A Level

Biology

7402/2

Report on the examination

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General Comments

As in previous years, this exam paper proved very effective in terms of producing a wide distribution of marks. Compared to last year, the exam paper was more accessible, and fewer questions were omitted by students. Several of the questions were very good discriminators. These enabled the best students to display their skills across the full range of assessment objectives. There were some excellent responses with students displaying knowledge and understanding across all the assessed topics. There was little evidence of any general misinterpretation of questions. However, in questions 10.1 and 10.4 some less successful responses did focus on irrelevant topics. Some students ignored the guidance provided in some questions on what to include or omit in their responses. This was evident in questions 02.2 and 05.3.

It was pleasing to note that this year, fewer students omitted questions assessing mathematical skills. Apart from question 04.3, at least two thirds of students were able to gain at least one mark on these questions. The imprecise use of scientific terminology continues to be a perennial problem. There were many references to 'results being significant' and confusion between the terms 'chance' and 'probability'. Less successful responses often included incorrect terminology in questions assessing practical skills. This was particularly evident in question 7.

Question one

01.1 This question was a reasonably good discriminator. Approximately two thirds of students obtained both marks and approximately a third, one mark. The biological terms cytoplasm for (1), pyruvate for (3), and NAD for (4) were correctly identified by most students. The most frequent incorrect answer for (1) was mitochondrion. Other incorrect answers included ribosome, chloroplast, matrix and stroma. Incorrect answers for (3) included GP, triose phosphate, lactate and RuBP. Almost invariably NADP was the incorrect answer for (4). Although phosphorylation was frequently credited for (2) a significant number of students incorrectly stated non-biological terms such as 'converted'.

01.2 Approximately 50% of students obtained both marks and approximately two thirds, at least one mark. This was another effective discriminator. The first pair of mark points were most frequently credited. Students described that one carbon dioxide molecule is produced from the link reaction and two molecules from the Krebs cycle. Many of these students then stated that these 'reactions' occur twice, or that two pyruvate are produced per glucose. A significant number of students did refer to mark points 3 and 4 to obtain the two marks for this

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question. These responses were often more concise. Many students correctly used the term 'decarboxylation', however a few mistakenly referred to 'carboxylation'. Less successful responses often confused the Krebs cycle with the Calvin cycle and referred to photosynthetic products and/or six cycles occurring.

01.3 This question was one of the most effective discriminators on the exam paper. Over a third of students obtained all three marks, two thirds at least two marks and almost 90% at least one mark. Many students outlined the role of oxygen as the final acceptor in the electro transport chain. Some students explained that oxygen uptake decreased due to anaerobic respiration taking place. This was not credited. Less successful responses sometimes referred to 'photolysis' not occurring. The decrease in production of ATP was usually explained in terms of less movement of protons/H^+ occurring. However, references to less/no oxidative phosphorylation were also common. Few students referred to less/no chemiosmosis. Some students only suggest that less electrons would move down the chain and therefore ATP production would be decreased. Students often linked the production of ethanol to anaerobic respiration taking place. However, this mark point was sometimes disqualified as lactate or lactic acid was also given as a product. A significant minority of students incorrectly suggested that pyruvate is oxidised to ethanol. A few students did not refer to anaerobic respiration and described pyruvate being 'converted' to ethanol. This response was not credited.

Question two

02.1 Almost 95% of students provided the correct answer of 'homeostasis'. Consequently, this question was a less successful discriminator.

02.2 This question was a good discriminator. Approximately 60% of students obtained both marks and approximately 80% at least one mark. Most students gained mark 2 by describing the loss of water from the body cells by osmosis. A few students stated the alternative for this mark point, i.e. water would enter the blood by osmosis. Some students only referred to 'diffusion' which was not credited. Students often obtained mark point 1 by referring to the decrease in the water potential of the blood. Fewer students gained this mark by referring to an increase in the water potential gradient between the blood and body cells. Some students only referred to 'a concentration gradient.' Less successful responses often focused on the movement of glucose or its conversion to glycogen. Despite the question stating not to do so, a few answers focused on the role of the kidneys.

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02.3 Almost 50% of students correctly indicated 'Activation of cyclic AMP hydrolysis' as the correct answer.

02.4 Almost 90% of students obtained at least one mark on this question and over 50%, both marks. This question was a less successful discriminator. Most students obtained mark point 2 for stating that negative feedback would return the pH (or another variable) to the 'norm', 'optimum' or 'set point'. Several other synonyms were accepted for 'norm'. Fewer students gained mark point 1 by using **Figure 1** to describe how returning to the 'norm' is achieved. Students obtaining this mark often described the response to an increase and to a decrease in pH of the blood. The mark scheme only required one of these changes to be described. Less successful responses usually omitted to state how a change in pH is detected

02.5 Approximately 75% of students obtained at least one mark on this question and approximately 25%, both marks. Mark points 1 and 2 were distributed evenly among responses gaining one mark. Students not achieving mark point 1 often omitted any reference to respiration. A significant number of students gave lactate and carbon dioxide as the products of anaerobic respiration. Failure to gain mark point 2 was often due to students omitting chemoreceptors or ventilation in their answers. Others stated that an increase in carbon dioxide would increases the pH of the blood. Many students described the effect of exercise on the heart rate, which was ignored. Students who obtained both marks used **Figure 1** to clearly describe and explain the changes occurring during exercise.

Question three

03.1 Approximately 80% of students obtained at least one mark on this question and approximately 50%, both marks. Failure to obtain mark point 1 was often due to omitting any reference to 'heat' or 'temperature'. Some students incorrectly referred to burning or incinerating the leaves. For mark point 2, many students did not appreciate the importance of 'a constant mass.' A common incorrect answer was to subtract the final mass from the initial mass. Better responses obtained both marks for concise statements such as 'heat until the leaves remain the same mass'.

03.2 Approximately 50% of students obtained the correct answer for this calculation to obtain both marks. Approximately 25% of students made a single error in their calculation and gained one mark. Many of these students provided an answer of an incorrect magnitude. Another common one-mark answer was 11.4, due to not dividing by 1.5. The other one-mark answers were far less frequent. Students

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who did not gain a mark, often made two errors. Invariably, one of these errors was a conversion error between joules and kilojoules.

03.3 This question was a reasonably good discriminator. There was almost an equal distribution of students obtaining both marks, one mark or zero marks for this question. Mark point 1 was most frequently awarded for showing an understanding of net primary production. Most students did this via an equation. Obtaining mark point 2 proved to be more problematic. Students who did achieve this appreciated that at higher temperatures respiration would increase, or photosynthesis would decrease. Incorrect responses often suggested that the rate of both processes would decrease. Some students simply stated that 'enzymes would denature' or that enzymes for photosynthesis and respiration would denature. Some of the less successful responses focused on transpiration, or on plants attempting to maintain their body temperature at higher temperatures.

Question four

04.1 This question was among the most effective discriminators on the exam paper. Approximately 20% of students obtained all four marks. Approximately 50% obtained at least three marks, approximately 75% at least two marks, and almost 90% at least one mark. Mark point one was the least accessible with most students omitting 'DNA' when describing a change in the base sequence. Mark points 2 and 4 relating to primary and tertiary structures respectively, were most accessible. However, less successful responses often confused base and amino acid sequences. Some students referred to amino acids being 'formed' which negated mark point 2. Although many students realised that bonds would be in different positions, only better responses named these bonds. It was pleasing to see that very few students suggested that 'the active site' would change. These students did not note 'Factor VIII is **not** an enzyme'. The best responses provided concise, detailed explanations which covered all four marking points.

04.2 This question was another very good discriminator. Approximately 5% of students obtained all five marks. Approximately 50% obtained at least three marks and approximately 90% at least one mark. Better responses correctly stated that the overlap in standard deviations (SDs) indicated that the difference in results was significant. This year there were fewer references to 'results being significant'. A few students recognised the overlap in the SDs but then stated that the difference in the results was not significant. There were also several responses which focused on the spread of data around each mean and did not refer to overlap. The fact that only males (or no females) were treated was the most accessible mark point. Reference to 'side effects' was also frequently awarded, often in relation to using a viral vector. Students' interpretation of the

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volunteers being 'at least 18 years of age' varied considerably. Some students incorrectly suggested that all the volunteers were 18 years old or even that adults were not treated. The fact that only severe HA was investigated usually only appeared in better answers. Often, these responses had already achieved the maximum three marks for mark points 4 to 7. Although a significant number of students noted that only one injection was required, some students considered this as being detrimental. This idea was not credited. Again, better responses correctly interpreted this as a positive aspect i.e. weekly or monthly injections would not be required. Very few students commented on the investigation comparing the same volunteers. In fact, many students suggested that there was no control group to compare results with. References to sample size and the length of the investigation were ignored. Some students suggested these were positive aspects of the investigation, others stated the converse.

04.3 It was surprisingly that only approximately 30% of students obtained this mark. The most frequent incorrect answer was 25% or 0.25. This indicated that most students did not include the probability of a son being born in their calculations. This interpretation was supported by many responses which showed the genetic cross used to determine the probability. Other incorrect responses included, 50%, 0.5, 75%, 0.75, 37.5%, 0.375 and 0.

Question five

05.1 Approximately 95% of students obtained at least one mark on this question and approximately 60%, both marks. One-mark answers usually mentioned the contribution of the genotype (or suitable alternatives) to the expression of the phenotype. Less frequently did answers refer to the effect of the environment on the phenotype and omit the genetic influence. Responses that did not obtain a mark simply stated that the phenotype showed the appearance of a characteristic. Occasionally, less successful responses provided a definition of 'proteome' rather than phenotype. Some responses referred to the genetic constitution and environment but did not refer to 'expression' or an equivalent term. These answers were awarded one mark.

05.2 Over a third of students obtained both marks for this question, and almost 80% at least one mark. The most frequent incorrect suggestion was 'mutation'. This response did not take into consideration that the rate of mutation is too low to affect phenotypic ratios. Another, but far less frequent incorrect response was 'independent segregation'. Other incorrect responses included 'immigration', 'selection' and 'genetic drift.' The most frequent correct responses were 'crossing over' and 'random fertilisation', followed by 'small sample size'. 'Epistasis', 'epigenetics' and refence to lethal genotypes were also seen and credited.

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05.3 Not surprisingly, this was among the best discriminators on the exam paper. Approximately 10% of students obtained all three marks. Approximately 30% obtained at least two marks and less than 60% at least one mark. Many students encounter difficulties with questions assessing knowledge of linkage. Mark point 2 relating to crossing over was the most accessible marking point. Most students were unable to provide a clear explanation of what is meant by autosomal linkage. Their definitions usually referred to alleles (unqualified) or traits, rather than to genes being on the same chromosome. Responses referring to alleles of different genes were credited. Some of the less successful responses described alleles on genes. Very few students provided the relative proportions of the different genotypes of gametes. In fact, very few students provided any genotypes of the gametes in the genetic cross outlined. Instead, most students provided details on the relative proportions of the offspring and therefore did not gain mark point 3. The best responses provided an excellent explanation of how autosomal linkage produced the results shown in **Table 1.**

Question six

06.1 Approximately 45% of students obtained both marks for this question, and approximately 90% at least one mark. Most students were able to correctly name part **B** and at least one other structure to gain a mark. The most frequent correct answer for part **A** was cell body followed by dendron or dendrite(s). Incorrect responses included 'axon terminal', 'axon head' and 'synapse'. Although many students recognised part **C** as a 'node of Ranvier', some students simply referred to it as a 'node'. Many different phonetic spellings were accepted for part **D**. Responses not credited included 'myelin sheath', 'nucleus' and other named organelles. Some students confused the correct names for parts **B**, **C** and **D** and scored zero.

06.2 Approximately 10% of students obtained maximum marks on this question. Approximately 40% obtained at least two marks and almost 90% at least one mark. Some students interpreted 'can increase reflex response times' as a quicker response time. These students could still access mark points 1 and 3. Many students appreciated that the destruction of the myelin sheath would result in less saltatory conduction or described why this would not occur. The idea that depolarisation would occur along the entire length of an axon was frequently referred to. Students who correctly interpreted the question often stated that the transmission of nerve impulses would then be slowed down. However, a significant number of students suggested that impulses would travel faster leading to a faster response. Some of these students suggested that the myelin sheath acted as 'an insulator' slowing nerve impulses. Mark point 3 was the least frequently awarded mark point. Usually, this mark point was credited by referring to an effector or less frequently to relay neurones. A common

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misconception in less successful responses was that reflexes only involve the spinal cord. Also, when mentioned, there was some confusion in the location of relay and motor neurones.

06.3 This question was a very good discriminator. Approximately 25% of students obtained maximum marks. Approximately 55% obtained at least two marks and approximately 80% at least one mark. Many students explained that the binding of atropine prevented or reduced the binding of acetylcholine to receptors. Many of these students then explained how this would decrease the heart rate. The mark scheme enabled students to gain full marks if they knew that atropine acted directly on the SAN. This is not on the specification. However, there was little evidence that students knew the mode of action of atropine at the SAN. Invariably, students explained how atropine would act at synapses before the SAN. Nevertheless, relatively few students specifically referred to the SAN to gain mark point 3.

06.4 Approximately 55% of students obtained the correct answer for this calculation to obtain both marks. Approximately 30% of students made a single error in their calculation and gained one mark. Many of these students provided an answer of an incorrect magnitude. Another common error was not to give an otherwise correct answer to three significant figures.

Question seven

07.1 This question assessed skills associated with required practical activity 10 and the use of a choice chamber. Approximately 20% of students obtained all three marks, approximately 60% two marks and approximately 85% at least one mark. All the features outlined on the mark scheme occurred on a regular basis in students' answers. Some responses described three features but did not provide explanations of how they ensured the validity of any conclusions made. Many responses referred to using the same water or gravel as in the stream. Most students linked this feature to providing a natural habitat or to ensuring that normal behaviour would occur. Fewer students explained that this feature ensured that light was the only variable. Very few students linked this feature to controlling the pH or oxygen concentration. Many students appreciated the importance of using 30 shrimps or a large sample size to ensure that the results were representative or reliable. A few students incorrectly referred to accuracy. There was considerable variation in students' explanations of the importance of waiting 10 minutes before counting the number of shrimps. Allowing sufficient time for shrimps to acclimatise or respond was regularly credited. However, a significant number of students simply referred to allowing time to 'move' rather than 'distribute'. The importance of placing the shrimps at the centre of the choice chamber was the least accessible mark point. Only better responses

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mentioned 'so no bias', or 'the same distance to each segment'. A few responses referred to reducing the effect of anomalies. Using layers of black paper to reduce the light intensity was a feature mentioned in less successful responses.

07.2 Approximately 40% of students obtained both marks for this question, and a similar percentage one mark. The most frequent incorrect responses for mark point 1 were 'kinesis' and 'phototropism'. Other incorrect answers were 'positive phototaxis' and 'directional'. Mark point 2 was more accessible with many students relating their answer to predation. However, correct answers referring to 'heat' and 'food' were also seen. Less successful responses were often too generalised such as 'to ensure survival' or 'to obtain more favourable conditions.' Some students suggested the shrimps moved 'to avoid dehydration' or moved towards light, 'for photosynthesis'.

07.3 Approximately 35% of students obtained both marks for this question, and approximately 80% at least one mark. Many students obtained mark point 1. Most null hypotheses clearly stated that the light intensity would have no effect on the movement of the shrimps. Some students correctly referred to no significant difference in the number of shrimps in the different light intensities. However, some null hypotheses were very general without any reference to light intensity. Mark point 2 was awarded less frequently than mark point 1. Most students who obtained this mark referred to categorical data or results. Fewer students mentioned observed and expected results and often these responses omitted the idea of determining a difference. There were incorrect answers which referred to correlation or comparing means.

07.4 This question was a very good discriminator. Less than 10% of students obtained all four marks. Approximately 25% obtained at least three marks and approximately 75% at least one mark. The mark scheme enabled students who misinterpreted the data to obtain two marks for showing an understanding of probability and significance difference. However, very few responses followed this pathway (route B) on the mark scheme. Many students correctly stated that the calculated chi-squared value was greater than the critical value to obtain mark point 1. However, some students did not obtain the mark as they did not give the critical value. Some students provided an incorrect critical value due to using an incorrect degree of freedom. Better responses correctly used the terms probability, chance and significant difference to obtain mark points 2 and 3. However, less successful responses often did not use 'less' or 'more' when referring to probability values. Some of these responses referred to 'results being significant'. Nevertheless, many students stated that the null hypothesis should be rejected to obtain mark point 4. This contributed to almost 50% of the students obtaining at least two marks on this question. The best responses were often concise and detailed, and covered all four marking points.

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Question eight

08.1 Approximately 50% of students obtained the correct answer for this calculation to obtain both marks. Approximately 20% of students gained one mark. One-mark responses were most frequently credited for an answer to the incorrect magnitude, usually 700, or for showing 7.98 or 8. The latter answer (did not divide by 1.14) was also awarded in the working.

08.2 This question was a very good discriminator. Less than 5% of students obtained both marks, and almost 60% at least one mark. Most students who did not obtain a mark simply stated that prokaryotic DNA is shorter or has fewer bases or genes. Invariably, one-mark responses were for mark point 1. Most students referred to prokaryotes not containing introns. The other alternatives for this mark point were less frequently credited. As indicated, less than 5% obtained a second mark by stating that eukaryotes contain (more) regulatory genes. Some less successful responses suggested the presence of histones or membrane bound organelles in eukaryotes make the analysis more difficult.

08.3 Approximately 40% of students obtained both marks for this question, and approximately 65% at least one mark. Most students appreciated that the proteomes of bacteria were related to the proteins produced by bacteria. However, far fewer students used the term antigen(s) to obtain mark point 1. Similarly, there were many general references to producing 'medicines' or 'drugs' to treat disease for mark point 2. However, better responses did specifically refer to the production of vaccines or antibodies. References to antitoxins and antiserums were infrequent. The production of antibiotics was ignored.

08.4 This question was a good discriminator. Less than 10% of students obtained all four marks. Approximately 20% obtained at least three marks, 50% obtained at least two marks and almost 80% at least one mark. To obtain maximum marks students had to refer to all the results in **Table 5** i.e., obtain mark points 1 and 2. Most students incorrectly stated that increasing the number of repeats of the VNTR increased the risk of breast cancer. This statement was ignored. Many students then correctly stated that two repeats decreased the risk of breast cancer and obtained mark point 1. Fewer students obtained mark point 2, usually due to poorly expressed responses. Mark point 3, relating to the limited number of VNTRs investigated, was awarded on a regular basis. Less successful responses displayed a lack of understanding of odds ratios making mark points 1 to 3 inaccessible. However, many students stated that other factors (often named or described) affect the risk of breast cancer. References to the sample size were not always in the correct context. Some students suggested that the sample size was small rather than unknown. Mark point 5, relating to breast cancers not all being the same type, was very rarely seen.

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Question nine

09.1 Approximately 50% of students obtained the correct answer for this calculation to obtain both marks. Approximately 20% of students gained one mark. Interestingly, this mark distribution is similar to that for question 08.1, also a two-mark calculation. Two marks were awarded for an answer in the range 238 to 240. This allowed for rounding at different points in the calculation. The most frequent correct answer was 238. One-mark answers invariably were credited for showing 16 e.g. 0.016. The other two options for one mark were rarely seen. A few students attempted to use the Hardy-Weinberg equation to calculate the answer.

09.2 This question assessed recall of knowledge and was a very good discriminator. Approximately 30% of students obtained two marks and a similar percentage one mark. Many answers focused on what a DNA probe is used for, or on the different methods of labelling a probe. This detail was often at the expense of providing a precise definition of a DNA probe. Many students referred to 'short sections' or 'fragments' of DNA rather than a single strand of DNA. Responses which didn't obtain mark point 2 often omitted either 'bases' or 'complementary'. Less successful responses confused DNA probes with restriction enzymes, sticky ends or a gene machine.

09.3 Approximately 20% of students obtained all three marks on this question. Over 50% of students obtained at least two marks and approximately 75% at least one mark. Most students obtained mark point 1 for correctly completing the 'Parent or child' column on **Table 7.** Many of these students were then able to assign the correct genotype to each lane. Students who did not, often reversed the correct genotypes for lanes 2 and 4. Achieving mark point 3 proved far more challenging. Better responses understood that the recessive allele would travel further. However, only one in five students explained this in terms of the deletion of bases. Almost 5% of students did not answer this question.

Question ten

10.1 Less than 10% of students obtained all three marks on this question. Most students did not obtain mark point 1. Very few students explained that the varied plant community indicated a (large) number or variety of plant species or populations. Approximately 30% of students obtained at least two marks and almost 70% at least one mark. Mark point 2 relating to more niches or more habitats was most frequently credited. It was pleasing to note that very few students referred to 'homes' or 'shelters.' Fewer students obtained mark point 3 relating to a greater variety of food sources. A significant number of students only referred to 'more food' being available which was not credited. A significant

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minority of students misinterpreted this question. The topics covered by these students included, succession, natural selection, speciation, interspecific competition and nutrient cycling. Occasionally, these responses also included relevant details relating to mark points 1 or 2.

10.2 Less than 10% of students obtained both marks on this question and approximately 40% at least one mark. Less successful responses often struggled to give two abiotic factors and often included a biotic factor. When abiotic factors were correctly named, many of the associated explanations lacked detail. For example, temperature was often linked to faster decomposition rather than enzyme activity or a named metabolic process. Water was often associated with providing waterlogged conditions for denitrification rather than with hydrolysis. Other incorrect responses outlined the role of water in photosynthesis, the weathering of rocks and absorption of mineral ions. Although rarely seen, an optimum pH for enzyme activity and oxygen for respiration were credited.

10.3 This question was among the most effective discriminators on the exam paper. Less than 20% of students obtained all four marks. Approximately 40% obtained at least three marks, approximately 60% at least two marks and approximately 80% at least one mark. Most responses did not obtain mark point 1. These responses did not refer to a named nitrogen-containing compound in dead organic matter. However, most students stated that saprobionts were involved in decomposing dead organic matter to obtain mark point 2. Better responses correctly referred to nitrifying bacteria and correctly described their role in converting ammonia to nitrites and then nitrates. However, a significant number of students suggested ammonia was converted into nitrates and then nitrites. Some students described nitrification as a process involving reduction. Less successful responses often confused nitrifying bacteria with nitrogen fixing bacteria. Many students included correct but irrelevant details of nitrogen-fixation and denitrification.

10.4 This question was the most effective discriminator on the exam paper. Over a third of students obtained all four marks. Approximately 55% obtained at least three marks, approximately 70% at least two marks and approximately 85% at least one mark. Mark point 2 relating to organisms changing the environment and mark point 5 for climax community were most frequently awarded. Some students obtained mark point 2 by stating that in secondary succession soil would already be present. Some students omitted pioneer species or simply referred to ‘pioneers’ or ‘colonisers’ so did not access mark point 1. Very few students referred to seeds or spores being present. It was pleasing to note that many students used the correct terminology e.g. ‘less hostile’ for mark point 3. However, a significant number of students referred to organisms rather than ‘species’ and did not obtain this mark. Mark point 4 relating to a change or increase in biodiversity was often credited. Better responses often included all

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five marking points to obtain a maximum of four marks. Some students described natural selection or speciation rather than succession.

10.5 This question was a less successful discriminator. Approximately a third of the students obtained both marks and approximately 80% at least one mark. The most frequent correct answers were growing crops, grazing cattle/sheep and the use of herbicides/pesticides. Ploughing and burning were sometimes awarded. The most frequent incorrect answers were deforestation, planting hedges and the use of fertilisers.

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Mark Ranges and Award of Grades

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