

國立中山大學八十九學年度碩博士班招生考試試題

科目：普通生物學 生物科學系碩士班

共四頁 第一頁

一、Multiple choice: (50%). There is **only one** correct answer for each question.

1. A hormone produced by the epithelial lining of the stomach is
A. secretin B. chymotrypsin C. cholecystokinin D. gastrin E. enterogastrone
2. Saltatory conduction is a term applied to conduction of impulses
A. across electrical synapses B. along myelinated nerve fibers.
C. in two directions at the same time. D. from one neuron to another.
E. along the postsynaptic membrane from dendrite to axon hillock.
3. What is necessary in order for a mother to supply her fetus with oxygen?
A. the affinity of her hemoglobin for oxygen must increase during early pregnancy
B. the blood types of mother and fetus must be compatible
C. the fetus must synthesize myoglobin during early development
D. the pH of maternal blood must be kept as alkaline as possible
E. fetal hemoglobin must have a greater affinity for oxygen than does maternal hemoglobin
4. Which of the following hormonal changes would result in the molt of an insect from an immature stage to an adult?
A. decrease in ecdysone, increase in juvenile hormone
B. increase in ecdysone, decrease in juvenile hormone
C. increase in both ecdysone and juvenile hormone
D. decrease in both ecdysone and juvenile hormone
E. molting is controlled strictly by the nervous system.
5. Organisms categorized as osmoconformers are most likely
A. terrestrial B. marine C. amphibious
D. found in freshwater streams E. found in freshwater lakes
6. The hypothalamus controls the anterior pituitary by means of
A. releasing factors B. second messengers C. enzymes
D. antibodies E. pyrogens
7. Which of the following is correct about the yolk of the frog egg?
A. it prevents gastrulation B. it is concentrated at the animal pole
C. it is homogeneously arranged in the egg D. it impedes the formation of a primitive streak
E. it leads to unequal rates of cleavage for the animal pole compared to the vegetal pole
8. Mitochondria and chloroplasts have double membranes because:
A. their DNA is light-sensitive B. they are derived from eukaryotic nuclei
C. they originated by endosymbiosis D. they need protection from lysosomes
E. the double membrane is required to maintain a H^+ gradient
9. The following reaction: $CH_3CHO + NADH + H^+ \rightarrow CH_3CH_2OH + NAD^+$
A. is a part of the Krebs cycle B. is a part of the Calvin cycle C. is a redox reaction
D. is a condensation reaction E. is a hydrolysis reaction
10. Carl Woese proposed that all life on earth can be classified into ____ Kingdoms:
A. 2 B. 3 C. 5 D. 6 E. 8
11. An animal uncovered on the campus of NSYSU with one or two pairs per segment. The animal must be a
A. millipede B. caterpillar C. centipede D. polychaete E. spider
12. Jaws first occurred in which of the following classes?
A. Agnatha B. Chondrichthyes C. Osteichthyes D. Ostracodermi E. Placodermi

13. Frederick Griffith's work with pneumonia-causing bacteria indicated:
- A. the capsule from smooth cells was able to transform rough cells
 - B. the polysaccharide coat of rough cells caused pneumonia
 - C. plasmid DNA was transferred from the smooth cells into the rough cells
 - D. heat killed smooth cells transferred something to rough cells transforming them into smooth cells.
 - E. heat-killed rough cells were able to cause pneumonia only when they were transformed by the DNA of smooth cells
14. Which of the following statements about the origin of genetic material (the first gene) is most probably correct?
- A. was DNA produced by reverse transcriptase from abiotically produced RNA
 - B. was DNA whose information was transcribed to RNA and later translated in polypeptides
 - C. was autocatalytic RNA molecules bound to clay surfaces
 - D. was RNA produced by autocatalytic, proteinaceous enzymes called ribozymes
 - E. was protobionts produced by dehydration syntheses of nucleic acids
15. The final electron acceptor of the electron transport chain which functions in noncyclic photophosphorylation is:
- A. P700
 - B. ADP
 - C. oxygen
 - D. NADP⁺
 - E. water
16. One major function of double fertilization in angiosperms is to
- A. decrease the potential for mutation by insulating the embryo with other cells
 - B. increase the number of fertilization events and offspring produced
 - C. promote diversity in flower shape and color
 - D. emphasize embryonic survival by increasing embryo size
 - E. coordinate developmental timing between the embryo and its food stores
17. The filaments of the I bands of a muscle cell consist mostly of:
- A. myosin
 - B. creatine phosphate
 - C. troponin
 - D. actin
 - E. sarcoplasmic reticulum
18. Which of the following is not descriptive of deuterostomes?
- A. radial cleavage
 - B. echinoderms and chordates
 - C. includes humans
 - D. development of a blastopore into a mouth
 - E. formation of the coelom from outpocketings of archenteron
19. Increasing the substrate concentration in an enzymatic reaction could overcome which of the following?
- A. denaturing of the enzyme
 - B. noncompetitive inhibition
 - C. allosteric inhibition
 - D. insufficient cofactors
 - E. competitive inhibition
20. Vaccination protects the body against catching a disease because:
- A. it provides antibodies made by another animal
 - B. it makes the disease organism histocompatible with the body
 - C. it provides an enlarged clone of memory cells against that disease
 - D. it builds up an immunological tolerance for the disease antigen
 - E. it releases large amounts of nonspecific defensive secretions
21. A restriction enzyme is:
- A. an enzyme that makes a DNA strand using RNA as a template
 - B. an enzyme that produces mirror image amino acids
 - C. an enzyme that cuts DNA at specific sequences
 - D. an enzyme that restricts which proteins can enter the endoplasmic reticulum
 - E. a regulatory protein that controls the cells entry into mitosis during the cell cycle

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國立中山大學八十九學年度碩博士班招生考試試題

科 目：普通生物學 生物科學系碩士班

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22. Which of the following is not a function of the mammalian liver?
 A. secretion of digestive enzymes for export to the gut
 B. regulation of blood glucose and amino acid content
 C. production of the nitrogenous waste urea
 D. production of plasma proteins for the blood
 E. detoxification of poisonous substances
23. Which of the following reactions is common to both respiration and fermentation?
 A. malate \rightarrow OAA
 B. phosphoenolpyruvate \rightarrow pyruvate
 C. pyruvate \rightarrow lactate
 D. pyruvate \rightarrow acetyl CoA
 E. phosphoenolpyruvate \rightarrow OAA
24. The secretory immune system that protects the nasal mucosa surface is mainly by
 A. IgA
 B. IgD
 C. IgG
 D. IgE
 E. IgM
25. The shaping of an animal and its individual parts into a body form with specialized organs and tissues is called
 A. pattern formation.
 B. induction.
 C. differentiation.
 D. determination.
 E. organogenesis.
26. Which of the following terms includes all others in the list?
 A. monosaccharide
 B. carbohydrate
 C. disaccharide
 D. starch
 E. glycogen
27. Which of the following components is present in a cyanobacterial cell?
 A. mitochondrion
 B. chloroplast
 C. ribosomes
 D. ER
 E. nuclear envelope
28. Which metabolic pathway is common to both fermentation and cellular respiration?
 A. Krebs cycle
 B. electron transport chain
 C. glycolysis
 D. reduction of pyruvate to lactate
 E. synthesis of acetyl CoA from pyruvate
29. The light reaction of photosynthesis supply the Calvin cycle with
 A. light energy
 B. ATP and NADPH
 C. CO₂ and ATP
 D. sugar and O₂
 E. H₂O and NADPH
30. A particular cell has half as much DNA as some of the other cells in a mitotically active tissue. The cell in question is most likely in
 A. G1
 B. G2
 C. prophase
 D. metaphase
 E. anaphase
31. In function, the plant cell structure that is analogous to animal cell's cleavage furrow is the
 A. telomere
 B. cell plate
 C. microtubule
 D. centromere
 E. spindle apparatus
32. The smallest biological unit that can evolve over time is
 A. a cell
 B. an individual organism
 C. a population
 D. a species
 E. an ecosystem
33. In a population that is in Hardy-Weinberg equilibrium, 16% of the individuals show the recessive trait. What would be the frequency of the dominant allele in the population?
 A. 0.84
 B. 0.4
 C. 0.36
 D. 0.48
 E. 0.6
34. As a mechanism of microevolution, natural selection can be most closely equated with
 A. assortive mating
 B. genetic drift
 C. differential reproductive success
 D. mutation
 E. gene flow
35. Most of biological diversity has probably arisen by
 A. anagenesis
 B. hybridization
 C. sympatric speciation
 D. cladogenesis
 E. phyletic evolution
36. Home canners pressur-cook vegetables as a precaution primarily against
 A. mycoplasmas
 B. pseudomonads
 C. actinomycetes
 D. enteric bacteria
 E. endospore-forming bacteria
37. A plant that produces flagellated sperm and has a diploid-dominant generation is most likely a
 A. moss
 B. liverwort
 C. hornwort
 D. charophyte
 E. cycad

38. The male gametophyte of an angiosperm is the
 A. anther B. microspore C. embryo sac D. pollen grain E. ovule
39. The closest relatives of fungi are probably
 A. animals B. brown algae C. vascular plants D. slime molds E. mosses
40. Which of the following cell structures are associated with asexual reproduction in fungi?
 A. ascospore B. ascogonia C. basidiospore D. conidia E. zygospore
41. Sieve-tube elements of the primary plant body originate from
 A. protoderm B. vascular cambium C. procambium
 D. cork cambium E. ground meristem
42. Which structure or compartment is not part of the plant's apoplast?
 A. the lumen of a xylem vessel B. the lumen of a sieve tube
 C. the cell wall of a mesophyll cell D. the cell wall of transfer cell
 E. the cell wall of root hairs
43. Most of the mass of organic material of a plant comes from
 A. water B. atmospheric air C. carbon dioxide D. sun E. soil minerals
44. A seed develops from
 A. an ovum B. an ovary
 C. a pollen grain D. an embryo E. an ovule
45. Buds often form on tree stumps. Which of the followings would you expect to stimulate their formation?
 A. auxin B. ethylene C. cytokinins D. gibberellins E. abscisic acid
46. Populations with low effective population sizes are susceptible to all of the following problems except
 A. inbreeding B. reduced heterozygosity C. bottlenecking
 D. genetic drift E. adaptive radiation
47. Which of the following ecosystems has the lowest primary productivity per square meter?
 A. a salt marsh B. a grassland C. an open ocean
 D. a tropical rain forest E. a coral reef
48. Which of the following organisms is incorrectly paired with its trophic level?
 A. cyanobacteria - primary producer B. grasshopper - primary consumer C. eagle - tertiary consumer
 D. zooplankton - secondary consumer E. fungi - detritivore
49. According to the hypothesis of island biogeography, species richness would be greatest on an island that is
 A. small and remote B. small and close to a mainland C. environmentally homogeneous
 D. large and remote E. large and close to a mainland
50. Predation and parasitism are similar in that both can be characterized as
 A. +/+ interactions B. +/- interactions C. +/0 interactions
 D. -/- interactions E. symbiotic interactions

二、Answer the following questions: (50%)

1. Why enzymes are important for the metabolism of living organisms. [5%].
2. Compare the structure and function of cell walls in eubacteria and plants. [5%]
3. Describe the process of blood clotting. [7%]
4. Draw the structure and the reproductive cycle of HIV. Identify the necessary terms with arrows [8%]
5. Describe the nine major terrestrial biomes of the world [10%]
6. Discuss the limiting factors of population growth. [6%]
7. Define "algae" and discuss their taxonomic positions. [9%]

國立中山大學八十九學年度碩博士班招生考試試題

科目：生物化學 生物科學系碩士班甲·乙 共 1 頁 第 頁

每題 10 分，共 100 分

1. Outline the steps of glycolysis.
2. Outline the TCA cycle.
3. Describe IP_3 -mediated signal transduction pathway.
4. There is a mixture containing A (protein a, 120 kDa, pI 4.0), B (protein b, 30 kDa, pI 5.0), C (protein c, 35 kDa, pI 8.5), and D (amino acid); please design the protein purification procedures to separate them.
5. Describe the four levels of protein structure.
6. Describe how ATP is synthesized in chemiosmotic coupling during respiration.
7. Outline the β -oxidation.
8. Describe four kinds of noncovalent interaction which are important in protein structure.
9. Outline the electron transport in the Z-scheme during photosynthesis.
10. Outline the initiation of polypeptide synthesis in *E. coli*.

I. Multiple choice: Choose the one best answer. 30%

1. Which of the followings is the histone-like protein, prevent non-specific DNA replication initiation at the sites other than oriC ? [A] Hu [B] DnaA [C] DnaB [D] Tu [E] SSB
2. Regulation of gene expression by product of the gene, is called [A] feedback inhibition [B] autoregulation [C] down regulation [D] up regulation [E] repression
3. Proteins may be assisted in folding by a family of helper proteins known as [A] heat shock protein [B] recognition protein [C] chaperon [D] histone [E] cofactor
4. Which of the following proteins is not involved in *E. coli* DNA replication ? [A] gyrase [B] primase [C] DNA polymerase [D] RNA polymerase [E] DNA ligase
5. The order of *E. coli* genes can be mapped by the technique of interrupted mating. The mating process is called [A] electroporation [B] transformation [C] transfection [D] transduction [E] conjugation
6. Which of the following statements concerning apoptosis is NOT correct?
[A] Apoptosis is the programmed death of specific cells.
[B] Apoptosis is a normal process during development.
[C] Apoptosis can only be induced when the Fas or TNF receptors bind their ligands.
[D] Apoptosis involves condensation of the nucleus, DNA fragmentation, protein degradation and the destruction of membranes.
[E] A family of enzymes called caspases are involved in the apoptotic pathway.
7. TATA boxes are found at
[A] every polymerase II promoter.
[B] most polymerase II promoters.
[C] rare polymerase II promoter.
[D] every polymerase III promoter.
[E] most polymerase III promoters.
8. Some macromolecules are formed by polymerization. Polymerization is a process that
[A] creates bonds between amino acids in the formation of a peptide chain.
[B] involves the removal of a water molecule.
[C] links the phosphate of one molecule with the sugar of the next.
[D] requires a condensation reaction.
[E] involves all of the above.

9. If a newly discovered human gene has sequence homology to a previously discovered gene in yeast, it can be inferred that

- [A] The similarity is of no significance.
- [B] The similarity might reflect a common function for the proteins encoded by the genes.
- [C] The amino acid code used by these organisms is the same.
- [D] Human and yeast are more closely related than previously thought.
- [E] The similarity might be a consequence of mutation or artefact of experiments.

10. Special chromosomal structures called telomeres are needed in eukaryotic cells but not in bacteria because

- [A] eukaryotic cells contain linear chromosomes.
- [B] eukaryotic cells have more than one chromosome.
- [C] eukaryotic cells contain a nucleus.
- [D] eukaryotic cells contain more forms of DNA polymerase.
- [E] eukaryotic cells have different strategies for gene expression.

II. Answer the following questions:

1. Please explain (with examples and diagrams) how prokaryotes are different from eukaryotes in terms of [1] genome structure and [2] regulation patterns of gene expression. (10 %)

2. What is the human genome project? What are the potential benefits and social-ethical problems associated with the genome research. (10 %)

3. Explain the followings (15 %)

- [1] Wobble hypothesis
- [2] Aminoacyl tRNA synthetase
- [3] Palindrome
- [4] DNA footprinting
- [5] SOS response in *E. coli*

4. Recombinant DNA technology, also known as genetic engineering, has made a major revolution in biology during the past 20 years. This technology is dependent on many different experiments and enzymes involved. Describe the properties of enzymes and the techniques used that permit (a) cloning of DNA, (b) DNA sequencing, (c) the polymerase chain reaction, and (d) production of cDNA, respectively. (20%)

5. Compare the enzymatic machinery and mechanism of DNA replication in prokaryotes to that in eukaryotes. (15%)

國立中山大學八十九學年度碩博士班招生考試試題

科目：(選考) 動物生理學 生物科學系碩士班 共 / 頁 第 頁

1. 何謂骨骼疏鬆症(osteoporosis)? 試述其病因。 10%
2. 哺乳動物維持正常生殖功能的器官有那些? 設計實驗並以預期結果來說明其調控機轉。 12%
3. 敘述哺乳動物的胚胎發育,從受精卵(zygote)至著床(implantation)於子宮黏膜,各階段的胚胎與母體子宮之特徵。 12%
4. 解釋名詞: 共 15 分每題 3 分,請註明題號作答
 - a) Transport across cell
 - b) Membrane potential
 - c) Function of lysosome
 - d) Synaptic transmission
 - e) Cone cells and rod cells in retina
5. 鈣離子在骨骼肌中具有 secondary messenger 的功能,它也實際參與肌肉化學反應促成肌肉的收縮。試分別申述其作用過程。 12%
6. 有些神經元釋出的物質可作為神經傳遞物促成神經衝動(nerve impulses)的傳送,有些則具有內分泌作用之特性。試分別舉例申述之。 12%
7. 腎小管及相關血管組成的功能系統中有一結構稱為 Juxtaglomerular apparatus 的,請指出其解剖位置,並申述其功能。 12%
8. 試說明
 - a. 神經細胞膜上形成的動作電位(action potential)為何能遵循全無律 (all or none law)? 5%
 - b. saltatory conduction 之原理。 5%
 - c. 自律神經系統(autonomic neural system)神經與體神經系統(somatic neural system)神經之傳遞路徑,所使用之神經傳遞物質之種類,以及主要功能等之差異。 5%

Answer the following questions:

- (1) How to produce a monoclonal anti-idiotypic antibody vaccine against *Trypanosoma cruzi* (the pathogen causes a human disease and its antigens can induce immunosuppression and autoantibodies in the human body) and what is its advantage? (10 %)
- (2) Give examples of the cytokine attributes of pleiotropy, redundancy, synergism, and antagonism including their targets and effects. (10 %)
- (3) Compare the peptide bindings by class I and class II MHC molecules with a clear "Table". (10 %)
- (4) Describe the sequence of events and characteristics of cell stages in B-cell maturation occurred in the bone marrow. (10 %)
- (5) Describe the procedure and reactions of the hapten-inhibition assay employed in the home pregnancy test. (10 %)
- (6) What are 4 types of hypersensitive reactions? Describe in detail the mechanism and typical manifestations of each type of hypersensitive reaction. (20 %)
- (7) The following table summarized the results of CTL activity assay against variety of target cells. Fill in the following blanks with lysis or no lysis, and explain your answers. (20 %)

Treatment of target cells*	CTL activity	
	Class I restricted	Class II restricted
Live influenza virus	(a) _____	_____
UV-inactivated influenza virus	(b) _____	_____
Hemagglutinin protein	(c) _____	_____
Hemagglutinin gene	(d) _____	_____
Synthetic hemagglutinin peptide	(e) _____	_____

*Target cells that expressed both class I and class II MHC molecules were treated with indicated preparation of influenza virus and other agents. The hemagglutinin gene was transfected into target cells as a recombinant expression plasmid.

(8) Define the following terms: (10 %)

- (1) iccosomes
- (2) class switching
- (3) opsonin
- (4) epitope
- (5) complementary-determining region

國立中山大學八十九學年度碩博士班招生考試試題

科目：(選考) 微生物學 生物科學系碩士班乙共 3 頁 第 1 頁

一、Multiple Choice (2 pts each) 60%

1. Which of the following is an example of bioremediation:
 - a. using fermenting microorganisms to make beer.
 - b. microbes living in the digestive tracts of cattle that aid in digestion.
 - c. using antibiotic-producing microbes to develop new drugs.
 - d. using microbes to produce needed human proteins.
 - e. using microbes to remove toxic waste from the soil.
2. When comparing glucose to ribose, which is NOT correct:
 - a. both are monosaccharides.
 - b. glucose has one more carbon atom compared to ribose.
 - c. both have one hydrogen atom for every two carbon and oxygen atoms.
 - d. both have alcohol functional groups.
 - e. ribose is found in all RNA molecules but glucose is not found in any nucleic acids.
3. The technique of heat-fixing a specimen onto a microscope slide is:
 - a. used to prepare a hanging drop.
 - b. a procedure used in electron microscopy but not in light microscopy.
 - c. only used in simple-stain techniques.
 - d. used to make wet mounts.
 - e. a procedure that causes the microbial cells to adhere to the slide.
4. A microbiologist uses a stain on specimen that when viewed on a microscope shows clear cells against a stained background. Which of the following pertains to this stain:
 - a. it had to involve a basic dye.
 - b. it is designed to stain cell walls rich in lipids.
 - c. the microbiologist probably overdecolorized the cells.
 - d. it is called a negative stain.
 - e. the specimen was improperly heat-fixed.
5. Lipopolysaccharide:
 - a. is found in all bacterial cell walls.
 - b. can induce fever and dilation of blood vessels in infected patients.
 - c. is extremely thick in gram positive bacteria.
 - d. is found in the periplasmic space.
 - e. is found in cells that will appear purple after the Gram stain.
6. If a student accidentally inoculates a bacterial culture into a hypertonic solution instead of balanced nutrient broth, which of the following describes the inoculated culture:
 - a. the solution has a lower solute concentration compared to the cells.
 - b. the solution has a higher water concentration compared to the cells.
 - c. water will leave the cells.
 - d. water will enter the cells.
 - e. the cells will burst.
7. A microbiologist is examining a sample of moist soil under the microscope and sees many green cells with nuclei and cell walls. Which of the following microorganisms is likely to be the cells seen in the sample:
 - a. cyanobacteria
 - b. yeasts
 - c. protozoa
 - d. algae
 - e. molds
8. Which prokaryotes have cholesterol in their cell membranes:
 - a. mycoplasmas
 - b. Gram negative bacteria
 - c. Gram positive bacteria
 - d. cyanobacteria
 - e. mycobacteria
9. Where would you expect to find an exoenzyme participating in a chemical reaction:
 - a. inside mitochondria
 - b. in the cytoplasm
 - c. inside the lysosome
 - d. outside the cell membrane
 - e. inside the cell membrane
10. Laboratory analysis of an unknown microorganism shows that the organism has the following characteristics: 1) utilizes glucose to form lactic acid 2) grows in an anaerobic environment. This organism's utilization of glucose could be termed:
 - a. photosynthesis
 - b. respiration
 - c. biosynthesis
 - d. facultative
 - e. fermentation
11. What do the pentose phosphate pathway, the Entner-Doudoroff pathway and the glycolytic pathway have in common:
 - a. oxidize glucose to pyruvate
 - b. occur in all species of bacteria
 - c. are fermentation pathways
 - d. are anabolic pathways
 - e. use the same set of enzymes

國立中山大學八十九學年度碩博士班招生考試試題

科目：(選考) 微生物學 生物科學系碩士班乙 共 3 頁 第 2 頁

12. A medium which contains substances whose exact chemical composition is known is called a(n) _____ medium:
a. selective b. complex c. natural d. differential e. synthetic defined
13. A bacterium that undergoes a mutation causing it to be nutritionally deficient is called a(n):
a. progeny b. wild types c. prototrophs d. auxotrophs e. mutagen
14. What do F plasmids code for?
a. viral replication b. F pilus c. capsule production
d. enzyme for drug resistance e. competence factor
15. Protozoans are a member of which kingdom:
a. Fungi b. Monera c. Protista d. Plantae e. Animalia
16. Which of the following is the BEST method to determine bacteriophage concentration in a sample
a. spectrophotometer b. plaque assay c. light microscopy
d. animal inoculation e. biochemical tests
17. Prions:
a. are infectious particles not destroyed by DNase or RNase
b. are infectious pieces of RNA
c. are also called viroids
d. are easily inactivated at 90 °C
e. is the name given to latent viruses
18. A patient with encephalitis is diagnosed with a togavirus infection. How did she acquire the infection:
a. respiratory droplets b. sexual contact c. contact with lesions
d. mosquito bite e. food contaminated with human feces
19. Which microorganisms include species associated with red tides and bioluminescence:
a. diatoms b. dinoflagellates c. amoeba d. helminths e. water molds
20. Attenuation is a process that:
a. increases a pathogen's virulence
b. allows opportunities to cause disease
c. increases the ability of a toxin to cause disease
d. involves microbial factors leading to body fever
e. decreases a pathogen's virulence
21. A disease that is present in high numbers throughout the world is most accurately called:
a. endemic b. epidemic c. sporadic d. pandemic e. indigenous
22. A physician receives a lab report indicating that acid-fast bacilli were found in sputum from a patient with a lower respiratory tract infection. The physician suspects:
a. pneumococcal pneumonia b. primary atypical pneumonia c. tuberculosis
d. histoplasmosis e. Legionnaire's disease
23. The formation of ammonia from nitrogen gas is called:
a. denitrification b. nitrification c. nitrogenation d. nitrogen fixation
e. sulfur oxidation
24. The enrichment of water from run-offs of detergents and fertilizers that often results in a bloom is called:
a. hydrologic cycle b. flocculation c. eutrophication d. sludge e. humus
25. System of water purification where sewage is sprayed over rocks coated with bacteria is called:
a. sludge digestion b. activated sludge system c. bulking
d. eutrophication e. trickling filter system
26. The presence of *Saccharomyces cerevisiae* in baked goods will
a. produce needed CO₂ b. cause pink mold spoilage c. cause soft rot
d. add vitamin K e. produce acids
27. What do dengue fever, yellow fever, Rift Valley fever, and Colorado tick fever have in common:
a. rickettsial diseases b. tick vectors c. caused by viruses
d. symptoms always include fever, headache, rash
e. treated with antimicrobials

國立中山大學八十九學年度碩博士班招生考試試題

科目：(選考) 微生物學 生物科學系碩士班乙共 3 頁 第 3 頁

28. If a microbiology lab sets up a Kirby-Bauer assay, which of the following will pertain to this test:
- pathogen is added to serial dilutions of various antimicrobial
 - after incubation, an agar plate with the pathogen will show various zones of inhibition reflecting the microbe's sensitivity or resistance to each drug
 - minimum inhibitory concentrations of various drugs will be determined
 - the lab will be able to tell if a pathogen was killed or merely inhibited by each drug
 - a patient's serum is tested for its bactericidal action
29. If the phenol coefficient of disinfectant A is 7.5, and the phenol coefficient of disinfectant B is 0.5, and the phenol coefficient of disinfectant C is 50.0, what conclusion can be made:
- disinfectant B is more effective than phenol
 - disinfectant C is less effective than phenol
 - disinfectant A is less effective than phenol
 - of the three test agents, disinfectant C has the greatest effect compared to phenol
 - agent C was exposed to the test microbes for a longer time than agents A & C
30. What does a virulent phage do:
- lyses bacteria
 - undergoes lysogeny
 - produces prophage
 - produces plasmids
 - produces competence factor

二、問答題 (每大題 10 分) 40%

1. *Salmonella* bacteria cause a form of food poisoning. Often they live in poultry and eggs. Newly hatched chicks acquire them when they ingest bacteria-laden feces of healthy adult chickens. However, harmless bacteria ingested the same way colonize the surface of intestinal cells, leaving no place for *Salmonella* to take hold. Some farmers raise thousands of chicks in confined quarters with no adult chickens. Should they feed the chicks a known mixture of bacteria from a lab or a mixture of unknown bacteria from healthy adult chickens? Devise an experiment to test which approach may be more effective. (10 pts)
2. (1)What is the distinction between natural drug resistance and acquired drug resistance as it occurs in bacteria? (2)It is said that bacteria can acquire drug resistance by means of "horizontal evolution" or "vertical evolution". Explain the distinction between these terms, and their underlying genetic mechanisms. (10 pts)
3. What are the essential biochemical differences between photosynthesis by bacteria (green and purple bacteria) and by green plants? Please discuss in detail on their photosynthesis pigments, biochemical pathway, substrates, and products. (10 points)
4. Discuss the origin and the importance of the "envelope" that surrounds the nucleocapsid of many animal viruses. Why do you think that virtually all bacterial viruses lack an envelope? (10 pts)

國立中山大學八十九學年度碩博士班招生考試試題

科目：(選考) 植物生理學 生物科學系碩士班 共 1 頁 第 1 頁

問答：100%

1. List the principal organelles in a plant cell and describe the distinctive features of each. (10%)
2. Explain how guard cells regulate the size of the stomatal aperture. (10%)
3. In what significant way does Crassulacean acid metabolism (CAM) differ from C4 metabolism? (10%)
4. Describe the source-sink concept. To what extent are source-sink relationships involved in determining the direction and rate of translocation in the phloem? (10%)
5. Auxin transport is said to be polar. What does this mean and how is it achieved? (10%)
6. If there were an auxin receptor in plant tissues, how do you distinguish auxin carrier from auxin receptor? Please describe in brief. 10%
7. Describe the molecular mechanism of auxin action. 10%
8. How do you prove that the transcription factors regulate α -amylase gene expression? Describe in brief. 10%
9. Describe the model of ethylene signaling in Arabidopsis. 10%
10. Describe the model for ABA action in stomatal guard cells. 10%

I. 簡答題 (每題 10 分) 20%

1. 何謂基石物種(Keystone species)? 舉例說明之。
2. 試以生態學的關點來解釋輻射適應及趨同演化, 並舉例說明之。

II. 申論題 (每題 20 分) 80%

3. 試論述「行為」如何可能調節或影響一物種族群的成長方式, 並舉例說明之。
4. 試分別論述物種喪失與物種入侵對群聚 (Community) 可能之影響, 並舉例說明之。
5. 試以「能量-穩定性-面積理論」(Energy-Stability-Area Theory) 解釋地球上生物分布之形式。
6. 最易受到全球氣候變遷所影響之物種與群聚類型為何? 理由為何?

國立中山大學八十九學年度碩博士班招生考試試題

科目：(選考) 植物分類學 生物科學系碩士班丙

共一頁

I. 解釋名詞：(20分)

- | | |
|---------------------------|-------------------------------------|
| 1. Taxon | 2. Operational Taxonomic Unit (OTU) |
| 3. Evolutionary Unit (EU) | 4. Monophyletic |
| 5. Character State | 6. Vicariance |
| 7. Palynology | 8. Pollination |
| 9. Autogamy | 10. Apomixis |

II. 寫出五種臺灣原生裸子植物的中文及學名(10分)。

III. 怎樣叫作一個種 (species) (10分)。

IV. 敘述生殖隔離的機制(10分)。

V. 例舉生殖器官之一特徵以區別下列各子題之相對二科植物(述明該例舉之特徵在二科中呈現之性狀)(20分)。

- | | |
|--------------------------------------|--------------------------------------|
| 1. Pinaceae vs. Cupressaceae | 2. Magnoliaceae vs. Lauraceae |
| 3. Cactaceae vs. Caryophyllaceae | 4. Guttiferae vs. Malvaceae |
| 5. Caesalpiniaceae vs. Papilionaceae | 6. Verbenaceae vs. Labiatae |
| 7. Oleaceae vs. Scrophulariaceae | 8. Lycopodiaceae vs. Selaginellaceae |
| 9. Araceae vs. Palmae | 10. Liliaceae vs. Orchidaceae |

VI. 例舉營養器官之一特徵以區別下列各子題之相對二科植物(述明該例舉之特徵在二科中呈現之性狀)(20分)。

- | | |
|-------------------------------------|---|
| 1. Psilotaceae vs. Equisetaceae | 2. Cycadaceae vs. Taxaceae |
| 3. Moraceae vs. Fagaceae | 4. Polygonaceae vs. Amaranthaceae |
| 5. Cucurbitaceae vs. Convolvulaceae | 6. Verbenaceae vs. Rubiaceae |
| 7. Araliaceae vs. Umbelliferae | 8. Rosaceae vs. Leguminosae (broad sense) |
| 9. Junaceae vs. Gramineae | 10. Rutaceae vs. Myrsinaceae |

VII. 寫出一檢索表，以鑑定下列各科之植物(10分)。

- | | |
|------------------|------------------|
| 1. Polypodiaceae | 2. Taxodiaceae |
| 3. Ericaceae | 4. Ranunculaceae |
| 5. Commelinaceae | 6. Cyperaceae |

國立中山大學八十九學年度碩博士班招生考試試題

科目：(選考) 生物統計學
生物科學系碩士班丙 共 3 頁 第 1 頁

每題 20 分 共 100 分

1. The weights (Y) and heights (X) of 10 people are shown below:

Weight	Height	Weight	Height
50	160	40	150
70	180	60	170
60	160	70	165
80	185	50	165
65	175	70	175

- a. Obtain the regression equation using the least-squares method.
- b. Compute the coefficient of determination. What does the coefficient mean?
- c. Compute the sample correlation coefficient.

2. A study about seat-belt use and result of automobile crashes was conducted.

Seat-belt use	Result of Crash		
	Fatality	Non fatality	total
Yes	12	68	80
No	18	2	20
Total	30	70	100

Is the result of crash independent of the seat-belt use? Let $\alpha=0.05$.

3. Two populations of a plant are compared for their stem height.

Sample	n	\bar{x}	s.d.
1	10	20	4
2	10	18	3

Can we conclude that the mean stem height in population 1 is higher than that of population 2? Assume that the heights of plant of the populations are normally distributed. Let $\alpha=0.01$.

4. A psychologist claims that 30 percent of all men are afraid of flying. If, in a random sample, 40 of the 150 men are afraid of flying, test the null hypothesis $p = 0.30$ against the alternative hypothesis $p \neq 0.30$ at the 0.05 level of significance. What is the 95% confidence interval for the p ?


5. The mean grades of students taking science courses in three departments, which were treated as blocks, are shown below:

Department	Mean grades			
	Calculus	Physics	Chemistry	Biology
Mathematics	80	85	70	65
Physics	80	95	60	65
Biology	80	90	80	90

- a. Construct an ANOVA table.
- b. Do these data provide sufficient evidence to indicate a difference in grades among the different science courses? Let $\alpha=0.05$.

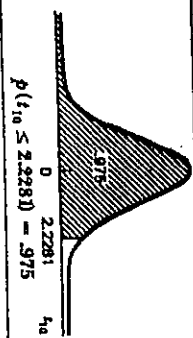
國立中山大學八十九學年度碩博士班招生考試試題
 科目：生物統計學 (生科丙)

Probability of a random value of $Z = (Y - \mu)/\sigma$ being greater than the values tabulated in the margins



Z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	.5000	.4960	.4920	.4880	.4840	.4801	.4761	.4721	.4681	.4641
0.1	.4602	.4562	.4522	.4483	.4443	.4404	.4364	.4325	.4286	.4247
0.2	.4207	.4168	.4129	.4090	.4052	.4013	.3974	.3936	.3897	.3859
0.3	.3821	.3783	.3745	.3707	.3669	.3632	.3594	.3557	.3520	.3483
0.4	.3446	.3409	.3372	.3336	.3300	.3264	.3228	.3192	.3156	.3121
0.5	.3085	.3050	.3015	.2981	.2946	.2912	.2877	.2843	.2810	.2776
0.6	.2743	.2709	.2676	.2643	.2611	.2578	.2546	.2514	.2483	.2451
0.7	.2420	.2389	.2358	.2327	.2296	.2266	.2236	.2206	.2177	.2148
0.8	.2119	.2090	.2061	.2033	.2005	.1977	.1949	.1922	.1894	.1867
0.9	.1841	.1814	.1788	.1762	.1736	.1711	.1685	.1660	.1635	.1611
1.0	.1587	.1562	.1539	.1515	.1492	.1469	.1446	.1423	.1401	.1379
1.1	.1357	.1335	.1314	.1292	.1271	.1251	.1230	.1210	.1190	.1170
1.2	.1151	.1131	.1112	.1093	.1075	.1056	.1038	.1020	.1003	.0985
1.3	.0968	.0951	.0934	.0918	.0901	.0885	.0869	.0853	.0838	.0823
1.4	.0808	.0793	.0778	.0764	.0749	.0735	.0721	.0708	.0694	.0681
1.5	.0668	.0655	.0643	.0630	.0618	.0606	.0594	.0582	.0571	.0559
1.6	.0548	.0537	.0526	.0516	.0505	.0495	.0485	.0475	.0465	.0455
1.7	.0446	.0436	.0427	.0418	.0409	.0401	.0392	.0384	.0375	.0367
1.8	.0359	.0351	.0344	.0336	.0329	.0322	.0314	.0307	.0301	.0294
1.9	.0287	.0281	.0274	.0268	.0262	.0256	.0250	.0244	.0239	.0233
2.0	.0228	.0222	.0217	.0212	.0207	.0202	.0197	.0192	.0188	.0183
2.1	.0179	.0174	.0170	.0166	.0162	.0158	.0154	.0150	.0146	.0143
2.2	.0139	.0136	.0132	.0129	.0125	.0122	.0119	.0116	.0113	.0110
2.3	.0107	.0104	.0102	.0099	.0096	.0094	.0091	.0089	.0087	.0084
2.4	.0082	.0080	.0078	.0075	.0073	.0071	.0069	.0068	.0066	.0064
2.5	.0062	.0060	.0059	.0057	.0055	.0054	.0052	.0051	.0049	.0048
2.6	.0047	.0045	.0044	.0043	.0041	.0040	.0039	.0038	.0037	.0036
2.7	.0035	.0034	.0033	.0032	.0031	.0030	.0029	.0028	.0027	.0026
2.8	.0026	.0025	.0024	.0023	.0023	.0022	.0021	.0021	.0020	.0019
2.9	.0019	.0018	.0018	.0017	.0016	.0016	.0015	.0015	.0014	.0014
3.0	.0013	.0013	.0013	.0012	.0012	.0011	.0011	.0011	.0010	.0010
3.1	.0010	.0009	.0009	.0009	.0008	.0008	.0008	.0008	.0007	.0007
3.2	.0007	.0007	.0006	.0006	.0006	.0006	.0006	.0005	.0005	.0005
3.3	.0005	.0005	.0005	.0004	.0004	.0004	.0004	.0004	.0004	.0003
3.4	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0002
3.6	.0002	.0002	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001
3.9	.0000									

TABLE Percentiles of the t Distribution



d.f.	$t_{.90}$	$t_{.80}$	$t_{.70}$	$t_{.60}$	$t_{.50}$	$t_{.40}$
1	3.078	6.3138	12.706	31.821	63.657	9.9248
2	1.886	2.9200	4.3027	6.965	9.8409	5.8409
3	1.638	2.3534	3.1825	4.541	5.8409	4.6041
4	1.533	2.1318	2.7764	3.747	4.6041	4.0321
5	1.476	2.0150	2.5706	3.365	4.0321	3.7074
6	1.440	1.9432	2.4469	3.143	3.7074	3.4935
7	1.415	1.8946	2.3646	2.998	3.4935	3.3554
8	1.397	1.8595	2.3060	2.896	3.3554	3.2498
9	1.383	1.8331	2.2622	2.821	3.2498	3.1693
10	1.372	1.8125	2.2281	2.764	3.1693	3.1058
11	1.363	1.7959	2.2010	2.718	3.1058	3.0545
12	1.356	1.7823	2.1798	2.681	3.0545	3.0123
13	1.350	1.7709	2.1604	2.650	3.0123	2.9768
14	1.345	1.7613	2.1448	2.624	2.9768	2.9467
15	1.341	1.7530	2.1315	2.602	2.9467	2.9208
16	1.337	1.7459	2.1199	2.583	2.9208	2.8982
17	1.333	1.7396	2.1098	2.567	2.8982	2.8784
18	1.330	1.7341	2.1009	2.552	2.8784	2.8609
19	1.328	1.7291	2.0930	2.539	2.8609	2.8453
20	1.325	1.7247	2.0860	2.528	2.8453	2.8314
21	1.323	1.7207	2.0796	2.518	2.8314	2.8188
22	1.321	1.7171	2.0739	2.508	2.8188	2.8073
23	1.319	1.7139	2.0687	2.500	2.8073	2.7969
24	1.318	1.7109	2.0639	2.492	2.7969	2.7874
25	1.316	1.7081	2.0595	2.485	2.7874	2.7787
26	1.315	1.7056	2.0555	2.479	2.7787	2.7707
27	1.314	1.7033	2.0518	2.473	2.7707	2.7633
28	1.313	1.7011	2.0484	2.467	2.7633	2.7564
29	1.311	1.6991	2.0452	2.462	2.7564	2.7500
30	1.310	1.6973	2.0423	2.457	2.7500	2.7239
35	1.3062	1.6896	2.0301	2.438	2.7239	2.7045
40	1.3031	1.6839	2.0211	2.423	2.7045	2.6886
45	1.3007	1.6794	2.0141	2.403	2.6886	2.6778
50	1.2987	1.6759	2.0086	2.403	2.6778	2.6603
60	1.2959	1.6707	2.0003	2.390	2.6603	2.6480
70	1.2938	1.6669	1.9945	2.381	2.6480	2.6388
80	1.2922	1.6641	1.9901	2.374	2.6388	2.6316
90	1.2910	1.6620	1.9840	2.368	2.6316	2.6260
100	1.2891	1.6602	1.9799	2.358	2.6260	2.6175
120	1.2887	1.6577	1.9799	2.358	2.6175	2.6114
140	1.2876	1.6558	1.9749	2.353	2.6114	2.6070
160	1.2869	1.6545	1.9733	2.347	2.6070	2.6035
180	1.2863	1.6534	1.9719	2.345	2.6035	2.6006
200	1.2858	1.6525	1.9719	2.345	2.6006	2.5976
∞	1.282	1.645	1.96	2.326	2.576	

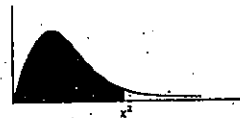
國立中山大學八十九學年度碩博士班招生考試試題

科目：生物統計學 (生科丙)

共 3 頁 第 3 頁

Cumulative chi-squared distribution

$$F(x^2) = P[X^2 \leq x^2]$$



χ^2	.005	.010	.025	.050	.100	.250	.500	.750	.900	.950	.975	.990	.995
1	.0000393	.000157	.000982	.00393	.0168	.102	.455	1.32	2.71	3.84	5.02	6.63	7.88
2	.0100	.0201	.0606	.103	.211	.575	1.39	2.77	4.61	5.99	7.38	9.21	10.6
3	.0717	.115	.216	.352	.584	1.21	2.37	4.11	6.25	7.81	9.35	11.3	12.8
4	.207	.297	.484	.711	1.06	1.92	3.36	5.89	7.78	9.49	11.1	13.3	14.9
5	.412	.564	.831	1.15	1.61	2.67	4.35	6.63	9.24	11.1	12.8	15.1	16.7
6	.676	.872	1.24	1.64	2.20	3.45	5.85	7.84	10.6	12.0	14.4	16.8	18.5
7	.989	1.24	1.69	2.17	2.85	4.25	6.35	9.04	12.0	14.1	16.0	18.5	20.3
8	1.34	1.65	2.18	2.73	3.49	5.07	7.34	10.2	13.4	15.5	17.5	20.1	22.0
9	1.73	2.09	2.70	3.33	4.17	5.90	8.34	11.4	14.7	16.9	19.0	21.7	23.6
10	2.16	2.56	3.25	3.94	4.87	6.74	9.34	12.6	16.0	18.3	20.5	23.2	25.2
11	2.60	3.05	3.82	4.57	5.58	7.58	10.3	13.7	17.3	19.7	21.9	24.7	26.8
12	3.07	3.57	4.40	5.23	6.30	8.44	11.3	14.8	18.5	21.0	23.8	26.2	28.3
13	3.57	4.11	5.01	5.89	7.04	9.30	12.3	16.0	19.8	22.4	24.7	27.7	29.8
14	4.07	4.68	5.63	6.57	7.79	10.2	13.3	17.1	21.1	23.7	26.1	29.1	31.3
15	4.60	5.23	6.26	7.26	8.55	11.0	14.3	18.2	22.3	25.0	27.5	30.6	32.8
16	5.14	5.81	6.91	7.96	9.31	11.9	15.3	19.4	23.5	26.3	28.8	32.0	34.3
17	5.70	6.41	7.58	8.67	10.1	12.8	16.3	20.5	24.8	27.6	30.2	33.4	35.7
18	6.26	7.01	8.23	9.39	10.9	13.7	17.3	21.6	26.0	28.9	31.5	34.8	37.2
19	6.84	7.63	8.91	10.1	11.7	14.6	18.3	22.7	27.2	30.1	32.9	36.2	38.6
20	7.43	8.26	9.59	10.9	12.4	15.5	19.3	23.8	28.4	31.4	34.2	37.6	40.0
21	8.03	8.90	10.3	11.6	13.2	16.3	20.3	24.9	29.6	32.7	35.5	38.9	41.4
22	8.64	9.54	11.0	12.3	14.0	17.2	21.3	26.0	30.8	33.9	36.8	40.3	42.8
23	9.26	10.2	11.7	13.1	14.8	18.1	22.3	27.1	32.0	35.2	38.1	41.6	44.2
24	9.89	10.9	12.4	13.9	15.7	19.0	23.3	28.2	33.2	36.4	39.4	43.0	45.6
25	10.5	11.5	13.1	14.6	16.5	19.9	24.3	29.3	34.4	37.7	40.6	44.3	46.9
26	11.2	12.2	13.8	15.4	17.3	20.8	25.3	30.4	35.6	38.9	41.9	45.6	48.3
27	11.8	12.9	14.6	16.2	18.1	21.7	26.3	31.5	36.8	40.1	43.2	47.0	49.6
28	12.5	13.6	15.3	16.9	18.9	22.7	27.3	32.6	37.9	41.3	44.5	48.3	51.0
29	13.1	14.3	16.0	17.7	19.8	23.6	28.3	33.7	39.1	42.6	45.7	49.6	52.3
30	13.8	15.0	16.8	18.5	20.6	24.5	29.3	34.8	40.3	43.8	47.0	50.9	53.7

Cumulative F distribution

$$P[F_{\nu_1, \nu_2} \leq f] = .95$$



$\nu_2 \backslash \nu_1$	1	2	3	4	5	6	7	8	9	10	12	15	20	24	30	40	60	120	∞
1	161.4	199.5	215.7	224.6	230.2	234.0	236.8	238.9	240.5	241.9	243.9	245.9	248.0	249.1	250.1	251.1	252.2	253.3	254.5
2	18.51	19.00	19.16	19.25	19.30	19.33	19.35	19.37	19.38	19.40	19.41	19.43	19.45	19.46	19.46	19.47	19.48	19.49	19.50
3	10.13	9.55	9.28	9.12	9.01	8.94	8.89	8.85	8.81	8.79	8.74	8.70	8.66	8.64	8.62	8.59	8.57	8.55	8.53
4	7.71	6.94	6.59	6.39	6.26	6.16	6.09	6.04	6.00	5.96	5.91	5.86	5.80	5.77	5.75	5.72	5.69	5.66	5.63
5	6.61	5.79	5.41	5.19	5.05	4.95	4.88	4.82	4.77	4.74	4.68	4.62	4.56	4.53	4.50	4.46	4.43	4.40	4.38
6	5.99	5.14	4.76	4.53	4.39	4.28	4.21	4.15	4.10	4.06	4.00	3.94	3.87	3.84	3.81	3.77	3.74	3.70	3.67
7	5.59	4.74	4.35	4.12	3.97	3.87	3.79	3.73	3.68	3.64	3.57	3.51	3.44	3.41	3.38	3.34	3.30	3.27	3.23
8	5.32	4.46	4.07	3.84	3.69	3.58	3.50	3.44	3.39	3.35	3.28	3.22	3.15	3.12	3.08	3.04	3.01	2.97	2.93
9	5.12	4.26	3.86	3.63	3.48	3.37	3.29	3.23	3.18	3.14	3.07	3.01	2.94	2.90	2.86	2.82	2.79	2.75	2.71
10	4.96	4.10	3.71	3.48	3.33	3.22	3.14	3.07	3.02	2.98	2.91	2.85	2.77	2.74	2.70	2.66	2.62	2.58	2.54
11	4.84	3.98	3.59	3.36	3.20	3.09	3.01	2.95	2.90	2.85	2.79	2.72	2.65	2.61	2.57	2.53	2.49	2.45	2.40
12	4.75	3.89	3.49	3.26	3.11	3.00	2.91	2.85	2.80	2.75	2.69	2.62	2.54	2.51	2.47	2.43	2.38	2.34	2.30
13	4.67	3.81	3.41	3.18	3.03	2.92	2.83	2.77	2.71	2.67	2.60	2.53	2.46	2.42	2.38	2.34	2.30	2.25	2.21
14	4.60	3.74	3.34	3.11	2.96	2.85	2.76	2.70	2.65	2.60	2.53	2.46	2.39	2.35	2.31	2.27	2.22	2.18	2.13
15	4.54	3.68	3.29	3.06	2.90	2.79	2.71	2.64	2.59	2.54	2.48	2.40	2.33	2.29	2.25	2.20	2.16	2.11	2.07
16	4.49	3.63	3.24	3.01	2.85	2.74	2.66	2.59	2.54	2.49	2.42	2.35	2.28	2.24	2.19	2.15	2.11	2.06	2.01
17	4.45	3.59	3.20	2.96	2.81	2.70	2.61	2.55	2.49	2.45	2.38	2.31	2.23	2.19	2.15	2.10	2.06	2.01	1.96
18	4.41	3.55	3.16	2.93	2.77	2.66	2.58	2.51	2.46	2.41	2.34	2.27	2.19	2.15	2.10	2.06	2.02	1.97	1.92
19	4.38	3.52	3.13	2.90	2.74	2.63	2.54	2.48	2.42	2.38	2.31	2.23	2.16	2.11	2.07	2.03	1.98	1.93	1.88
20	4.35	3.49	3.10	2.87	2.71	2.60	2.51	2.45	2.39	2.35	2.28	2.20	2.12	2.08	2.04	1.99	1.95	1.90	1.84
21	4.32	3.47	3.07	2.84	2.68	2.57	2.49	2.42	2.37	2.32	2.25	2.18	2.10	2.05	2.01	1.96	1.92	1.87	1.81
22	4.30	3.44	3.05	2.82	2.66	2.55	2.46	2.40	2.34	2.30	2.23	2.15	2.07	2.03	1.98	1.94	1.89	1.84	1.78
23	4.28	3.42	3.03	2.80	2.64	2.53	2.44	2.37	2.32	2.27	2.20	2.13	2.05	2.01	1.96	1.91	1.86	1.81	1.75
24	4.26	3.40	3.01	2.78	2.62	2.51	2.42	2.36	2.30	2.25	2.18	2.11	2.03	1.98	1.94	1.89	1.84	1.79	1.73
25	4.24	3.39	2.99	2.76	2.60	2.49	2.40	2.34	2.28	2.24	2.16	2.09	2.01	1.96	1.92	1.87	1.82	1.77	1.71
26	4.23	3.37	2.98	2.74	2.59	2.47	2.39	2.32	2.27	2.22	2.15	2.07	1.99	1.95	1.90	1.85	1.80	1.75	1.69
27	4.21	3.35	2.96	2.73	2.57	2.46	2.37	2.31	2.25	2.20	2.13	2.06	1.97	1.93	1.88	1.84	1.79	1.73	1.67
28	4.20	3.34	2.95	2.71	2.56	2.45	2.36	2.29	2.24	2.19	2.12	2.04	1.96	1.91	1.87	1.82	1.77	1.71	1.65
29	4.18	3.33	2.93	2.70	2.55	2.43	2.35	2.28	2.22	2.18	2.10	2.03	1.94	1.90	1.85	1.81	1.75	1.70	1.64
30	4.17	3.32	2.92	2.69	2.53	2.42	2.33	2.27	2.21	2.16	2.09	2.01	1.93	1.89	1.84	1.79	1.74	1.68	1.62
40	4.08	3.23	2.84	2.61	2.45	2.34	2.25	2.18	2.12	2.08	2.00	1.92	1.84	1.79	1.74	1.69	1.64	1.58	1.51
60	4.00	3.15	2.76	2.53	2.37	2.26	2.17	2.10	2.04	1.99	1.92	1.84	1.75	1.70	1.65	1.59	1.53	1.47	1.39
120	3.92	3.07	2.68	2.45	2.29	2.17	2.09	2.02	1.96	1.91	1.83	1.75	1.66	1.61	1.55	1.50	1.43	1.35	1.25
∞	3.84	3.00	2.60	2.37	2.21	2.10	2.01	1.94	1.88	1.83	1.75	1.67	1.57	1.52	1.46	1.39	1.32	1.22	1.00