Questions #1-48. 2 Points Each. Unless otherwise indicated, circle the letter of the single best answer.

1. A drug used in the treatment of atrial fibrillation because of its ability to block cardiac voltage-gated calcium channels: __________ blocker
   A. Procainamide ×
   B. Flecaainide ×
   C. Verapamil
   D. A and B
   E. B and C

2. Isosorbide is used in the treatment of angina because of its ability to:
   A. Block voltage-gated calcium channels ×
   B. Produce nitric oxide ✓
   C. Block α1 receptors ×
   D. A and B
   E. B and C

3. Drug Z has an ED50 of 0.20 mg/kg for producing a therapeutic effect, and a TD50 of 0.05 mg/kg for producing a toxic effect. The therapeutic index of this drug is:
   A. 100
   B. 40
   C. 4
   D. 0.4
   E. 0.25

4. Drug A has a lower ED50 for producing an increase in smooth muscle contraction compared to drug B. Therefore we can say that in this test system:
   A. Drug A will have a greater potency compared to drug B ✓
   B. Drug A will have a higher efficacy compared to drug B ×
   C. Drug A will have a lower efficacy compared to drug B ×
   D. Drug A will have a lesser potency compared to drug B ×
   E. A and B
5. Symptoms of poisoning by organophosphate insecticides or nerve gases would include all of the following EXCEPT:

A. Involuntary urination  
B. Teary eyes  
C. Constricted pupils  
D. Dry mouth  
E. Involuntary defecation

6. A 45 year-old female patient presents with sinus bradycardia (a low heart rate of 36 beats per minute) and symptoms of fatigue. She is not currently taking any medication. Which drug could reverse the parasympathetic tone in this patient?

A. Atropine  
B. Bethanechol  
C. Neostigmine  
D. A and B  
E. B and C

7. All of the following are true concerning tubocurarine (a curare-related drug) EXCEPT:

A. It binds to the cholinergic nicotinic receptor  
B. It is used in conjunction with general anesthetics during abdominal wall surgery  
C. It causes skeletal muscle depolarization  
D. It is a competitive antagonist of acetylcholine at the neuromuscular junction  
E. Its effects at the neuromuscular junction are antagonized by neostigmine

8. Indicate which of the following statements concerning digoxin are CORRECT:

A. Its effects on cardiac contraction increase as serum potassium levels increase  
B. It has a positive inotropic effect on cardiac tissue  
C. It activates a Na⁺-K⁺ ATPase in cardiac tissue  
D. A and B  
E. B and C
9. Mr. Nerveless has recently had a successful cardiac transplant operation in which his badly damaged and failing heart was replaced by a healthy donor organ. Which of the following drugs would be expected to have the SMALLEST effect on his heart function, as compared to the function of a normal (non-transplanted) heart?

A. Bethanecol - mACH agonist  
B. Norepinephrine  
C. Propranolol - $\beta_1$ $\beta_2$ blocker  
D. Tyramine  
E. Isoproterenol - $\beta_1$$\beta_2$ agonist

10. The anticholinergic effects of botulinum toxin:

A. Are caused by acetylcholine receptor blockade $\times$  
B. Are caused by inhibition of acetylcholinesterase $\times$  
C. Are treated with choline infusions  
D. Occur only at the neuromuscular junction in the peripheral nervous system  
E. Are caused by inhibition of acetylcholine release

11. A drug which can cause bronchodilation with minimal stimulation of the heart:

A. Epinephrine  
B. Tyramine  
C. Albuterol  
D. Isoproterenol  
E. Norepinephrine

12. Norepinephrine stimulation of $\alpha_1$ receptors on vascular smooth muscle produces an increase in intracellular levels of: 

A. Cyclic AMP $\times$  
B. Inositol triphosphate (IP$_3$)  
C. Cyclic GMP  
D. A and B  
E. B and C

13. Your patient suffers from variant (Prinzmetal's) angina. Which of the following drugs would be the least desirable for treatment of this patient?

A. Nitroglycerin $\times$  
B. Nifedipine $\times$  
C. Isosorbide  
D. Propranolol - $\beta_2$ blocker  
E. Diltiazem
14. According to the *Vaughan Williams* classification of anti-arrhythmic drugs, Class I drugs are characterized by their ability to:

A. Block sodium channels  
B. Block β receptors  
C. Activate potassium channels  
D. Block calcium channels  
E. Block potassium channels

15. The use of *milrinone* in *congestive heart failure* depends upon its ability to increase cardiac levels of:

A. Nitric Oxide  
B. Inositol triphosphate (IP₃)  
C. Potassium  
D. Inositol triphosphate receptors  
E. Cyclic AMP

16. All of the following are examples of *G-protein coupled* receptors EXCEPT:

A. Muscarinic receptors in the heart  
B. Muscarinic receptors in the gut  
C. Norepinephrine receptors in the heart  
D. Nicotinic receptors at the neuromuscular junction  
E. Norepinephrine receptors in vascular smooth muscle

17. Prazosin produces *less tachycardia* than phentolamine because:

A. Prazosin is a weaker β₁ agonist  
B. Prazosin is a weaker α₂ antagonist  
C. Prazosin is a weaker α₁ antagonist  
D. Prazosin is a weaker β₂ agonist  
E. Prazosin is a weaker muscarinic antagonist

18. You are attending in the hospital emergency room when a 3-year-old child is admitted for a suspected *antimuscarinic drug poisoning* (e.g., scopolamine). When examining this child, you might expect to observe any of the symptoms below EXCEPT:

A. Blurred vision  
B. Relaxation of gastrointestinal smooth muscle  
C. Constricted pupils  
D. Decrease in gastric secretion  
E. Increase in cardiac rate
19. Eating cheese is dangerous in a patient who is taking a *monoamine oxidase inhibitor* (MAOI) because:

A. Dopamine in the cheese will not be metabolized  
B. Norepinephrine in the cheese will not be metabolized  
C. Epinephrine in the cheese will not be metabolized  
D. Tyramine in the cheese will not be metabolized  
E. MAOIs combine with cheese to produce uncontrollable peristaltic activity

20. Indicate which of the following statements concerning *amiodarone* are *CORRECT*:

A. It can be used to treat both atrial and ventricular arrhythmias ✓
B. It has an extremely short half-life (<1 hour) ✗
C. According to the Vaughan-Williams classification its primary action would place it in Class IV ✗
D. A and B ✓
E. B and C ✗

21. A new drug was given by subcutaneous injection to 20 normal subjects in a *phase I* clinical trial (we will discuss *phases of clinical trials* later this semester). The cardiovascular effects are summarized below:

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>Peak Drug Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Systolic Blood Pressure (BP: mm Hg)</td>
<td>116</td>
<td>144 ‡BP</td>
</tr>
<tr>
<td>Diastolic BP</td>
<td>76</td>
<td>96 †</td>
</tr>
<tr>
<td>Heart Rate (beats/min)</td>
<td>71.2</td>
<td>54.3 ‡HR</td>
</tr>
</tbody>
</table>

Which of the following drugs does the new experimental agent *most resemble*?

A. Bethanechol ‡MACH 2 agonist ‡PARASYMP ‡HR ‡NOT HEP  
B. Epinephrine ‡THETA ‡BP  
C. Isoproterenol ‡B1 + B2 agonist ‡HR  
D. Neostigmine ‡ACH  
E. Phenylephrine ‡1 agonist Vasoconstrict
22. An 18-year-old female patient presents with an acute hypertensive crisis as a result of self-administering amphetamine. An appropriate drug treatment to quickly lower blood pressure would be: 

A. Atropine - nACHr blocker * 
B. Phentolamine ✓
C. Phenylephrine - α1 agonist
D. Dobutamine - β1 
E. Ephedrine - nACHr

23. Succinylcholine produces neuromuscular relaxation because:

A. It is a competitive nicotinic receptor antagonist ✓
B. It is a competitive muscarinic receptor antagonist *
C. It is a competitive nicotinic and muscarinic receptor antagonist *
D. It is a nicotinic receptor agonist +it desensitizes nACHr so get relaxation
E. It is a muscarinic receptor agonist

24. A normotensive 65-year-old female began experiencing dyspnea (shortness of breath) upon exertion associated with chest pain. The chest discomfort was determined to be angina pectoris (pain due to ischemia of the heart muscle). In order to improve her exercise tolerance, medication was prescribed. Consider each drug and rationale and select the most appropriate:

A. Scopolamine: the muscarinic agonistic effects would reduce heart rate and therefore reduce oxygen demand *
B. Prazosin: hypotension associated with prazosin would reduce myocardial work and prevent ischemic symptoms
C. Isoproterenol: increased β1 stimulation would increase cardiac output and therefore increase coronary perfusion, resulting in decreased angina symptoms ✓
D. Atenolol: reduced effects of adrenergic nerve activity and circulating catecholamines on the heart result in reduced rate and force of contraction, reducing myocardial oxygen demand and also reducing anginal symptoms ✓
E. Albuterol: selective β2 stimulation will increase cardiac output without affecting β1-mediated bronchoconstriction *
25. The graph below depicts physiological effect (e.g., muscle contraction) vs. \( \log \) of the agonist concentration. Show what a plot would look like for a full agonist; label it A. Show what the plot would look like in the presence of the full agonist plus a competitive antagonist; label it B.

![Graph showing physiological effect vs. log [Agonist]]

26. Drug X is a full agonist at a particular receptor site. Drug Y is a partial agonist at this same receptor site. This tells you that:

A. The efficacy of drug X is lower than that of drug Y
B. The potency of drug X is lower than that of drug Y
C. The efficacy of drug X is greater than that of drug Y
D. A and B
E. B and C

27. All of the following statements concerning nitroglycerin are correct EXCEPT:

A. It causes an increase in intracellular cyclic GMP
B. It can cause postural hypotension
C. It may cause significant reflex tachycardia
D. It undergoes significant first-pass metabolism in the liver
E. It significantly decreases AV conduction

28. All of the following mechanisms of anti-arrhythmic action correctly match a drug EXCEPT:

A. Procainamide: Blocks \( K^+ \) channels
B. Verapamil: Blocks \( Ca^{++} \) channels
C. Bretylium: Blocks \( K^+ \) channels
D. Propranolol: Blocks \( \beta \) receptors
E. Quinidine: Blocks \( Na^+ \) channels
29. You are examining the dose-response curve for the norepinephrine-induced increase in heart rate in an isolated heart preparation. Indicate which of the following statements concerning this dose-response curve are CORRECT:

A. If you know what the \( K_d \) is for norepinephrine binding to the heart \( \beta_1 \) receptor, then you will know the \( ED_{50} \) for increasing the heart rate  \( \times \)
B. If you know what the \( ED_{50} \) is for increasing heart rate, then you will know the potency for increasing the heart rate  \( \checkmark \)
C. If you know what the \( ED_{50} \) is for increasing heart rate, then you will know the efficacy for increasing the heart rate  \( \times \)
D. A and B
E. B and C

30. Your patient suffers from attacks of paroxysmal atrial tachycardia. Which of the drugs below would be best for chronic prophylactic treatment? \( \beta \) blocker

A. Adenosine  \( \times \)
B. Lidocaine  \( \times \)
C. Nifedipine  \( \beta \) blocker – smooth muscle
D. Verapamil  \( \checkmark \)
E. Procaainamide  \( \times \)

31. The therapeutic action of \( \beta \)-adrenergic receptor blockers in angina pectoris is believed to be primarily via:

A. Dilation of coronary vasculature
B. Increased peripheral resistance
C. Decreased requirement for myocardial oxygen  \( \checkmark \)
D. Increased sensitivity to catechoalamines  \( \times \)
E. Reduced production of catechoalamines  \( \times \)

32. A 69-year-old male is given a drug for treatment of his angina. He then experiences dizziness, headaches, lethargy and constipation. The most likely drug he was administered:

A. Propranolol
B. Nitroglycerin  \( \times \)
C. Dobutamine  \( \times \)
D. Captopril  ACE inhibition  \( \times \)
E. Nifedipine  \( \beta \) blocker.
33. All of the following statements concerning angiotensin converting enzyme (ACE) inhibitors are correct EXCEPT:

A. They are the drugs of choice in treating congestive heart failure ✓
B. They increase the secretion of aldosterone ❌
C. They can produce postural hypotension ✓
D. They inhibit the production of angiotensin II ✓
E. They can produce a dry cough ✓

34. The first-line drug for treating an acute attack of reentrant supraventricular tachycardia:

A. Adenosine ✓
B. Digoxin
C. Propranolol
D. Phenylephrine
E. Edrophonium

35. Nitric oxide is normally synthesized in endothelial cells from:

A. Sodium nitrite
B. Nitrous oxide
C. Arginine ✓
D. Cyclic GMP
E. Glutathione

36. Indicate which of the following drugs would be the most appropriate for treating a patient with myasthenia gravis:

A. Atropine ❌
B. Neostigmine
C. Acetylcholine ❌
D. Phystostigmine ✗ lasts longer? ✓
E. Tubocurarine ❌
37. You are treating a 50-year-old male farm worker who was brought to the emergency room. He was found confused in the orchard and since then has lost consciousness. His heart rate is 45 beats/min and his blood pressure is 80/40 mm Hg (normotensive = 120/80). He is sweating and salivating profusely. Which of the following treatments would be most appropriate? 

A. Edrophonium X
B. Neostigmine X
C. Bethanecol X
D. Pilocarpine X
E. Atropine

38. Relaxation of vascular smooth muscle produced by minoxidil is mediated via:

A. Inhibition of sodium permeability
B. Inhibition of calcium permeability
C. Activation of chloride permeability
D. Activation of potassium permeability
E. Activation of calcium permeability

39. When injected intravenously, a certain dosage of epinephrine produces a marked general vasoconstriction. When drug X is added to the same epinephrine dosage, and the two drugs are added together, a general vasodilation response is produced. This is known as epinephrine reversal. Indicate the most likely identity of drug X:

A. Atropine
B. Propranolol
C. Atenolol
D. Prazosin
E. Dobutamine

40-42. In column A below, several drugs that are effective in treating supraventricular arrhythmias are listed. Match each drug with the mechanism in column B that is responsible for its therapeutic effect.

<table>
<thead>
<tr>
<th>Column A</th>
<th>Column B</th>
</tr>
</thead>
<tbody>
<tr>
<td>40. C Propranolol</td>
<td>A. Blocks slow calcium-mediated action potentials.</td>
</tr>
<tr>
<td>41. A Verapamil</td>
<td>B. Sensitizes the carotid sinus and enhances vagal tone at the SA and AV nodes.</td>
</tr>
<tr>
<td>42. D Phenylephrine</td>
<td>C. Blocks sympathetic influences on the AV node.</td>
</tr>
<tr>
<td></td>
<td>D. Increases pressure in the carotid sinus to reflexly increase vagal tone and reduce sympathetic tone.</td>
</tr>
<tr>
<td></td>
<td>E. Inhibits acetylcholinesterase.</td>
</tr>
</tbody>
</table>
43. In patients with supraventricular tachycardia, indicate which of the following drugs would be least likely to cause myocardial depression:

A. Atenolol
B. Digoxin
C. Diltiazem
D. Verapamil
E. Propranolol

44. An appropriate treatment for vasospasm associated with Raynaud's Syndrome:

A. Atenolol
B. Nitroglycerin
C. Prazosin
D. A and B
E. B and C

45. A 65 year-old male has exertional angina. He is prescribed nifedipine to treat his angina. Shortly thereafter he begins his medication and complains of increased angina. Which explanation is most appropriate?

A. Nifedipine, via direct action on \( \beta_1 \) cardiac receptors, has increased oxygen demand
B. Nifedipine, via direct action of \( \alpha_1 \) vascular receptors, has produced vasoconstriction
C. Nifedipine-induced vasodilation has produced reflex tachycardia
D. Nifedipine has reduced blood flow to the kidney, which stimulates renin secretion
E. Nifedipine, via blockade of vascular \( \beta_2 \) receptors, has produced vasoconstriction

46. A patient with congestive heart failure is not being helped by therapy with diuretics and digoxin. Which of the following would be the most appropriate choice of treatment for this patient?

A. Enalapril
B. Dobutamine
C. Verapamil
D. Prazosin
E. Propranolol
47. A cellular consequence of an increase in internal inositol triphosphate (IP₃) concentration in vascular smooth muscle: 

A. An increase in calcium release from internal stores such as the smooth endoplasmic reticulum (smooth ER) 
B. An increase in myosin light chain kinase (MLCK) phosphorylation ✓
C. An increase in smooth muscle contraction.
D. A and B
E. A, B and C

48. Which drug would be most useful in a patient with early stage congestive heart failure and atrial fibrillation?

A. Propranolol ✓β₁/b₂ blocker ✓contractility
B. Digoxin ✓Ca²⁺
C. Verapamil Ca²⁺ blocker ×
D. Nifedipine ×
E. Lidocaine ×

#49-56. True/False. 0.5 Point Each.

49. Losartan is an example of an angiotensin converting enzyme (ACE) inhibitor. F

50. Adenosine-induced hyperpolarization of the cardiac atrioventricular (AV) node contributes to its usefulness in treating supraventricular arrhythmias. T

51. Phenylethylamine compounds such as amphetamine increase blood pressure via displacement of catecholamines from peripheral nerve terminals. F

52. Blockade of sphincter muscle muscarinic receptors in the eye produces constriction of the pupils. F

53. Nitroglycerin is a useful drug treatment for stable, unstable and variant angina. T

54. Oral L-DOPA treatment is more effective in treating Parkinson's disease compared to oral tyrosine treatment because only L-DOPA can gain entry into the brain. F

Tyrosine can enter too but tyrosine hydroxylase is already saturated.
55. Pilocarpine is used in the treatment of glaucoma because of its ability to block muscarinic receptors. 

56. Dobutamine is relatively more efficacious with regard to its ability to increase cardiac force of contraction compared to its ability to increase heart rate.

END OF PHARMACOLOGY EXAM!