```cpp
#include <iostream>
using namespace std;

int main()
{
    char names[5][10] = {"Omar", "Ibtasaam", "Maaz", "Aryan",
"Rayyan"};
    cout<<static_cast<char>(*( *(names + 2) + 3))<<endl;
    cout<<names<<endl;
    cout<<&names<<endl;
    cout<<*(&names)<<endl;
    cout<<*names<<endl;
    cout<<*( *(names))<<endl<<endl;

    int nums[5][3] = {{1, 2, 3}, {4, 5, 6}, {7, 8, 9}, {10, 11, 12},
{13, 14, 15}};
    cout<<(unsigned long long)nums<<endl;
    cout<<(unsigned long long)(nums+1)<<endl;
    cout<<&nums<<endl;
    cout<<*(&nums)<<endl;
    cout<<*nums<<endl;
    cout<<*( *nums)<<endl;

    int (*ptr)[3] = &nums[0];
    cout<<*( *(ptr+3) + 1)<<endl;
}


Try and understand this program...it will teach you everything on
how arrays store data in the memory
```

Program Overview:

The program demonstrates how multi-dimensional arrays (both character and integer types) are stored in memory. It explores pointer arithmetic, memory addresses, and dereferencing techniques to access elements of these arrays.

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1. Character Array (2D):

Code Block:

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```
char names[5][10] = {"Omar", "Ibtasaam", "Maaz", "Aryan", "Rayyan"};

cout << static_cast<char>(*( *(names + 2) + 3)) << endl;

cout << names << endl;

cout << &names << endl;

cout << *(&names) << endl;

cout << *names << endl;

cout << *( *(names)) << endl << endl;
```

Explanation:

1. **Declaration:**
    - char names[5][10] creates a 2D character array with 5 rows and 10 columns.
    - Each row can hold a C-style string of up to 9 characters (last column reserved for the null character \0).
2. **Accessing a Specific Character:**

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```
cout << static_cast<char>(*( *(names + 2) + 3)) << endl;
```

    - names + 2: Points to the 3rd row (index 2, "Maaz").
    - *(names + 2): Dereferences to point to the first character of the 3rd row ('M').
    - *(*(names + 2) + 3): Moves 3 characters forward in the 3rd row, reaching 'z'.
    - The static_cast<char> ensures proper character output.
3. **Address and Dereferencing Analysis:**
    - names: Pointer to the first row of the 2D array.

- &names: Pointer to the entire array.
- *(&names): Dereferences the pointer to the array, resulting in the same as names.
- *names: Pointer to the first character of the first row.
- *(*(names)): Dereferences to the first character of the first row ('O' from "Omar").

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2. Integer Array (2D):

Code Block:

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```
int nums[5][3] = {{1, 2, 3}, {4, 5, 6}, {7, 8, 9}, {10, 11, 12}, {13, 14, 15}};
cout << (unsigned long long)nums << endl;
cout << (unsigned long long)(nums+1) << endl;
cout << &nums << endl;
cout << *(&nums) << endl;
cout << *nums << endl;
cout << *( *nums) << endl;

int (*ptr)[3] = &nums[0];
cout << *( *(ptr+3) + 1) << endl;
```

Explanation:

1. **Declaration:**
   - int nums[5][3] creates a 2D integer array with 5 rows and 3 columns.
   - Each row contains 3 integers.
2. **Memory Address Exploration:**
   - (unsigned long long)nums: Address of the first row (pointer to nums[0]).
   - (unsigned long long)(nums + 1): Address of the second row (nums[1]). The difference between these two addresses is 3 * sizeof(int) (12 bytes for 3 integers).
   - &nums: Address of the entire 2D array (similar to nums but treated as a pointer to the entire array).
   - *(&nums): Dereferences the pointer to the 2D array, equivalent to nums.
3. **Pointer Arithmetic and Dereferencing:**

- *nums: Pointer to the first row of the array (nums[0]).
- *(*nums): Dereferences to the first element of the first row (1 from nums[0][0]).

4. **Using Pointer to Row:**

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```
int (*ptr)[3] = &nums[0];
cout << *( *(ptr+3) + 1) << endl;
```

- ptr: A pointer to an array of 3 integers.
- ptr + 3: Points to the 4th row (nums[3]).
- *(ptr + 3): Dereferences to get the 4th row.
- *(*(ptr+3) + 1): Moves to the 2nd element of the 4th row, yielding 11.

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3. Key Takeaways:

Pointer Arithmetic:

- **Row Traversal:** nums + i points to the i-th row. Each increment adds the size of one row (in bytes).
- **Element Traversal:** *nums + j points to the j-th column in the current row.

Memory Layout:

- A 2D array in C++ is stored contiguously in memory. For nums[5][3], the layout in memory is:

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```
nums[0][0], nums[0][1], nums[0][2],
nums[1][0], nums[1][1], nums[1][2], ...
```

Address Differences:

- Adding 1 to a pointer increases the address by the size of the type it points to. For example:
  - Adding 1 to a row pointer (nums + 1) moves by sizeof(int) * columns.
  - Adding 1 to a pointer to the array (&nums + 1) moves by sizeof(int) * rows * columns.

Pointers to Arrays:

- int (*ptr)[3]: A pointer to an array of 3 integers.
- Such pointers allow row-level traversal.

Character Arrays:

- Accessing a specific character in a 2D character array requires two dereferences:
    - First dereference points to the row.
    - Second dereference points to the character within the row.

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4. Notes on Casting:

- **Static Casting:**
    - static_cast<char> ensures correct type interpretation when dereferencing character pointers.
- **Unsigned Casting for Addresses:**
    - (unsigned long long) is used to display memory addresses as integers to prevent ambiguity.

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5. Summary Table of Outputs:

Expression	Description	Example Output
names	Pointer to the first row of names.	Address of names[0]
&names	Pointer to the entire 2D array.	Address of the array
*names	Pointer to the first element of the first row.	Address of 'O'
*(*(names + 2) + 3)	Specific character in the array (row 3, column 4).	'z'
nums	Pointer to the first row of nums.	Address of nums[0]
(nums + 1)	Pointer to the second row of nums.	Address offset by 12 bytes
*(*(ptr + 3) + 1)	Value at 4th row, 2nd column.	11