:
    A. 10
    B. 50
    C. 70
    D. 110
31. The normal oxygen saturation of the coronary sinus is:___%
    A. 0
    B. 60
    C. 80
    D. 98
32. The oxygen saturation of the pulmonary veins is:___%
    A. 0
    B. 60
    C. 80
    D. 98
33. The strain phase of the Valsalva maneuver ___ venous return.
    A. Increases
    B. Decreases
    C. No change
    D. Cannot be predicted
34. The release during Valsalva maneuver ___ venous return.
    A. Decreases
    B. Increases
    C. No change
    D. Cannot be predicted
35. The release phase of the Valsalva is useful in the evaluation of:
    A. Aortic regurgitation (AR)
    B. Mitral regurgitation (MR)
    C. Patent foramen ovale (PFO)
    D. Hypertrophic obstructive cardiomyopathy (HOCM)
36. The strain phase of the Valsalva is **LEAST** useful in the evaluation of:
    A. HOCM
    B. Grade 2 diastolic function
    C. PFO
    D. Grade 3 diastolic function
37. Inspiration ____ venous return.
    A. Increases
    B. Decreases
    C. No change
    D. Cannot be predicted

38. Expiration ____ venous return.
    A. Increases
    B. Decreases
    C. No change
    D. Cannot be predicted
39. Mitral valve (MV) and tricuspid valve (TV) closure creates the normal S__ heart sound.
    A. 1
    B. 2
    C. 3
    D. 4
40. Aortic valve (AoV) and pulmonary valve (PV) closure creates the normal S___ heart sound.
    A. 1
    B. 2
    C. 3
    D. 4
41. Increased early diastolic filling creates the abnormal S__ heart sound.
    A. 1
    B. 2
    C. 3
    D. 4
42. Abnormal late diastolic filling creates the abnormal S___ heart sound.
    A. 1
    B. 2
    C. 3
    D. 4
43. How many normal heart sounds are there?
    A. 1
    B. 2
    C. 3
    D. 4

Answers: 1.D; 2.B; 3.D 4.A; 5.B; 6.C; 7.C; 8.A; 9.B; 10.A; 11.A; 12.B; 13.A; 14.B; 15.A; 16.B; 17.B; 18.C; 19.D; 20.A 21.A; 22.D; 23.B; 24.A; 25.B; 26.D; 27.B 28.A; 29.D; 30.C; 31.B; 32.D; 33.B; 34.B; 35.C; 36.C; 37.A; 38.B 39.A; 40.B; 41.C; 42.D; 43.B

Cardiac Evaluation Methods

1. Angina pectoris?
2. Stable angina: Chest pain at rest or Chest pain that is predictable?
3. Unstable angina: Chest pain at rest or Chest pain which is predictable??
4. Chest pain relieved with a change in position?
5. Chest pain radiating to the back with normal EKG?
6. Chest pain with difficulty in breathing: Pericarditis? Pulmonary embolism?
7. Atypical chest pain?
8. Dyspnea?
9. DOE?
10. Most common cardiac symptom?
11. Cachexia?
12. Heart failure – Four common causes: 1. LV dysfunction (e.g.; reduced EF due to CAD)? 2.LV pressure overload (e.g.; Aortic stenosis (AS), Systemic hypertension)? 3. LV volume overload (e.g.; Chronic significant MR, Chronic significant aortic regurgitation (AR)? 4. LV diastolic dysfunction (e.g.; Grade 2, Grade 3)?
13. Cor pulmonale: Right heart failure or Left heart failure due to intrinsic pulmonary disease?
14. Peripheral edema (bilateral): Right heart? or Left heart?
15. Pulmonary edema: Right heart? Or Left heart?
16. Jugular venous distention (JVD): Right heart or Left heart?
17. A patient presents with fever unknown origin (FUO), chills, new murmur, positive blood cultures and/or IV drug abuse: Evaluate for?
18. Depression of the sternum towards the spine: Pectus excavatum? or Pectus carinatum? (e.g. Marfan's)
19. Outward projection of the sternum: Pectus carinatum? Or Pectus Excavatum?
20. Kyphosis? Upper back curvature? (hunched- rounded appearance)?
21. Scoliosis? Sideways curvature of the spine?
22. Straight back syndrome?
23. Hemoptysis: MS? or TS?
24. Syncope: RVOT obstruction? Or LVOT obstruction (e.g.; AS; HOCM)
25. How to help a patient who faints?
26. Pulsus paradoxus is a drop in BP > 10 mm Hg with inspiration – Associated with cardiac tamponade (and constrictive pericarditis): Yes or No?
27. Electrical alternans – Definition? Associated with?
28. Pulsus alternans? Definition? Associated with?
29. Bisfierens pulse – Definition? Associated with?
30. Mid-systolic click and late systolic murmur is associated with?
31. Fixed split S2: ASD? or VSD?
32. Early systolic murmur: ASD? or VSD?
33. Systolic ejection murmur (SEM) at the right upper sternal border: AS? or PS?
34. Holosystolic murmur heard best at the cardiac apex radiating to the axilla: MR? or TR?
35. Early diastolic decrescendo murmur at the left sternal border: AR? or PR?
36. Continuous murmur: Patent ductus arteriosus Yes or No? Ruptured sinus of Valsalva aneurysm? Coronary artery fistula Yes or No?
37. Normal sinus rhythm? (Be able to identify on an electrocardiogram)
38. Atrial fibrillation? (Be able to identify on an electrocardiogram)
39. Premature ventricular contraction (PVC)? (Be able to identify on an electrocardiogram and never measure post-PVC due to compensatory pause)

40. Bigeminy? (Be able to identify on an electrocardiogram)
41. Ventricular tachycardia? (Be able to identify on an electrocardiogram)
42. Ventricular fibrillation? (Be able to identify on an electrocardiogram) Medical emergency?
43. First degree AV block? (Be able to identify on an electrocardiogram)
44. 2nd degree AV block (Wenckebach – Mobitz 1)? (Be able to identify on an electrocardiogram)
45. Complete heart block? (Be able to identify on an electrocardiogram)
46. ST segment elevation indicates acute MI: Yes or No?
47. ST segment depression indicates myocardial ischemia: Yes or No?
48. Pathologic Q waves?
49. Be able to identify electrical systole on an EKG tracing
50. Be able to identify ventricular diastole on an EKG tracing
51. Be able to identify isovolumic relaxation and isovolumic contraction – EKG? (Occurs after the P wave? T wave?)
52. The normal duration of the PR interval?
53. The normal duration of the QRS complex?
54. Catheterization peak to peak gradient compared to cardiac Doppler peak (maximum, instantaneous) pressure gradient. Which is higher?
55. Which gradient is the preferred gradient to use when evaluating valve stenosis? Peak? Mean? Peak to Peak?
56. Chest x-ray mediastinal widening suggests?
57. MUGA nuclear exam predicts EF: Yes or No?
58. Nuclear perfusion scan-be able to identify a picture of a myocardial perfusion scan
59. CT: Be able to identify a picture of a cardiac CT (e.g; aortic coarctation)
60. CT scan test for pulmonary embolism?
61. MRI: be able to identify a picture of a cardiac MRI
62. The contrast agent used during a cardiac MRI?
63. What is HIPAA? (Health Insurance Portability and Accountability Act)
64. Be able to identify a cardiac catheterization tracing of the following: aortic stenosis (AS), mitral stenosis (MS), mitral regurgitation (MR), aortic regurgitation (AR)

Cardiac Evaluation Methods – Multiple Choice Questions

1. Chest pain due to coronary artery disease (CAD) is:
    A. Angina pectoris
    B. Peripheral edema (bilateral)
    C. Cachexia
    D. JVD
2. Chest pain at rest is:
    A. Normal
    B. Angina pectoris
    C. Stable angina pectoris
    D. Unstable angina pectoris
3. Chest pain related to exercise due to CAD is:
    A. Normal
    B. Angina pectoris
    C. Stable angina
    D. Unstable angina

4. Chest pain alleviated with a change in position is:
    A. Angina pectoris
    B. Stable angina pectoris
    C. Unstable angina pectoris
    D. Pericardial effusion
5. Chest pain radiating to the back with a normal EKG suggests:
    A. Acute MI
    B. MVP
    C. Aortic dissection
    D. Pericarditis
6. Chest pain where the patient is holding their side is:
    A. Normal
    B. Atypical chest pain
    C. Angina pectoris
    D. Pericarditis
7. Chest pain with shortness of breath:
    A. Acute MI
    B. Aortic dissection
    C. Pericarditis
    D. Pulmonary embolism
8. Most common symptom in cardiac disease:
    A. Palpitations
    B. Dyspnea
    C. Syncope
    D. Chest pain
9. General wasting away due to long-standing heart disease is:
    A. Jugular venous distention (JVD)
    B. Cachexia
    C. Peripheral edema
    D. Syncope
10. The most common cause of heart failure in the United States is:
    A. Systolic dysfunction due to CAD
    B. Pressure overload (e.g.; AS, Systemic hypertension)
    C. Volume overload (e.g.; Significant chronic MR, AR)
    D. Diastolic dysfunction
11. Right heart failure due to intrinsic pulmonary disease is:
    A. Cor pulmonale
    B. Heart failure
    C. Syncope
    D. Cachexia
12. The most common cause of right heart failure is:
    A. Left heart failure
    B. Tricuspid stenosis (TS)
    C. Significant TR
    D. Pulmonary stenosis (PS)

13. Which of the following is **LEAST** likely to result in bilateral peripheral edema?
    A. TS
    B. Significant TR
    C. MVP
    D. Right ventricular systolic failure
14. Which of the following is **LEAST** likely to result in pulmonary edema?
    A. Acute MI
    B. Acute severe MR
    C. Acute severe TR
    D. Myocardial ischemia
15. A patient presents with fever unknown origin (FUO), new heart murmur and/or positive blood cultures. Evaluate for:
    A. Infective endocarditis
    B. Aortic dissection
    C. MVP
    D. Cardiac tamponade
16. A patient presents with a history IV drug abuse. Evaluate for:
    A. Infective endocarditis
    B. Aortic dissection
    C. MVP
    D. Cardiac tamponade
17. Depression of the sternum towards the spine is:
    A. Normal
    B. Pectus excavatum
    C. Pectus carinatum
    D. Kyphosis
    E. Scoliosis
18. Outward projection of the sternum is:
    A. Normal
    B. Pectus carinatum
    C. Pectus excavatum
    D. Kyphosis
    E. Scoliosis
19. Excessive outward curvature of the spine:
    A. Pectus excavatum
    B. Pectus carinatum
    C. Scoliosis
    D. Kyphosis
20. Abnormal lateral curvature of the spine:
    A. Scoliosis
    B. Kyphosis
    C. Pectus carinatum
    D. Pectus excavatum

21. Jugular venous distention (JVD) would **LEAST** likely be present is:
    A. TS
    B. Severe TR
    C. Cardiac tamponade
    D. MVP
22. The coughing or spitting up of blood due to increased left atrial pressure is:
    A. Syncope
    B. JVD
    C. Cachexia
    D. Hemoptysis
23. Fainting (loss of consciousness) is:
    A. Syncope
    B. Cachexia
    C. JVD
    D. Hemoptysis
24. Syncope is associated with:
    A. Normal
    B. LVOT obstruction (e.g.; AS, HOCM)
    C. ASD
    D. Coarctation
25. Pulsus paradoxus (drop in blood pressure with inspiration > 20 mm Hg) is associated with:
    A. Normal
    B. MVP
    C. Aortic dissection
    D. Cardiac tamponade
26. Alternating R wave height on the EKG suggests:
    A. Constrictive pericarditis
    B. Large pericardial effusion
    C. Mitral valve prolapse
    D. Secundum atrial septal defect
27. Pulsus alternans is most likely to be present in which cardiomyopathy?
    A. Dilated
    B. Hypertrophic
    C. Restrictive-Infiltrative
    D. Takotsubo
28. Bisfierens pulse is most likely to be present in which cardiomyopathy?
    A. Dilated
    B. Hypertrophic
    C. Restrictive-Infiltrative
    D. Non-compaction
29. Mid-systolic click and late-systolic murmur suggests:
    A. Normal
    B. MVP
    C. AS
    D. ASD

30. Fixed split S2 suggests:
    A. ASD
    B. VSD
    C. PDA
    D. Coarctation
31. Early systolic murmur suggests:
    A. Normal
    B. ASD
    C. VSD (restrictive)
    D. PDA
32. Systolic ejection murmur at the right sternal border suggests:
    A. Normal
    B. AS
    C. PS
    D. HOCM
33. Holosystolic murmur heard best at the cardiac apex radiating to the axilla suggests:
    A. Normal
    B. TR
    C. MR
    D. AR
34. Early diastolic decrescendo murmur hear best at the lower left sternal border suggests:
    A. Normal
    B. AS
    C. AR
    D. MR
35. A continuous murmur suggests:
    A. Normal
    B. AS
    C. PDA
    D. MR
36. A continuous murmur suggests:
    A. Normal
    B. Sinus of Valsalva aneurysm (ruptured)
    C. ASD
    D. VSD
37. Alternating normal beat with PVC is:
    A. Normal
    B. Bigeminy
    C. Trigeminy
    D. Ventricular tachycardia
38. Three or more consecutive PVC's suggests:
    A. Normal
    B. Acute MI
    C. Ventricular tachycardia
    D. Ventricular fibrillation

39. No effective identifiable EKG waveform suggests:
    A. Normal
    B. PVC
    C. Ventricular tachycardia
    D. Ventricular fibrillation
40. A PR interval greater than .20 sec suggests:
    A. Normal
    B. 1st degree AV block
    C. Wenckebach (2nd degree AV block)
    D. Complete heart block
41. Prolongation of the PR interval with a beat dropped is:
    A. Normal
    B. 1st degree AV bock
    C. 2nd degree AV block (Wenckebach)
    D. 3rd degree AV block
42. No association with the P wave and the QRS complex suggests:
    A. Normal
    B. 1st degree AV block
    C. Wenckebach (2nd degree AV block)
    D. Complete heart block (3rd degree)
43. ST segment elevation suggests:
    A. Normal
    B. Acute MR
    C. Acute TR
    D. Acute MI
44. ST segment depression suggests:
    A. Normal
    B. Acute MI
    C. Myocardial ischemia
    D. Aortic dissection
45. Pathologic Q waves suggests:
    A. Acute MI
    B. Old (chronic) MI
    C. Aortic dissection
    D. Cardiac tamponade
46. The cardiac catheterization peak to peak pressure gradient will be ____ than the Doppler peak (instantaneous, maximum) pressure gradient.
    A. Less than
    B. Equal to
    C. Greater than
    D. Cannot be predicted
47. The cardiac Doppler peak pressure gradient will be ____ than the cardiac catheterization peak-to-peak gradient.
    A. Greater than
    B. Less than
    C. Equal to
    D. Patient dependent

48. Mediastinal widening on CXR suggests:
    A. Normal
    B. Cardiac tamponade
    C. Aortic dissection
    D. MVP
49. Which test accurately predicts EF?
    A. MUGA
    B. CXR
    C. Myocardial perfusion
    D. CT calcium scoring scan
50. For CCI, you need to be able to identify:
    A. Cardiac MRI
    B. Nuclear myocardial perfusion scan
    C. CT (e.g.; aortic coarctation)
    D. CT exam for pulmonary embolism
    E. Cardiac catheterization tracing of AS, MS, MR, AR
    F. CXR
    G. EKG tracings (e.g.; NSR, PVC, 1st degree AV block, 3rd degree AV block, atrial fibrillation, ventricular tachycardia, ventricular fibrillation)
    H. All of the above

Answers: 1.A; 2.D; 3.C; 4.D; 5.C; 6.B; 7.D; 8.B; 9.B; 10.A; 11.A; 12.A; 13.C; 14.C; 15.A; 16.A; 17.B; 18.B; 19.D; 20. A; 21.D; 22.D; 23.A; 24.B; 25.D; 26.B; 27.A; 28.B; 29.B; 30.A; 31.C; 32.B; 33.C; 34.C; 35.C; 36.B; 37.B; 38.C; 39.D; 40.B; 41.C; 42.D; 43.D; 44.C; 45.B; 46.A; 47.A: 48.C; 49.A

Cardiac Hemodynamics

1. Poiseuille's law (predicts the amount of flow through a tube) - Q = Pressure gradient x $Radius^4$ ÷ Viscosity x Length of tube: Which has the greatest effect on flow volume?
2. The primary determinant of flow through a tube: Pressure gradient? $Radius^4$? Viscosity? Length of tube?
3. According to Poiseuille's law, As valve area decreases (e.g.; valve stenosis), there will be an increase in: Pressure gradient? Radius? Length? Viscosity?
4. What is laminar flow?
5. What is parabolic laminar flow? Where is the highest velocity?
6. What is inlet (plug) laminar flow? Where is most often found?
7. What is Disturbed flow? Where is most often located?
8. What is turbulent flow?
9. The four components of turbulent flow are?
10. Laminar core of a turbulent jet is called the:
11. Where does pressure recovery occur?
12. Bernoulli equation predicts? (conservation of energy) PG = 4 x V_2^2
13. Calculate peak pressure gradient (pressure drop, pressure difference) for a peak velocity of 2 m/sec:
14. The TR peak velocity is 2 m/sec. The inferior vena cava measures 1.9 cm with a greater than 50% inspiratory collapse, the right ventricular systolic pressure (RVSP) and the systolic pulmonary artery pressure (SPAP) are _____ mm Hg.
15. Blood pressure (BP): 120/80 mm/Hg, Peak velocity of restrictive VSD: 5.0 m/sec: RVSP and SPAP = __ mm Hg
16. BP: 120/80 mm Hg. MR peak velocity: 5.0 m/sec; left atrial pressure (LAP) = ___ mm Hg

17. Pulmonary regurgitation (PR) end-diastolic velocity is 2 m/sec. The pulmonary artery end-diastolic pressure (PAEDP) is: ___ mm Hg. (assume normal inferior cava dimension and collapsibility)
18. PR peak velocity is 3 m/sec. The mean pulmonary artery pressure (MPAP) = _____ mm Hg. (assume normal inferior cava dimension and collapsibility)
19. Blood pressure (BP): 120/76, The AR end-diastolic velocity is 4 m/sec. The left ventricular end-diastolic pressure (LVEDP) is: ____ mm Hg
20. Continuity equation: $CSA_1 \times VTI_1 = CSA_2 \times VTI_2$ or SV = SV or Flow in = Flow out (Conservation of mass)
21. Left ventricular outflow tract (LVOT) diameter: 2.0 cm; LVOT VTI: 20 cm; AoV VTI 100 cm – aortic valve area (AVA): ____ cm^2
22. LVOT diameter: 2.0 cm; LVOT peak velocity: 1.0 m/sec; AoV peak velocity: 5.0 m/sec AVA: __cm^2
23. LVOT CSA: 3.0; LVOT VTI: 20 cm; AoV VTI: 100 cm – AVA: _____ cm^2
24. LVOT diameter: 2.0 cm; LVOT VTI: 20 cm; MV VTI 100 cm – MVA: _____ cm^2
25. 220 ÷ Pressure half-time (PHT) =?
26. 220 ÷ Deceleration time x 0.3 = ?
27. Deceleration time: 700 msec. (Mitral valve area (MVA)? _____ cm^2 Severity? _____.
28. MV PHT is 88 msec. MVA = ___ cm^2
29. The aortic regurgitation (AR) pressure half time is 549 msec. How severe is the AR?
30. For ASD - Qp/Qs: RVOT diameter: 3.0 cm; RVOT VTI 20 cm; LVOT diameter: 2.0 cm; LVOT VTI 15 cm =___:1
31. Reynolds number of 2000 predicts:

Secondary Effects

Tell if a Pressure or Volume Overload (PO or VO); Represents an increase in Preload (P) or Afterload (A), Which chamber(s) are directly involved; Tell if it results in chamber dilatation (CD) or chamber hypertrophy (CH):

32. AS:
33. PS:
34. MS:
35. TS:
36. Aortic coarctation:
37. Systemic hypertension:
38. Pulmonary hypertension:
39. Pulmonary embolism:
40. Eisenmenger's
41. Chronic significant MR:
42. Chronic TR:
43. Chronic AR:
44. Chronic PR:
45. ASD:
46. VSD:
47. PDA:
48. Partial anomalous pulmonary venous return (PAPVR):

Cardiac Hemodynamics – Multiple Choice Questions

1. The primary determinant of the amount of flow through a tube (Q) according to Poiseuille's law is:
    A. Pressure gradient
    B. Radius (diameter)
    C. Length
    D. Viscosity
2. The valve area decreases (e.g.; valve stenosis – AS, PS, MS, TS), according to Poiseuille's law to maintain flow (Q) there will be an increase in:
    A. Pressure gradient
    B. Radius
    C. Viscosity
    D. Length
3. Normal flow is: ____ flow.
    A. Laminar
    B. Disturbed
    C. Turbulent
    D. Mosaic
4. Where is the highest velocity when parabolic laminar flow is present?
    A. Center
    B. Edge
    C. Proximal
    D. Distal
5. Inlet (plug) flow is found at (the):
    A. Annulus and Outflow tracts
    B. Aortic arch
    C. PA branches
    D. Stenotic valve
6. Abnormal flow with multiple velocities, vortices and eddies is:___ flow.
    A. Normal
    B. Disturbed
    C. Turbulent
    D. Mosaic
7. Flow found at bifurcations and associated with mild stenosis is: ___ flow.
    A. Normal
    B. Disturbed
    C. Turbulent
    D. Mosaic
8. Where is the highest velocity found in parabolic flow?
    A. Edge
    B. Center
    C. Upstream
    D. Downstream

9. Which of the following is **NOT** a component of turbulent flow?
    A. Flow convergence (PISA)
    B. Vena contracta
    C. Turbulent region
    D. Relaminarization
    E. Disturbed
10. The highest velocity in turbulent flow is found at the:
    A. PISA
    B. Vena contracta
    C. Turbulent region
    D. Relaminarization
11. The laminar core of a turbulent jet is the:
    A. PISA
    B. Vena contracta
    C. Turbulent region
    D. Relaminarization
12. Which of the following predicts the pressure gradient (pressure drop, pressure difference) between two chambers?
    A. Doppler
    B. Bernoulli
    C. Poiseuille's
    D. Continuity
13. Predict the pressure gradient (pressure drop, pressure difference) for 3 m/sec. ___ mm Hg.
    A. 3
    B. 9
    C. 36
    D. 46
14. The BP is 124/70 mm Hg. The peak velocity of a restrictive VSD is 4 m/sec. The RVSP and SPAP are: ____ mm Hg.
    A. 120
    B. 60
    C. 64
    D. 74
15. The BP is 125/80 mm Hg. The MR peak velocity is 5 m/sec. The LAP is:___ mm Hg.
    A. 5
    B. 25
    C. 100
    D. 110
16. The TR peak velocity is 3.0 m/sec. The inferior vena cava measures 1.8 cm with a less than 50% inspiratory collapse. The right ventricular systolic pressure and systolic pulmonary artery pressure are: _____ mm Hg
17. The PR end-diastolic velocity is 2 m/sec. The IVC is normal in dimension and inspiratory collapse. The PAEDP is: ____ mm Hg.
18. The PR peak velocity is 3 m/sec. The inferior vena cava is dilated without inspiratory collapse. The MPAP is: _____ mm Hg.
19. The BP is 110/46 mm Hg. The AR end-diastolic velocity is 3 m/sec. The LVEDP is: ___ mm Hg.

20. Flow in = Flow out or SV = SV or whatever goes in must come out is (the)
    A. Doppler principle
    B. Bernoulli equation (conservation of energy)
    C. Poiseuille's law prediction of Q through a tube
    D. Continuity equation (conservation of mass)
21. The actual continuity equation is:
    A. $4 \times V_2^2$
    B. $CSA_1 \times VTI_1 = CSA_2 \times VTI_2$
    C. $.785 \times Diameter^2 \times VTI_1$? VTI_2
    D. EDV – ESV / EDV x 100
22. Determine the aortic valve area (AVA) for the following using the continuity equation: LVOTd: 2.0 cm; LVOT VTI: 20 cm; AoV VTI: 90 cm._____ cm^2 Severity? _____
23. Determine the aortic valve area (AVA) for the following using the continuity equation: LVOTd: 2.0 cm; LVOT peak velocity: 1.0 m/sec; AoV peak velocity: 4 m/sec. ____ cm^2 Severity? _____
24. 220/PHT = ____
25. Determine the MVA: LVOTd: 2.0 cm; LVOT VTI: 15 cm; MV VTI: 80 cm; MVA: _____ cm^2 Severity? _____
26. Determine the MVA where the PHT is 88 msec: _____ cm^2. Severity? _____
27. Determine the MVA for a mitral valve deceleration time of 800 msec. _____ cm^2 Severity? _____
28. Qp/Qs: LVOT diameter: 2.0 cm; LVOT VTI: 18 cm; RVOT diameter: 2.0 cm; RVOT VTI: 42.42 cm; Qp/Qs = ___:1 – Shunt size? _____
29. The Reynolds number (density, viscosity, velocity) - which number predicts when turbulent flow will occur
    A. 2
    B. 20
    C. 200
    D. 2000

Answers: 1.B; 2.A; 3.A; 4.A; 5.A; 6.C; 7.B; 8.B; 9.E; 10.B; 11.B; 12.B; 13.C; 14.B; 15.25; 16.44; 17.19; 18.51; 19.10; 20.D; 21.B; 22.0.7-Severe; 23..08-Severe; 24. Mitral valve area; 25.0.59-Severe; 26.2.5-Mild; 27.0.9-Severe; 28.2.4-Large; 29.D

Secondary Effects

30. **Tell the secondary effects for the following: Pressure overload (PO) or Volume overload (VO), Preload (P) or Afterload (A), Which chamber(s) would be involved, Chamber dilatation (CD) or Chamber hypertrophy (CH)**
    A. Aortic stenosis (AS)
    B. Pulmonary stenosis (PS)
    C. Mitral stenosis (MS)
    D. Tricuspid stenosis (TS)
    E. Aortic coarctation
    F. Systemic hypertension
    G. Pulmonary hypertension
    H. Pulmonary embolism
    I. Eisenmenger syndrome:
    J. Chronic significant MR
    K. Chronic significant TR
    L. Chronic significant AR
    M. Chronic significant PR
    N. ASD
    O. VSD
    P. PDA
    Q. Partial anomalous pulmonary venous return (PAPVR)

Answers:

AS: PO - A – LV – LVH
PS: PO - A – RV – RVH
MS: PO (LA) – A (LA) – LA – LAE
TS: PO (RA) – A (RA) – RA – RAE
Aortic coarctation: PO – A – LV – LVH
Systemic hypertension: PO – A – LV – LVH
Pulmonary hypertension: PO – A - – RV – RVH
Pulmonary embolism: Po – A – RV – RVE
Eisenmenger syndrome: PO – A - RV – RVH
Chronic significant MR: VO – P - LA, LV – LAE, LVE
Chronic significant TR: VO – P – RA, RV – RAE, RVE
Chronic significant AR: VO – P – LV – LVE
Chronic significant PR: VO – P – RV - RVE
ASD: VO – P – RA, RV, RAE, RVE
VSD: VO – P – LA, LV – LAE, LVE
PDA: VO - P – LA, LV – LAE, LVE
PAPVR: VO -P – RA, RV – RAE, RVE

Miscellaneous

1. Mitral valve (MV) closure to aortic valve (AoV) opening is isovolumic contraction or isovolumic relaxation?
2. Isovolumic relaxation coincides with the T wave of the EKG?
3. Increase in left atrial pressure will increase? or decrease? the isovolumic relaxation time (IVRT)
4. Impaired left ventricular relaxation will increase? or decrease? The IVRT?
5. Aortic valve (AoV) closure to mitral valve (MV) opening is isovolumic contraction or isovolumic relaxation?
6. Dichrotic notch (incisura):?
7. Know the Normal values for AVA; MVA; TVA; PVA.
8. Know the values for mild, moderate, severe AS, MS, TS, PS

Miscellaneous – Multiple Choice Questions

1. MV closure to AoV valve opening is:
    A. Isovolumic contraction
    B. Isovolumic relaxation
2. Aortic valve closure to mitral valve opening is:
    A. Isovolumic relaxation
    B. Isovolumic contraction
3. Closure of the aortic valve creates the dichrotic notch also called the:
    A. Incisura
    B. Closing click
    C. Opening click
    D. Murmur

Answers: 1.A; 2.A; 3.A

Cardiac Pharmacology

Anticoagulants (Blood thinners)

These agents prevent coagulation or clotting of blood but do not dissolve existing blood clots. Two common examples of anticoagulants are heparin and Warfarin (Coumadin).

Antiplatelet agents

Platelets are an important component of blood clotting. Antiplatelets are used to prevent myocardial infarction. Examples of antiplatelet agents are aspirin, ticlopidine and dipyridamole.

Thrombolytic agents

Thrombolytic agents are used to break up clots that have formed. Examples include streptokinase, reteplase and altepase.

Angiotensin-converting enzyme (ACE) inhibitors - These agents expand blood vessels by lowering levels of angiotensin II, a potent vasoconstrictor that drives blood pressure up. ACE inhibitors are used to treat high blood pressure, heart failure and heart attacks. Examples of agents in this class include captopril, enalapril, fosinopril and lisinopril.

Angiotensin II receptor blockers (ARBs) - These agents prevent angiotensin II from having any effects on the heart and blood vessels by blocking the receptors it usually binds to. These agents are useful in the treatment of high blood pressure, heart failure and heart attacks. Examples of drugs in this class include candesartan, irbesartan, losartan, telmisartan and valsartan.

Beta blockers or beta-adrenergic blocking agents - These agents decrease the heart rate and the final cardiac output. This lowers blood pressure and heart rate. Beta blockers are useful therapies in high blood pressure and some types of arrhythmia. Agents in this class include atenolol, bisoprolol, metoprolol, propranolol and sotalol.

Calcium channel blockers - Calcium channel blockers stop the movement of calcium into the cells of the heart and blood vessels. This relaxes the vessels and reduces blood pressure. Calcium channel blockers are useful therapies in high blood pressure, angina, and some forms of arrhythmia. Examples of drugs in this class include amlodipine, felodipine, nifedipine and varapamil.

Diuretics - Diuretics increase the excretion of water and sodium in the urine, therefore decreasing the total blood volume. This reduces blood pressure and the heart's workload. Examples of agents in this class include chlorothiazide, amiloride, furosemide, bumetanide, indapamide and spironolactone

Vasodilators - These drugs relax the blood vessels and cause blood pressure to fall. They are useful in the treatment of high blood pressure, heart failure, angina and heart attacks. Examples include isosorbide, dinitrate and hydralazine.

Digoxin - This agent is used to improve the force of contraction in some cases of heart failure.

Statins - These agents reduce the synthesis of blood cholesterol in the liver. High blood cholesterol is one of the major causes of atherosclerosis. Some of the most well known examples include atorvastatin, lovastatin and simvastatin.

Drugs that are used to regulate an abnormal heart rhythm include quinidine, lidocaine, amiodarone, sotalol, verapamil, diltiazem, dofetilide and adenosine.

Pharmacological Stress Echocardiogram – Dobutamine is used to for stress echocardiography to identify coronary artery disease and low dose dobutamine may be used to identify viability of ischemic wall segments. Dobutamine is a positive catecholamine (increases the heart rate) and normal heart muscle becomes hyperkinetic with the administration of dobutamine.

Cardiac Pharmacology – Multiple Choice Questions

1. Warfarin and heparin are examples of:
    A. Anticoagulants (blood thinners)
    B. Antiplatelets
    C. Thrombolytics
    D. ACE inhibitors
2. Aspirin is an example of:
    A. Anticoagulants (blood thinners)
    B. Antiplatelets
    C. Thrombolytics
    D. ACE inhibitors
3. Streptokinase is an example of:
    A. Anticoagulants (blood thinners)
    B. Antiplatelets
    C. Thrombolytics
    D. ACE inhibitors
4. Captopril is an example of:
    A. ACE inhibitors
    B. ARB's
    C. Beta blockers (beta-adrenergic blocking agents)
    D. Calcium channel blockers
5. Losartan is an example of:
    A. ACE inhibitors
    B. ARB's
    C. Beta blockers
    D. Calcium channel blockers
6. Propranolol (Inderal) is an example of:
    A. ACE inhibitor
    B. ARB's
    C. Beta blocker
    D. Calcium channel blocker
7. Yes or No: Should the patient undergoing a stress echocardiogram temporarily stop taking a beta blocker prior to the test?
8. Nifedipine is an example of:
    A. ACE inhibitors
    B. ARB's
    C. Beta blockers
    D. Calcium channel blockers

9. Furosemide is an example of:
    A. Diuretics
    B. Vasodilators
    C. Digoxin
    D. Statins
10. Dinitrate is an example of:
    A. Diuretics
    B. Vasodilators
    C. Beta blockers
    D. Calcium channel blockers
11. Yes or No: Digoxin (Digitalis) may improve ventricular contractility
12. Agents which reduce cholesterol are:
    A. Diuretics
    B. Vasodilators
    C. Beta blockers
    D. Statins
13. Which drug may be used in a pharmacological stress test examination?
    A. Inderal
    B. Digoxin
    C. Dobutamine
    D. Furosemide
14. Yes or No: Atropine may be added to a Dobutamine stress test exam to achieve the target heart rate.
15. Yes or No: Are all of the following possible complications for Dobutamine?
    A. Angina pectoris
    B. Hypotension
    C. Cardiac arrythmias (e.g.; atrial fibrillation, ventricular arrythmias)
    D. Premature ventricular contractions (10%)
    E. Mid-cavity left ventricular outflow tract obstruction (indicated by a drop in systolic blood pressure > 20 mm Hg)

Answers: 1.A; 2.B; 3.C; 4.A; 5.B; 6.C; 7.Yes; 8.D; 9.A; 10.B; 11.Yes; 12.D; 13.C; 14.Yes; 15.Yes