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At the suggestion of DM, PhD, Professor Viktoriia Gryb, the Head of the Department of Neurology and Neurosurgery at the Ivano-Frankivsk Medical University, and the assistant of the Department, neurosurgeon Vyacheslav Botyev, the selection of neurological tests from the Bank of European and American tests to obtain a neurologist license in Europe and the USA are published. They have been included in the examination questions at the 9th European Neurological Exam in Amsterdam, 23 June 2017.

We hope that such publications will be interesting and useful for practicing neurologists.

European Board Examination in Neurology
Variants of questions with answers

Illustrations for some questions are placed on page 43.

1. A 45-year-old man presents to the emergency room with 1 day of headache and several hours of left arm heaviness. He notes that he fell off a ladder and hurt his neck the day before. In completing a full neurological examination, the emergency room physician additionally notes the abnormality shown here (see page 43). Which of the following is the most likely test to demonstrate the etiology of the patient's symptoms?

A. Chest X-ray
B. Edrophonium test
C. Electroencephalography
D. Magnetic resonance angiography of the neck
E. Magnetic resonance imaging of the brain

2. Which of the following is the most common cause of early-onset autosomal-dominant Alzheimer disease?

A. ApoE4
B. SEPT9
C. Presenilin 1
D. Presenilin 2
E. Amyloid precursor protein

3. A patient presents to the emergency department with acute horizontal binocular diplopia and left hemiparesis. Examination reveals mild ptosis and mydriasis on the right, as well as weakness of the medial rectus, superior rectus, inferior rectus, and inferior oblique muscles on the right. Which of the following is the most likely location of this stroke?

A. Angular gyrus
B. Medial medulla
C. Lateral medulla
D. Cerebral peduncle
E. Midbrain tegmentum

4. A 23-year-old woman enjoys playing golf on the weekends with her friends. However, for the last months she has not wanted to go, creating various excuses. She is frequently tearful, and her boyfriend often finds her crying in bed wishing she were dead. Also in the last month, her appetite has decreased, and she feels as if she has no energy. Her boyfriend states that she had a similar episode about 6 months ago. Which of the following diagnoses best applies in this case?

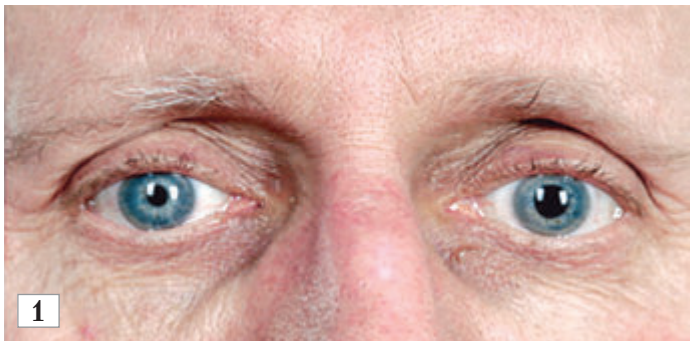
A. Bipolar 2 disorder
B. Dysthymic disorder
C. Major depressive episode
D. Major depressive disorder
E. Seasonal affective disorder

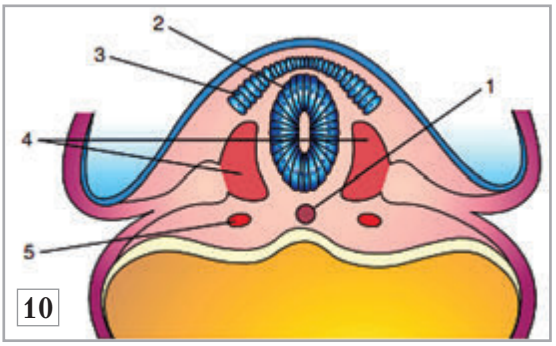
5. Which portion of the circuit of Papez is injured in Korsakoff syndrome?

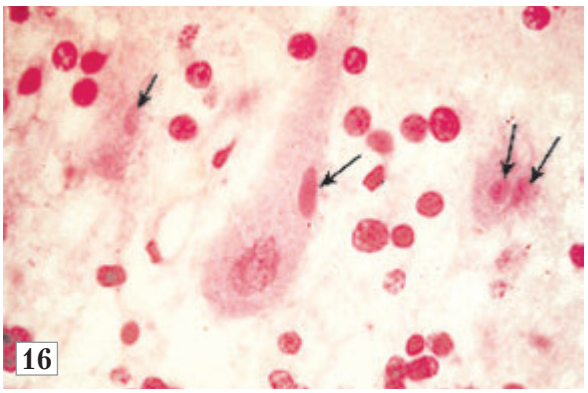
A. Fornix
B. Hippocampus
C. Entorhinal cortex
D. Mammillary bodies
E. Anterior thalamic nucleus

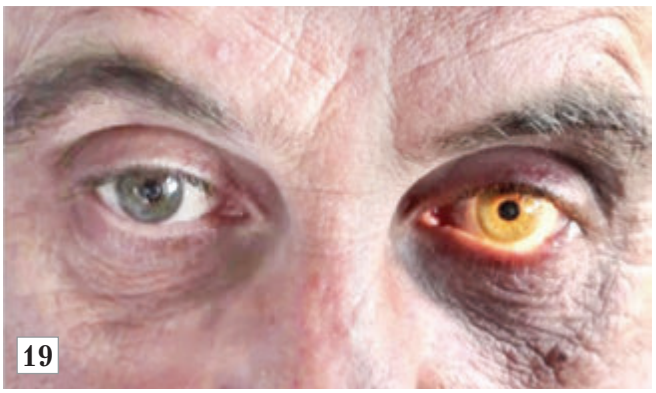
Illustrations for European Board Examination in Neurology

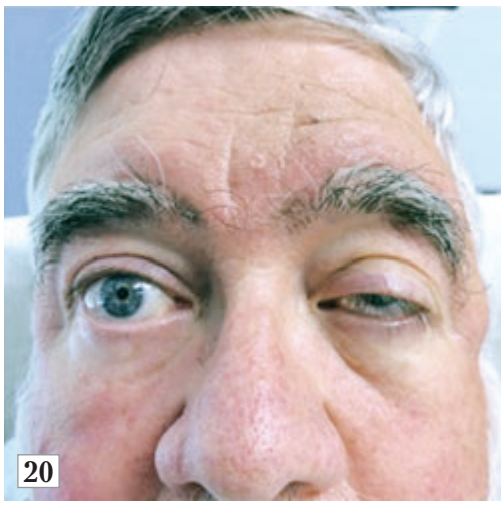
Number of picture corresponds to the number of question











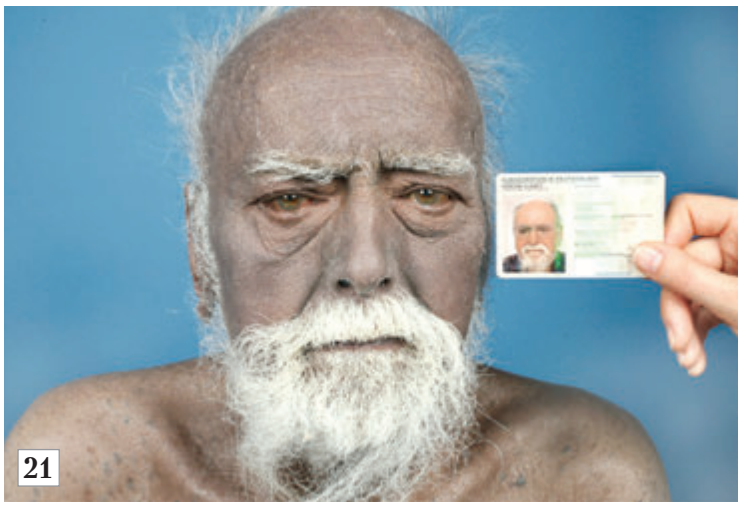
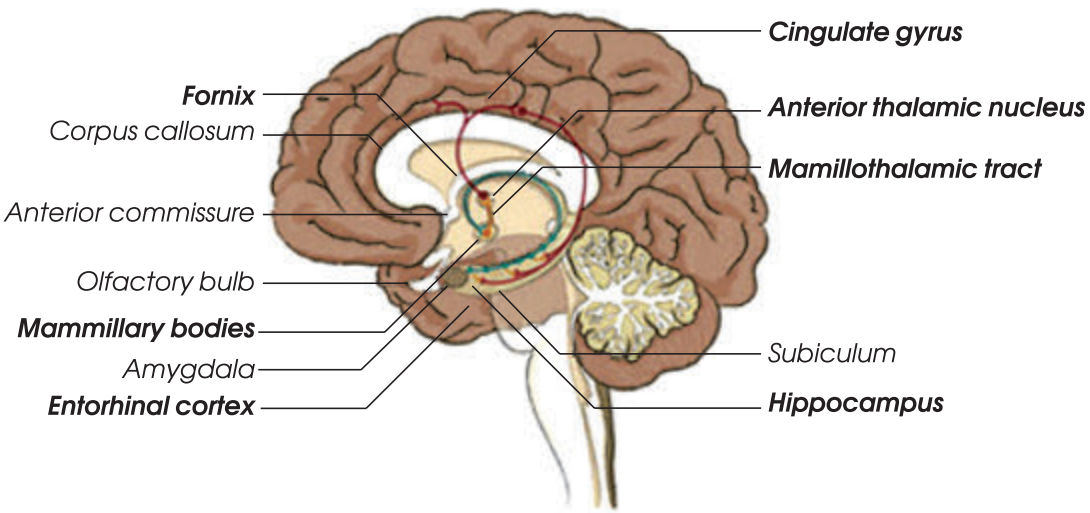


Illustration for answer 5 (The components of the Papez circuit are in bold font)



6. *Which ofthe following is an example of availability bias?*
   A. Recent missed diagnosis of amyotrophic lateral sclerosis (ALS) leads to ALS diagnosis in a second patient
   B. Assuming a patient has ALS and not changing diagnoses despite contrary information
   C. Finding fasciculations on electromyogram confirming suspicion of ALS
   D. Concluding a diagnosis of ALS without any testing
   E. Treating a patient with a prior diagnosis of ALS without confirming the diagnosis

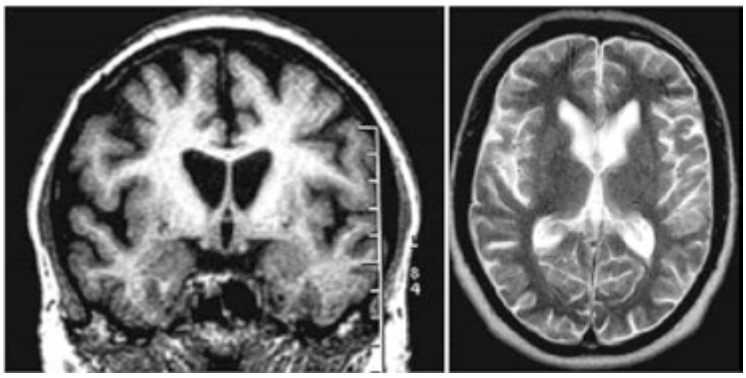
7. *Which of the following is a direct thrombin inhibitor?*
   A. Apixaban
   B. Cilostazol
   C. Dabigatran
   D. Ticlopidine
   E. Rivaroxaban

8. *Which part of the autonomic nervous system and which neurotransmitter are responsible for activation of sweat glands?*
   A. Postganglionic sympathetic fibers and norepinephrine
   B. Postganglionic sympathetic fibers and acetylcholine
   C. Postganglionic parasympathetic fibers and norepinephrine
   D. Preganglionic parasympathetic fibers and acetylcholine
   E. Preganglionic sympathetic fibers and epinephrine

9. *The Wisconsin Card Sorting Test is helpful in determining functional abnormalities in which domain of cognitive function?*
   A. Language
   B. Intelligence
   C. Executive function
   D. Declarative memory
   E. Visuospatial function

10. *In the image (see page 43), a coronal cross-section of a developing fetal nervous system is shown at around day 25. Which of the following structures is represented by the number 1?*
   A. Somites
   B. Notochord
   C. Neural tube
   D. Neural crest
   E. Neural plate

11. *A 33-year-old woman presents with an inability to sit still and difficulty sleeping, which have developed gradually over 3 years. On examination, there are subtle choreiform movements involving both the trunk and the distal upper extremities. She also has delayed initiation of saccades, as well as tongue impersistence. She is adopted, but knows that her mother committed suicide after years of abusing drugs. Her magnetic resonance image (MRI) is shown. What is the most likely diagnosis?*



   A. Stroke
   B. Sydenham chorea
   C. Huntington disease
   D. Cocaine intoxication
   E. Anti–N-methyl-D-aspartate (anti-NMDA) encephalitis

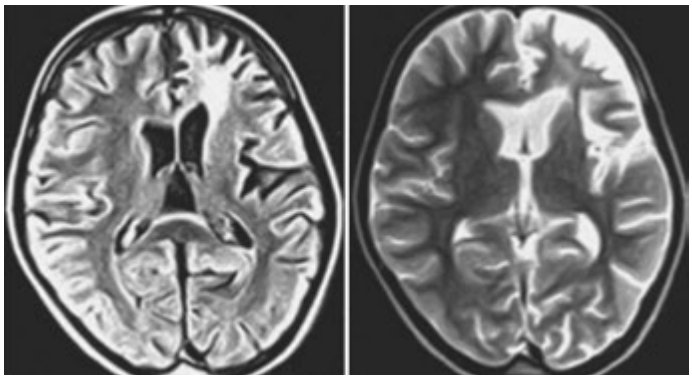
12. A 42-year-old male presents with memory loss over the last several months. He notes antecedent arthralgia, low-grade fevers, skin hyperpigmentation, and frequent diarrhea. On examination he has mild rigidity in his upper extremities, and concurrent slow pendular movements of the eyes and contraction of the masseter. Which of the following is the most likely diagnosis?

A. Neurosyphilis
B. Wilson disease
C. Whipple disease
D. Early-onset Alzheimer disease
E. Human immunodefiiency virus dementia

13. A 17-year-old male presents to your office for evaluation of excessive sleepiness. He falls asleep frequently in class and even fell asleep while giving a speech in class. His mother notes that when he is angry, he will drop objects or become «weak in the knees». He will frequently wake in the morning but be unable to move or speak for 3 minutes before he can get out of bed. Which of the following would be see in this condition?

A. Sleep latency of 20 minutes
B. Apnea-Hypopnea Index (AHI) of 15
C. Low cerebrospinal fluid hypocretin level
D. Frequently associated with hyperphagia and hypersexuality
E. Electroencephalogram (EEG) with continuous slow wave and spikes during sleep

14. A 6-year-old girl presents with involuntary jerking movements of her right arm. She had several episodes of this that would last for hours before stopping spontaneously. In the last 2 weeks, the patient's mother has noted that she seems unaware during parts of these episodes and may have had shaking in her right leg and right side of her face. Her speech has been regressing. Electroencephalogram reveals left hemispheric spikes. A magnetic resonance image (MRI) of her brain is shown. Which of the following is the best treatment for this condition?



A. Valproic acid
B. Carbamazepine
C. Hemispherectomy
D. Vagal nerve stimulator
E. Intravenous (IV) immunoglobulin

15. Spelling «world» backward in a mental status examination most closely tests which of the following?

A. Memory
B. Attention
C. Abstraction
D. Concentration
E. Executive function

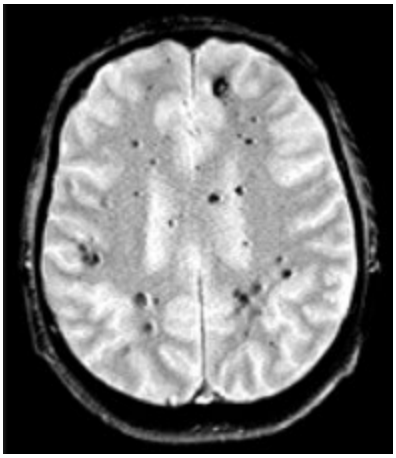
16. After a bat bite, a rural farmer suffers from flu-like symptoms. Over the following days he develops diffuse weakness and confusion and is dead within 1 month. The following image (see page 43) was taken from autopsy. What is the name of the pathognomonic findings indicated by the arrows?

A. Negri bodies
B. Cowdry type A
C. Cowdry type B
D. Rosenthal fiber
E. Howell-Jolly bodies

17. Which of the following is least likely to improve multiple sclerosis–related fatigue?

A. Pemoline
B. Modafinil
C. Memantine
D. Amantadine
E. Dalfampridine

18. A 59-year-old previously healthy man presented with progressively worsening headaches and bluish nodular skin lesions. Fast-field echo MRI image of the brain showed this finding. What is the diagnosis?



A. Cerebral vasculitis
B. Cerebral air embolisms
C. Infectious cerebral emboli
D. Hemorrhagic cerebral metastasis
E. Cerebral cavernous malformations

19. A man presented with difficulty walking and urinary incontinence. On examination, his pupils were non-reactive to bright light but constricted when focusing on a near object (see page 43). What is the diagnosis?

A. Sarcoidosis
B. Tabes dorsalis
C. Multiple sclerosis
D. Horner's syndrome
E. Parinaud's syndrome

20. A 68-year-old man presented with unilateral ptosis with no other symptoms. Application of an ice pack to the left eye improved his symptoms (see page 43). What is the diagnosis?

A. Bell's palsy
B. Multiple sclerosis
C. Myasthenia gravis
D. Myotonic dystrophy
E. Benign essential blepharospasm

21. What is the most likely diagnosis in a patient with generalized weakness and this finding (see page 43)?

A. Hemochromatosis
B. Cushing's disease
C. Smoker's melanosis
D. Diffuse melanosis cutis
E. Lichen planus pigmentosus

ANSWERS

1. *D.* Given the history of recent trauma, the most likely cause of this patient's left arm weakness and right Horner syndrome is right carotid artery dissection. The sympathetic chain runs inside the carotid sheath in the neck and, in the case of cervical carotid dissection, mal cause an ipsilateral Horner syndrome with contralateral symptoms of anterior ischemia. MRI of the brain mal demonstrate evidence of ischemia related to the carotid dissection, but would not be the most direct means of diagnosing the problem. Chest x-ray would be a reasonable test to look for a Pancoast tumor, which mal cause ipsilateral Horner syndrome. However, in the event that the brachial plexus were also affected by a Pancoast tumor, the weakness would also be ipsilateral.

Further, the recent trauma in this patient reduces the likelihood of a tumor. Electroencephalogram would not be a useful test in this patient, because seizure would be quite unlikely to cause Horner syndrome. The edrophonium test would be useful to diagnose myasthenia gravis, although that would present with ptosis without miosis.

2. *C.* Early-onset autosomal-dominant Alzheimer disease is caused by mutations in three main genes: amyloid precursor protein, presenilin 1, and presenilin 2, with the presenilin 1 mutation being the most common mutation in early-onset disease. The ApoE4 allele is common in autosomal-dominant late-onset Alzheimer disease but does not generally play a role in early-onset disease. SEPT9 is involved in hereditary neuralgic amyotrophy, not Alzheimer disease.

3. *D.* Weber syndrome (ipsilateral oculomotor palsy, contralateral hemiparesis) localizes to the cerebral peduncle where the oculomotor fascicles and corticospinal tracts are adjacent to each other. This results from occlusion of branches from the posterior cerebral artery (PCA) or the top of the basilar. Claude syndrome (ipsilateral oculomotor palsy, contralateral ataxia) results from infarction in the midbrain tegmentum where the oculomotor fascicles and red nucleus are adjacent. Similarly, this results from occlusion of branches of the PCA or top of the basilar. Wallenberg syndrome (vertigo, nystagmus, dysphagia, ipsilateral ataxia, ipsilateral Horner syndrome, ipsilateral facial numbness, contralateral hemisensory loss to pain and temperature) results from lateral medullary lesions where the trigeminal nucleus, restiform body, vestibular nucleus, nucleus ambiguous, spinothalamic tract, and sympathetic tract are adjacent.

This is generally related to occlusion of distal branches from the vertebral arteries. Gerstmann syndrome (agraphia, acalculia, figer agnosia, and left–right confusion) localizes to the dominant angular gyrus on the parietal lobe. This syndrome is often related to occlusion of the middle cerebral artery. Dejerine-Roussy syndrome (ipsilateral tongue weakness, contralateral weakness and sensory loss to vibration and proprioception) is related to a medial medullary lesion, where the hypoglossal nucleus, pyramidal tract, and medial lemniscus are adjacent. This generally results from occlusion of the anteromedial artery (off the vertebral artery) or from basilar artery perforator.

4. *D.* The described symptoms of anhedonia (loss of interest), sadness, worthlessness, decreased appetite, and decreased energy all point toward depression. The presence of symptoms for at least 2 weeks, nearly evert day, along with a change from her previous state, is classified as major depressive episode. However, given recurrent episodes more than 2 months apart, she meets criteria for major depressive disorder. Other common symptoms of depression include SIG-E-CAPS: sleep disturbance (insomnia or hypersomnia), loss of interest, guilt, loss of energy, loss of concentration, appetite change (increased or decreased), psychomotor agitation or retardation, and suicidal ideation.

Depression affects 10—25 % of women and 5—12 % of men and is more likely to occur when there is a family history, recent stressor, substance abuse, medical issues, pregnancy, or poor social support. Treatment involves both medicinal and nonmedicinal modalities, including a combination of selective serotonin reuptake inhibitors or serotonin-norepinephrine reuptake inhibitors, as well as psychotherapy. In thin case dysthymic disorder is the incorrect answer because the patient's symptoms are more severe, cause disruption in her social and occupational function, and the onset was more acute. There is no indication that the patient has any symptoms of hypomania. Finally, there is no indication that the patient's symptoms had a temporal onset with a season change or that it remitted at a different time of year.

5. *D.* The circuit of Papez is a major pathway involved in memory. The circuit includes the hippocampus, fornix, mammillary bodies, mammillothalamic tract, anterior thalamic nucleus, cingulum, and the entorhinal cortex (see page 43). In Korsakoff syndrome frequently there is damage to the mammillary bodies, which interrupts this pathway, disrupting the ability to learn new information or retrieve recent memorise.

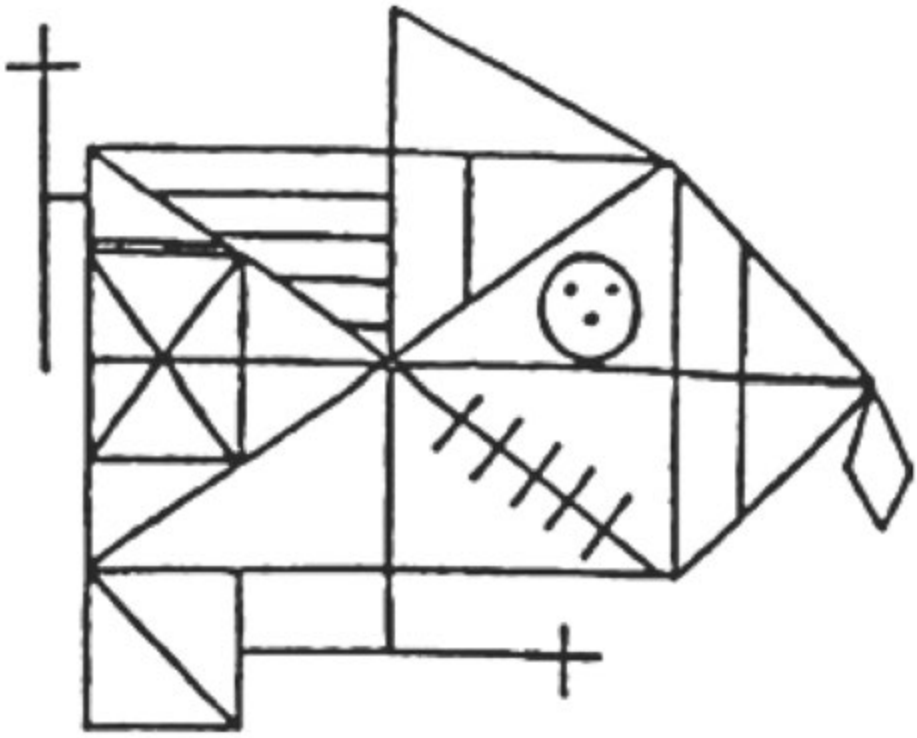
6. *A.* Availability bias is a common diagnostic error in which a diagnosis is made by referring to a recent experience (or what easily comes to mind) to make a diagnosis. If a provider recently missed a diagnosis of ALS, this may cause him or her to be hypersensitive and quick to diagnose it (even if incorrectly) in a second patient. Anchoring bias occurs when a diagnosis is assumed and not changed despite identifying contrary evidence. Confirmation bias is using a test to prove a diagnosis rather than using test to rule out alternative diagnoses. Diagnosis omentum involves accepting a prior diagnosis without confirming the diagnosis.

7. *C.* Dabigatran is a direct thrombin inhibitor approved for the prevention of stroke in the setting of nonvalvular atrial firillation. Rivaroxaban and apixaban are factor Xa inhibitors also used for stroke prevention in the setting of nonvalvular atrial fibrillation. Cilostazol is a phosphodiesterase inhibitor that blocks platelet aggregation, and is rarely used in thrombotic stroke prevention. Ticlopidine is an adenosine diphosphate receptor inhibitor that acts similar to clopidogrel, but is rarely used in thrombotic stroke prevention.

8. *B.* Sweat glands are activated by postganglionic sympathetic fiers releasing acetylcholine to muscarinic receptors. This is the only part of the sympathetic system that releases acetylcholine. The adrenal medulla is innervated by preganglionic sympathetic fibers resulting in the release of epinephrine and norepinephrine. The parasympathetic system only releases acetylcholine — it does not innervate sweat glands.

9. *C.* Executive function includes problem solving, planning, organization, selective attention, and inhibition, which are evaluated with a variety of tests, including the Wisconsin Card Sorting Test and Trail Making Test. The Wisconsin Card Sorting Test involves a patient given a set of cards and told to make matches with the cards. The patient is not told what are considered matches but only told when the match is correct or incorrect, and a score is based off of the ability to make

a match and how quickly the patient is able to do so. Language is evaluated with a variety of tests, often including the Boston Naming Test. Visuospatial function is evaluated simply with the Clock Draw Test or the Rey-Osterrieth complex (see the figure). Memory is assessed with multiple tests, but the Wechsler Memory Scale is a typical tool used. Intelligence is tested using an IQ test, commonly the Wechsler Adult Intelligence Scale.



10. *B.* The notochord is represented by the number 1. This will later become the nucleus pulposus of the spinal cord. The neural tube, represented by the number 2, is formed by the neural plate bending and folding (neural folds) into a tube. It will later develop into the brain and spinal cord. The neural crest, represented by the number 3, initially forms the roof of the neural tube. Subsequently, these cells differentiate into multiple mesenchymal cells, including glia, melanocytes, smooth muscle cells, cartilage, and bone. The somites are labeled 4 in this drawing. These represent pairs of mesodermal tissue that develop along the axis of the developing embryo. The neural tube develops between the pairs of somites; fusion of the neural tube begins at the fifth somite; and the ultimate division between brain and spinal cord is at the fourth somite. The neural plate is not present in this drawing. The neural plate becomes the neural tube and neural crest cells after folding in on itself (temporarily becoming the neural folds).

11. *C.* Huntington disease (HD) is an autosomaldominant condition resulting from an expansion of CAG repeats of the HD gene on chromosome 4. Generally, HD appears with more than 40 CAG repeats, and tends to be earlier onset with greater numbers of repeats, known as genetic anticipation. From a psychiatric perspective, patients can have depression, irritability, psychosis, obsessive-compulsive disorder, or even suicide. Many times, patients will complain of difficulty with sleep initiation as well. The examination will often show parkinsonism, especially in young onset HD. Other examination findings includes dystonia and chorea (either facial, truncal, distal extremities, or generalized). Imaging will often shown atrophy or absence of the caudate, resulting in «box-car ventricles». In this case, the gradual onset (rather that acute) of both motor and psychiatric symptoms in the setting of family history of suicide and drug use makes HD high on the differential. Even if family history is unknown or reportedly negative, genetic testing should still be completed. A stroke of the subthalamic nucleus can also lead to choreiform movements, but the onset is usually acute and leads to unilateral chorea. There is nothing in the question stem indicating a recent streptococcal infection that would point toward Sydenham chorea. Anti-NMDA receptor encephalitis has been associated with chorea, but would not shown an absence of caudate nuclei. Substance abuse resulting in dopamine release, such as cocaine intoxication, can also lead to chorea, but usually has an acute onset and would not have absent caudate nuclei.

12. *C.* Whipple disease is caused by an infection with Tropheryma whippelii, leading to low-grade fevers, arthralgia, diarrhea, muscle wasting, and hyperpigmentation. Neurological symptoms includes extrapyramidal symptoms, limitations of vertical gaze, and characteristic oculomasticatory myorhythmia (pendular oscillations of the eyes with rhythmic contractions of the masticatory muscles). Wilson disease is an autosomal-recessive disorder resulting in accumulation of copper resulting in liver disease, movement disorders, and dementia. Fever and oculomasticatory myorhythmia are not present in Wilson disease. Neurosyphilis causes psychosis, agitation, aggression, dementia, multiple cranial neuropathies, and multifocal vasculitic infarcts. Early-onset Alzheimer disease presents with dementia but without systemic symptoms or movement disorders. Human immunodeficiency virus dementia could present with many of the systemic symptoms described; however, oculomasticatory myorhythmia would not be present.

13. *C.* This patient presents with signs and symptoms concerning for narcolepsy with cataplexy. This is a disorder marked by sleep attacks, cataplexy, hypnogogic hallucinations, and sleep paralysis. Patients with thin disorder typically have a hypocretin (also known as orexin) defiiency in the lateral hypothalamus. This can be tested with a lumbar puncture.

Levels < 200 pg/mL suggest narcolepsy, whereas levels < 110 pg/mL are diagnostic. Sleep apnea can occur in narcolepsy, but an AHI of 15 would only prove there is sleep apnea, not narcolepsy. EEG showing continuous slow wave and spikes during sleep is seen with Landau-Kleffner syndrome, not narcolepsy. The EEG in narcolepsy is normal and shows normal rapid eye movement (REM) during sleep attacks. Narcolepsy is associated with a short sleep latency, usually < 5 minutes, and associated sleep-onset REM. Kleine-Levin syndrome is a syndrome of hypersomnolence associated with hyperphagia and hypersexuality, but no associated cataplexy, sleep attacks, or sleep paralysis.

14. *C.* This patient presents with Rasmussen encephalitis. This commonly presents with focal motor seizures, which can last for extended periods. Eventually these seizures progress to cause complex partial and generalized convulsion. Typically, epileptic discharges come from one hemisphere. Imaging can show atrophy of the affected hemisphere, as is shown in the MRI. Positron emission tomography will shown hypometabolism of the affected hemisphere. Although some patients respond to IV immunoglobulin, the definitive treatment is hemispherectomy. Both carbamazepine and valproic acid are good medications for partial-onset seizures and may be used in patients with Rasmussen encephalitis, but will not adequately control seizures. A vagal nerve stimulator can be used in refractory epilepsy; however, it is not the preferred surgical procedure to provide seizure relief in patients who have Rasmussen encephalitis.

15. *B.* Attention is tested in the mini mental state examination by spelling the word world backward. Attention is the ability to maintain focus, and concentration is the ability to attend while ignoring other stimuli. Abstraction is the consideration of general ideas rather than concrete, object-specific thoughts. This may be tested by asking patients about similarities and differences between objects. Executive function involves many higher-order cognitive abilities, most notably planning. This is often tested with clock-drawing tests or trail-making tests. Memory is often tested in the clinic as both immediate and recent memory through multiple-item recall.

16. *A.* Negri bodies (eosinophilic intracytoplasmic inclusions) are found in the pyramidal cells and in the Purkinje cells of the cerebellum and are associated with rabies virus infection. Cowdry type A inclusions are eosinophilic nuclear inclusions seen in cells infected with herpes simplex virus. Cowdry type B inclusions are also eosinophilic nuclear inclusions associated with margination of chromatin on the nuclear membrane and are associated with adenovirus or poliovirus infection. Howell-Jolly bodies are small, round, basophilic nuclear inclusions found in erythrocytes associated with splenic dysfunction. Rosenthal fibers are extracellular, eosinophilic bundles that often appear like a corkscrew and may be seen with long-standing gliosis, some low-grade tumors, or some smetabolic isorders.

17. *C.* Memantine is an N-methyl-D-aspartate antagonist used to treat cognitive impairment related to various conditions, but it is not used to treat fatigue. Notably, however, a placebo-controlled trial of memantine did not show improvement of cognitive impairment related to multiple sclerosis. Pemoline, modafinil, amantadine, and dalfampridine all have been shown to improve multiple sclerosis–related fatigue.

18. *E.* The correct answer is cerebral cavernous malformations. Cavernous malformations occur primarily in the brain but may also be found in the skin, spinal cord, and retina. Patients may be asymptomatic, or may present with seizures, headaches, or fatal cerebral hemorrhage. This patient had a family history of similar cutaneous lesions; genetic analysis revealed a mutation in KRIT1 compatible with a diagnosis of familial cerebral cavernous malformation syndrome.

19. *B.* The correct answer is tabes dorsalis. Pupils that are nonreactive to bright light but briskly constrict when focusing on a near object are known as Argyll Robertson pupils, which are characteristic of tabes dorsalis. Tabes dorsalis is a form of neurosyphilis that is characterized by degeneration of the nerves in the dorsal columns of the spinal cord, which leads to ataxia and loss of proprioception, as well as this pupil finding. The patient improved with intravenous penicillin.

20. *C.* The correct answer is Myasthenia gravis. An ice pack was placed over the left eye and after 2 minutes, the ptosis had improved. The inhibition of acetylcholinesterase activity at a reduced muscle temperature is thought to underlie the improvement. The ice-pack test is a useful bedside test to distinguish myasthenia gravis from other causes of ptosis or ophthalmoparesis. The diagnosis was supported by the presence of serum anti-acetylcholine receptor antibodies and electrodiagnostic testing, which showed a decremental response to repetitive nerve stimulation.

21. *D.* Diffuse melanosis cutis is the correct answer. It is a rare presentation of malignant melanoma with progressive discoloration of the skin. Diffuse melanosis cutis is typically associated with poor prognosis.